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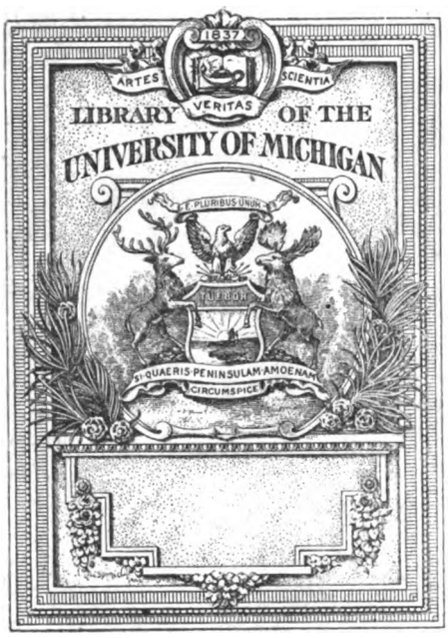

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THE

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NOTES.

Pacific Cable Conference.—The delegates to the conference on the Pacific cable question resumed their deliberations at the Colonial Office on Tuesday. Their Christmas holiday has therefore been a short one, and on reassembling they at once proceeded with the consideration of the report.

Forthcoming Events.—Readers of the *Electrical Engineer* are to have four more pages than hitherto, and as a result of this—one need not enumerate the connecting links, but convenience of printing comes in—these notes will have to be closed at a slightly earlier hour. It will therefore be better that the usual note on "Forthcoming Events" should disappear from its accustomed place and the equivalent information should be given in some form or other in another part of the paper.

Moving Pictures.—The chronophotographer, which is the invention of a Mr. G. Demeny, is yet another of the animatograph and cinematograph class of instruments. It is claimed for it that it can be worked without an arc light in the lantern—which will hardly recommend it to electricians. It would seem, however, that the new apparatus has not done anything to get rid in the projected picture of the flickering which occasionally proves a little trying to the spectator of "animated photographs," and which is, so far as the writer can see, likely to be an inevitable drawback in all work of this class.

Lectures to Teachers.—Prof. Fleming is to hold a free course for teachers on Saturday mornings at University College, Gower-street, on electricity and magnetism, commencing on Saturday, January 16, and Prof. Capper will hold a free course for teachers on Saturday mornings at King's College, Strand, on the theory of machines, commencing on Saturday, January 16. In connection with these lectures it has been announced that early application should be made by those desiring to attend to the professors who are delivering the courses, the number of available places being limited.

Glow-Worms.—A Japanese scientist, Mr. Muraoka, believes that he has discovered that glow-worms give off a radiation which is more paradoxical in its behaviour than any of the "invisible lights"—Röntgen, Becquerel, or other—that have been hitherto discovered. From what particulars are available, however, it looks as though another explanation of the matter were feasible; and the experiment cannot be checked or repeated just at present, anyway. The visible light from glow-worms has no special peculiarities, and from what the writer has seen does not even present a particularly interesting spectrum. There is, however, a French observation—which also requires repetition—that the light of a glow-worm will affect a sensitised plate through paper opaque to ordinary light.

The Victorian Exhibition.—A correspondent has written to the *Times* suggesting practically that the London Exhibitions Company should let the Earl's Court premises to a committee so as to have "a really high-class national exhibition on the lines of those of 1851, 1862, and some of the subsequent special exhibitions at South Kensington." The difficulty is that the sort of exhibition the correspondent wants is not supposed to pay as well as the sort he does not want. Who, then, is to make up the difference to the shareholders? Moreover, no exhibition of the class of 1851 and 1862 is of any use unless it is better and bigger than all previous exhibitions. And even if it had not been long ago decided to have no more of that sort of exhibition in this country, there would not now be time to get up a decent one by next May.

City Churches and Electric Lines.—The City Churches Preservation Society has held a preliminary meeting, at which Mr. H. C. Richards, M.P., presided, to organise an opposition to any interference with St. Mildred's Church, in Bread-street, for the purposes of the electric railway. Useless as is the preservation of everyone of all the empty churches in the City, it would be unreasonable to complain of the society for fulfilling the object of its existence—at least, they have begun at the right time. The City and South London had a distinct grievance against them in connection with St. Mary Woolnoth, since they were allowed to think that all interests had been settled with and all objections appeased before the society seriously took up the opposition which caused the company so much trouble and expense in connection with that edifice.

Brooklyn Bridge.—According to the *Electrical Age*, the substitution of "motorcars"—*i.e.*, electric engines—for shunting the trains running across the New York and Brooklyn suspension bridge has been a great success. The trains on the Brooklyn Bridge are now entirely operated by electricity, and the noisy, puffing, little steam locomotives in use since the first train was hauled across the bridge have been at last discarded. The change was effected on November 30, when 12 motorcars were put into service, operating the trains in conjunction with the cables more quickly, quietly, and more satisfactorily than the steam motor. Fourteen motorcars are now in service, and the remaining six car equipments are being installed as rapidly as possible to be put into service as soon as completed. The rolling-stock is fairly heavy considering the work it is designed for; and that the electric locomotives should supersede the steam one at shunting and starting work is a distinctly favourable augury for its use all along the line.

A Long Fall.—The following clipping from the *Liverpool Echo* (the hero of it is a Liverpool man) has been sent us with a request for insertion: "On Wednesday, December 23, an electrician named Robert Foulds was lighting up the decorations outside the establishment of Messrs. Henochsberg and Ellis at Islington. The ladder slipped, through the slippery state of the pavement, and the electrician fell from the third-storey windows. He shouted to the crowd of spectators viewing the windows, thus giving them a chance of getting out of the way of the falling ladder. He made a grab at the iron stays of the arc lights, and in missing that his arm fell across the rope of evergreens hanging from one arc to the

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other. Resting there a few seconds he, seeing the way clear, then jumped to the ground, a distance of about 15 yards, and landed on the pavement, receiving nothing worse than a shake." Foulds is considered by our correspondent to deserve congratulations on his escape. We can only envy him his luck or skill in the art of tumbling some 40ft. or 50ft. without injury.

Stamboul and Stupidity.—Some people call his Imperial Majesty the Sultan of Turkey a "great assassin." Others say that he is fond of electricity, and has a toy electric launch, but is afraid of overhead wires. Nobody seems really to know much about him, but everyone agrees that all things are not as they should be throughout his wide dominions. The latest Turkish outrage has, however, been discovered, or at least pointed out, by Mr. G. G. M. Hardingham, of 191, Fleet-street. That gentleman, in a letter to the *City Press*, goes so far as to say deliberately "that, as the result of the 'Palace' interference with the administration in Turkey, patents for inventions which relate to the production of electrical energy, or in which electricity is in any way employed, are refused. The only explanation afforded by the Turkish authorities is that orders have been received 'from the Palace.' Of course, the fees paid on application are retained." Perhaps Oriental ignorance in an intermediate official and a misinterpretation of the fear of overhead wires may have something to do with it. The giving a patent and taking a fee is an operation too much to the taste of a Turkish official for him to discourage fee-producing applicants of his own mere motion. However, until the government and administration get altered in that country a Turkish patent is not a very valuable property any way.

The Go-Ahead Foreigner.—Mr. Walter Dixon has been reading a paper before the West of Scotland Iron and Steel Institute at Glasgow on the subject of "Applications of the Electrical Transmission of Power." Mr. Dixon said that in France, Belgium, and other Continental countries there were few works of large size in which they were not adopting electrical machines. In America, too, electric working had made very rapid progress. Then, of course, Niagara Falls were referred to. While we as a nation were thinking and wondering whether the ideas were really practical, other nations were going ahead and taking advantage of us. In those countries where modern methods of driving and of the transmission of power were thoroughly understood there seemed to be no question that electric driving was preferable to other methods, and this should be kept in mind by those in this country who were erecting new works or extending old ones. There is, of course, much truth in this view, but then, again, if we pioneer it is absurd to grumble because foreigners following after us by avoiding the mistakes inevitable to a first piece of work, and adding a few small and obvious improvements, are able to produce the same result at a slightly reduced cost. Of course, we should pioneer, but it is just as well to get your design settled and your quantities worked out before you begin erecting. Mr. Dixon, of course, does not think otherwise, but there are some of us that seem in danger of erecting into a dogma the theory of our national inferiority to everybody in everything.

An Electric Tramship.—The spick-and-span toy ship built to run on wheels across the nursery floor is a present which occasionally takes the eyes of fond parents, but the well-constructed boy throws it away very speedily in favour of the roughest toy boat that will really swim. In America, however, they have constructed a toy land ship big enough to run upon an electric tramline. The *Chicago Times Herald* gives an account of the strange craft, and says that "the people of Chicago, Philadelphia, New York, Cincinnati, St. Louis, and Pittsburg, and even San Francisco, need not be at all surprised if they see some fine morning a big cruiser ploughing along down the principal street." Though there are plenty of large craft there they do not know much about men-of-war on the great lakes, but it is a little difficult to imagine what our Western contemporary would consider a small cruiser if a big one can be got on an ordinary tramline. The tramship is named "President-Elect McKinley," but the idea of a ship on land is in such close mental connection with a fish out of water, that the compliment seems to European eyes to be somewhat of a doubtful one. The ship is got up as a complete man-of-war, and some of the papers have even discussed her fighting properties in cases of street riot or other disturbance. It might possibly occur to the rioters to interfere with her navigation by cutting the trolley wire or blocking the line. But there are doubtless people who would pay to take pleasure rides in this queer craft; and in the last resort, sweet are the uses of advertisement. Her builders probably know what they are about.

The Davy-Faraday Laboratory.—Dr. Mond's new laboratory at the Royal Institution will be open for research work after the 18th inst. The object of the laboratory is the promotion of original research in pure and physical chemistry, and under the deed of trust workers in the laboratory are entitled, free of charge, to gas, electricity, and water, as far as available, and, at the discretion of the directors, to the use of the apparatus belonging to the laboratory, together with such materials and chemicals as may be authorised. Any person desiring to use the laboratory for the purpose of conducting a research must send to the directors evidence of scientific training and previous experience in original research, along with a statement of the nature of the investigation he proposes to undertake. Application should be made in the first instance to the assistant secretary, Royal Institution, from whom further information on the subject of the purposes for which the laboratory is available will be forthcoming. The directors are Lord Rayleigh and Prof. Dewar, and the superintendent of the laboratory is Dr. Alexander Scott. As this is the only institution of the kind in existence, it may reasonably be anticipated that the directors will have somewhat of a task to decide between the applicants desiring to use the facilities offered. Should these prove very numerous, the position will be one of some delicacy since not only are there no precedents to fall back upon but there is the consciousness that, besides what is actually accomplished there, the working of the Davy-Faraday laboratory may have indirectly most important effects on the future of science, since a few years of conspicuous success there would almost certainly serve to turn some portion of the stream of public beneficence into the direction of similar institutions and the much desired endowment of pure research.

Du Bois-Reymond.—The death last Saturday of Dr. Emil du Bois-Reymond is a severe loss to the University of Berlin and to German science. As might be conjectured from his name, du Bois Reymond was not of German ancestry, though by birth he was a good enough Prussian. As a matter of fact he was born in Berlin in 1818 of French-Swiss parents, and studied at the Berlin University, of which he afterwards became a distinguished professor. In science, of course, he was primarily a physiologist, but in Germany, as the classical example of Helmholtz shows, there does not seem to be that uncrossable gulf between the physicist and the physiologist which there is in this country. Under the tuition and influence of J. Müller,

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Du Bois-Reymond devoted himself to an investigation of the phenomena of animal electricity, and utilised the results of his researches to discomfit the vitalist school of physiologists, and joined Helmholtz and Mayer in the task of showing that all biological phenomena, when thoroughly investigated, were found to be as obedient to physical and chemical laws as the phenomena of non-living matter. Du Bois-Reymond also did good work in popularising a knowledge of the methods, aims, and results of modern science. While ready to protest against some of the crudities of Haeckel and the "monists," he did not fail to impress upon a public which is prone to imagine that "philosophic doubt" has something in common with practical uncertainty, that although the man of science is ready to confess that he is yet in darkness upon many matters, yet his darkness is brilliant illumination compared with those of his opponents who would confine scientific results within the narrow limits of a philosophy which is the outcome of times and men ignorant alike of the very alphabet of the laws of nature and of thought. Du Bois-Reymond had been professor of Berlin University since 1855.

Education.—There is always a danger of any discussion on education developing into a partisan squabble between the advocates of modern languages and those of elementary physics and chemistry, or even the teaching of handicrafts. The latter have been most conspicuous lately, but now the Modern Languages Association has had a field day. Sir John Lubbock was got to give a qualified assent to the teaching of Hindustani and Chinese—that is to say, "it would be absurd to suggest that Hindustani or Chinese should be taught in all schools, but it would be very desirable that they should be taught in some." How many of the advocates of Chinese, it may be wondered, know how long it takes to learn to write that language, or, when it comes to speaking, it how many mutually incomprehensible pronunciations there are among the common folk? The sort of people that talk in an airy way about other people learning Chinese and Hindustani are seldom even capable of pointing out on a map of India those districts in which Urdu is understood, and those in which it is about as useful as Portuguese would be at Moscow. Meanwhile, the headmasters are protesting against the "congestion of subjects" in the modern educational curriculum, and the *Times* is satisfied that "the old classical training is the best training." We have the "key" argument for Latin and the beauties of Greek, only the man with the key never seems able to unlock the door and converse with a foreigner, or even read a German scholar in his own tongue, while as for Greek, few, save schoolmasters, remember much of it after 25. Sir John Gorst, speaking at Bristol on the same subject, has said that "at first there is not very much difference between a baby and a monkey, but in a short time the monkey will be jumping about trees grinning, while years elapse before the child's powers become fully developed." This appears to have terribly shocked the *Daily News*, which is distinctly old-fashioned in many of its notions. But nobody seems to have seen that the true moral of the fact is that the best education in the world is no use whatever as a substitute for innate mental capacity.

Christmas Lectures.—It is curious that the Christmas lectures to children at the Royal Institution and at the London Institution, which began on Tuesday, should in each case be on light and in each case be delivered by an electrical man. The lectures are not, of course, attended solely by children; indeed, some preliminary education is necessary before at any rate the explanation of the experiments could be really comprehensible. Of course, with Prof. Silvanus Thompson, with all the resources of the Royal Institution at command, there are bound to be any quantity of pretty experiments. Among the prettiest were those illustrating internal reflexion, and in the multiplication of objects by means of mirrors set at various angles. A sector of Christmas cake got multiplied in a most tantalising manner. The use of a photometer was also shown in some detail. The Japanese magic mirrors were exhibited, reproducing from their polished surface the markings on their backs. The lecturer explained that this was due to the method of manufacture. The mirrors, made of bronze, had certain crests and images in relief on the back. When the polished front is being made, scraped with iron and severely scoured, the thicker parts offered more resistance than the thinner, and the result was a delicate hollow tracing of the back on the polished surface. This had been reproduced in modern times by etching on a plate of bronze and then polishing off, and even if the polishing continued for an hour after the etching had become invisible to the eye, the reflected light showed up the original sketch. So much for Albemarle-street. At Finsbury-circus the course is much shorter, so that Prof. Fleming has to cover much more ground on each afternoon. He dealt very much in optical illusions produced by reflection and showed some very beautiful kaleidoscope combinations. That instrument was once a common toy, and, moreover, might occasionally not be without use in the suggestion of formal patterns, but it seems now to have fallen into complete oblivion.

A Curious Suggestion.—A contemporary of very high authority has described the motorcar in its present stage of evolution as little better than "a gas-engine in a cart," and at times it seems that the gas, or rather benzine vapour, engine is apt to prove an unpleasant companion for the other occupants of the vehicle. Mr. A. J. Allen, writing from the London Institution, has suggested getting over the difficulty in a curious way. In his own words: "We will place on our carriage an electric motor working on to the axle by the usual gearing, and then, for the purpose of supplying a current to it, we will provide a compact oil-engine turning a dynamo; but, instead of mounting these latter on the carriage itself, we will place them in a separate tender attached to it behind, which tender they may shake as much as they please without disturbing the occupants of the carriage." He further suggests a storage battery as a reservoir of energy, and adds there "will be loss of power as compared with that of an oil-engine acting directly on to the carriage axle, but, as a set-off to this, we have complete absence of vibration, protection of the engine from dust and mud, a reservoir of power to draw upon, and readiness to start at a moment's notice." After the continuous and prolonged fuss that has been made in France over the Heilmann locomotive, it would be rash to simply scoff at a combination of this sort, so the writer will simply add two suggestions on his own account. The first is, that in the country, where there is little traffic, Mr. Allen should not couple up his engine-dynamo truck close, but trail it on a tow rope as far behind as he dare, taking the current, of course, through a cable, and that in towns and places where they supply a continuous current he should load his truck with storage cells and leave his oil-engine at home in the backyard. To a man that is prepared with a light heart to add the cost of a dynamo, motor, and appendages to the already by no means trifling sum asked for a motorcart, expense is evidently no object.

The District Rail.—It may be noted that the Bill deposited for next session by the Metropolitan District Railway Company not only covers the proposed electric lower level fast traffic line, but also gives the company

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power to apply electric working to any or all parts of the company's existing system. That this will be done sooner or later, at any rate for all those portions of the line which are in almost continuous tunnel, there can be little doubt. There is, indeed, no other thorough solution of the ventilation question possible. Nevertheless, assuming that the company get their Bill through all right, it may be taken that there is a good deal to be done before we shall have electric locomotives drawing clean brightly-painted trains through whitewashed tunnels. That is, of course, the form which the thing will have to take, since the "foreign" companies will certainly never consent to give up their running powers over just that portion of the line where some form of traction is wanted which does not fill the tunnels with steam and pollute the air with unbreathable gas; it will be trouble enough for the District Company to arrange to have their trains drawn by electric locomotives. Now, the type of electric locomotive for this kind of work has yet to be worked out. Even in such a well-understood matter as the ordinary railway rolling-stock a great mistake was made when from the commencement the Metropolitan and District rolling-stock was made of almost the heaviest type then known in railway practice, instead of the lightest—a matter of the very greatest importance where most of the journey is starting and stopping. And there is this existing stock to be disposed of. *Chi va piano va sano*, and however anxious we may be to see the application of electric working to ordinary railways tried on a line where more than any other its qualifications should secure it an immediate success, it is impossible to doubt that the District Board will be perfectly right not to proceed in too great a hurry, and so risk a failure, not because the principle is bad, but because the details are not properly worked out. Up to the present all our experience in electric railway work has been with short trains on light lines, and at comparatively slow speeds.

Royal Society of Edinburgh.—Considerations of space and time prevented justice being done last week to the meeting of the Royal Society of Edinburgh, at which the president (Lord Kelvin) made a communication on "The Electrification of Air by Röntgen Rays," the outcome of experiments which have occupied his attention, along with that of Dr. Beattie and Dr. Smolan, since the end of October last. The primary object of their investigations was to test the effect of Röntgen rays upon electrified air, and to see whether or not the Röntgen rays had any electrifying effect on air. A lead cylinder 76cm. long and 23cm. in diameter, with the ends closed with paraffined cardboard, was used in the experiments, the cardboard being, of course, transparent to the Röntgen rays and an insulated electric filter connected to an electrometer. Air drawn through indiarubber tubing from the quadrangle of the University of Glasgow outside the laboratory, when submitted to the action of the radiations, was found to be negatively electrified when no screen (or an aluminium screen) was used, and either not electrified at all or only slightly negatively when a lead screen was used. (Aluminium is, of course, transparent and lead opaque to the radiations.) When the radiation tube was removed or stopped, and air pumped through the apparatus, no deflection was observed on the electrometer. In the earlier experiments, in which the air of the room was used, evidence was found of disturbance due to electrification of the air of the laboratory by brush discharges from electrodes between the induction coil and the radiation tube, and from sparks at the induction coil. There was also found a very decided electrification of air—sometimes negative, sometimes positive—when the Röntgen rays were sent across a glass tube or an aluminium tube, and the air pumped through from the quadrangle to the filter. A primary object of the experiments was to test whether air electrified positively or negatively lost its charge by the passage of Röntgen rays through it. An affirmative answer to that question was soon obtained, but it was found that positively electrified air not only lost its positive electricity, but in some cases acquired negative electricity under the influence of Röntgen rays, and it was thus that the experimenters were led to investigate the effect of Röntgen rays on air unelectrified to begin with. In carrying out the experiments, Lord Kelvin added, they found it absolutely necessary not only to surround the electrometer with wire gauze in the usual manner, but they had also to place it on a sheet of lead, and to surround the side facing the Röntgen lamp with lead, too. In some cases it was even necessary to cover up the whole with paper to prevent the electrified air of the room from disturbing the instrument. A physical interpretation of these results is not easy at present.

Block Signalling.—In Mr. Pigg's series of articles on block-signalling apparatus which has just come to a conclusion in our columns, attention is called to the fact that the best mechanism, the working of which depends entirely upon the memory, skill, and attention of a signalman, cannot ensure absolute safety. It may be possible to devise perfect machinery, but it is not possible to find perfect men, not even (with due deference to certain people) by limiting them to an eight hours' shift. The following two reports of the Board of Trade inspectors supply a practical comment on the matter. The first is one from Lieut.-Colonel Addison, R.E., and relates to a collision that occurred on November 19 near Tottenham North junction, on the Great Eastern Railway. In this case, after a main-line passenger train to Liverpool-street had passed Tottenham North junction signal box it ran into a shunting engine with the loaded trucks attached, which had been let out of the up sidings on to the up main line a few minutes previously. Lieut.-Colonel Addison says that the collision was due to a blunder made by the signalman on duty in the North junction cabin in carrying out an ordinary shunting operation. At 8.59 a.m. the signalman sent an engine and nine loaded trucks out of the up sidings on to the up main line, but he did not then pull over the cross-over road points for the goods train to go across to the down line and its destination. Just at this time the signalman in the station cabin gave him "Is line clear?" for an up passenger train, and he at once offered it on to, and got it accepted by, the South junction cabin; upon which, at 9·2, he gave "Clear' to the station cabin and released the starting signal at the station, at the same time pulling off his own up home signal, entirely forgetting that the goods train was on the line. The report adds that the fact that a signalman of great experience, and bearing a very high character as a careful and reliable man, could accept a train in entire forgetfulness of having placed a goods train on the line only two minutes previously is very strong evidence of the desirability of adopting means for putting it out of the signalman's power to err in this way. The second report is by Major Marindin, and relates to an earlier collision which occurred on October 29 near the Surrey Canal Junction on the South-Eastern Railway. A down train from Charing Cross to Greenwich and Woolwich ran into the tail of the preceding train, the down train from Charing Cross to Maidstone. Major Marindin finds that the accident, which occurred during a partial fog, was due to a failure of block working between Corbett's-lane and Surrey Canal Junction signal-cabins. He cannot decide which of two particular signalmen was to blame, and he comments on the fact that

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each signalman's booking-boy supported the evidence of his master. Major Marindin recommended the South-Eastern Company to consider the desirability of adopting one of the systems of "lock and block" working in use on several suburban lines.

The Junior Engineers.—At the last meeting of the Institution of Junior Engineers, held at the Westminster Palace Hotel on December 18, the chairman, Mr. H. B. Vorley, presiding, a paper was read by Mr. P. W. McDougall, A.I.E.E., on "Electric Central-Station Working." The paper was in some respects a description of how they did things at Deptford. The author began with a reference to the choice of a suitable site for a station. This depended much upon whether the system to be adopted was high or low pressure, and on the cost of obtaining the daily supplies of fuel. Low-pressure stations had to be close to the consumers, but those of high pressure could be placed right away on inexpensive ground, and with a river frontage. This was a great advantage for the latter, not only from the fact that any quantity of water could be obtained for condensing purposes, but also on account of the facility with which water-borne coal could be brought to the station. As to boilers, Mr. McDougall thought the marine type most suitable for an electric supply station, where quick steaming was an essential quality. A marine boiler saved a large amount of space compared with several kinds of boilers of equal evaporative power, and it also needed to be less frequently cleaned. The boiler often met with in electricity works was of the water-tube type, but for several reasons it was unsuitable, especially where the feed-water was bad, as in that case frequent cleaning was necessary, and the cost of maintenance was a very heavy item in the running expenses of the station. In certain feed-waters there were many impurities which combined to form very hard corrosive scales, the hardest being that produced by magnesia. A dangerous scale also was that created by cylinder oil carried with the exhaust steam into the hot-well and fed back into the boilers again; the oil formed a greasy scale on the boiler plates, and, being non-porous, although soft, prevented the water from coming into contact with the plates, resulting in their overheating and giving way under pressure. Owing to the fact that these impurities behaved very differently when subjected to high temperatures, and also that it was by no means an easy matter to perform experiments with water when under the normal working conditions of a boiler, chemists could only surmise the exact amount of disintegration and combination of the several impurities contained in water. As to engines, electric light engines used to drive alternators should have as even a turning moment on the crankshaft as possible so as to ensure satisfactory parallel running, and the author went on to say that the latest addition to the Deptford station of the London Electric Supply Corporation, which was designed by Mr. P. Walter d'Alton, engineer-in-chief, had this quality in a very high degree. It was a direct-coupled plant. The engine consisted of three separate compound engines, with cylinders tandem fashion on a three-throw crankshaft with cranks at 120deg. The alternator was of the Ferranti type, and generated 100 amperes at 10,000 volts at a speed of 150 revolutions per minute. The design of the armature, which was built on to the rim of a wheel 16ft. diameter, was very open, and therefore gave plenty of ventilation and ensured cool running. The governors were either of the throttle or expansion type. The expansion governor was perhaps more generally the practice in electric light stations, but although the throttle governor was often considered not at all suitable for electric light engines, where steady governing and economy were such important matters, it had been adopted in some stations with very satisfactory results, especially when the engines were non-condensing. Whatever the type of governor used, it was a matter of first importance that all the governors should have as near as possible the same range of sensitiveness. If an engine had a governor which allowed a variation of 1 per cent., another of 2 per cent., then when put into parallel the one would work against the other, and the load would not be divided evenly. Consequently great unsteadiness of the light would result, and perhaps failure of the dynamos. Alternators could be excited either by small continuous-current dynamos driven by separate steam-engines, or by ropes from the alternator shaft, or by a rectified current from the alternator. The rectifier method had not proved an unqualified success, the regulation not being satisfactory, a slight variation in the speed of the engine producing a very considerable variation in the voltage of the alternator. The exciters were often a weak part of an alternating station. There should be one for each alternator, and should not run in parallel on to a 'bus bar; and in the author's opinion should be driven by ropes off the alternator shaft and made of ample size, so that the exciting system may not need any special attention on the part of the engineer in charge. With regard to the mains and their insulation, paper saturated with ozokerit or resinous oil had given very satisfactory results in high-tension work. Ozokerit as a dielectric was developed by patents of Mr. S. Z. de Ferranti, whose concentric armoured cable insulated with waxed paper had been in use some time by the London Electric Supply Company to transmit the current from Deptford to London at 10,000 volts. The switching gear of a large central station was generally rather complicated, and in a high-tension station the switches had not only to be sure in their action of "breaking" the current, but great care had to be taken that they were well insulated, so that the operator was not endangered. The high-tension switches at Deptford, which had been redesigned by the company's own engineers, consisted of a long light gun-metal arm worked by a lever of the signal-box pattern. The "break" was 4ft. 6in., and being high up overhead, perfect safety was assured. There had been no difficulty in "breaking" the current with the machine working at full speed—*i.e.*, 100 amperes at 10,000 volts—and also on a short-circuit. Owing to certain effects due to the capacity and length of the trunk mains from Deptford, it had not been possible to put on a main or withdraw it suddenly by pulling off a plug without producing a variation in the voltage on the system. But this had been successfully overcome by an arrangement suggested by Mr. G. W. Partridge, of the London Electric Supply Corporation. The main was connected to the 'bus bar through high inductive resistance, and was gradually charged to the required potential by reducing the induction. As soon as the potential on the main was equal to that of the 'bus bar, then the main plug was inserted and the discharger disconnected. The reverse operation was performed when it was necessary to withdraw the main from commission. Arc lamps supplied by Ferranti rectifiers were perhaps the most practicable and efficient method of lighting on alternating-current systems. Very satisfactory results have been obtained in several provincial towns with street-lighting carried out in this way. In the discussion which followed the reading of the paper Mr. F. W. Crawter, Mr. H. J. Fraser, Mr. G. C. Allingham, Mr. A. W. Marshall, Mr. L. G. Ferreira, Mr. W. Powrie, Mr. J. H. Millen, and the chairman took part, and the proceedings concluded with the usual vote of thanks.

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PROGRESS IN ELECTRICAL ENGINEERING.

BY ALFRED HAY, B.SC., A.I.E.E.

Probably no other branch of applied science has ever advanced with strides as rapid as those which have characterised the progress of electrical engineering. To some extent this may be accounted for by the fact that whereas most other branches of industry had their origin at a remote date of human industry, electrical engineering came into existence at a time when the spirit of scientific enquiry had already become a dominant factor in shaping human progress. It is, like many another industry of recent date, the direct result of scientific research. Electrical engineering without a scientific foundation is an anomaly, an impossibility.

To an outsider, the marvellous growth of the new industry is somewhat difficult to realise. The time is not far back when dynamos were regarded with curiosity, and an arc light excited a feeling of wonder. The extraordinarily rapid development of electric lighting does not seem to have been brought home to the mind of the general public. Large central stations for electric lighting and power distribution are a growth so recent that we have not yet ceased being told that "electricity is in its infancy," a saying repeated so often that it is apt to excite a feeling somewhat akin to nausea. At this time of day, indeed, when millions of pounds are invested in costly electrical plant it seems somewhat late to be made the recipient of this startling piece of information. Nevertheless, the saying has a moral of its own; it indicates a development so rapid that the mind of the general public has been unable to keep pace with it. What was new some three or four years ago is pretty well matter of ancient history to-day.

In surveying the rapid growth of the electrical industry, it may be said that development has proceeded along certain well-defined lines, and that along many of these a very advanced state has been reached. Early in the century we had the discovery of the electric arc, which first rendered electric lighting a possibility. Then came the development of the dynamo, by means of which the production of currents on a commercial scale was rendered possible; and the introduction of the incandescent lamp solved the difficulty of "distributing" the electric light. For a time, however, the high hopes which had been entertained regarding electric lighting were doomed to disappointment. A large number of companies, formed somewhat prematurely, came to an untimely end, and a reaction set in. Meanwhile, those who were capable of seeing somewhat more clearly than the promoters of ill-starred companies did not despair of the problem they had taken in hand. During the years of comparative inactivity which intervened between the first spasmodic efforts to introduce the electric light as a general illuminant and the subsequent successful solution of the problem, the dynamo received such careful study and attention as transformed it from a somewhat crude optician's toy into a substantial engineering structure perfect in every detail, and possessed of an efficiency which few other machines could boast. The calamities which overtook the earlier companies cannot, therefore, be looked upon as having produced wholly undesirable results. They prevented the introduction of machinery which eventually would only have retarded the progress of electrical engineering.

The last decade has witnessed the establishment of central stations in all the more important towns throughout the United Kingdom. Something still remains to be done (in some towns, at any rate) towards rendering the supply pressure between the distributing mains somewhat more constant than it is at present. The price charged per supply unit will also probably be reduced when further advances have been made in dealing with the inconvenience caused by the peaky nature of the load curve. It is to be hoped that with a more general use of electric motors this latter difficulty will be to a large extent overcome.

Electric traction and the applications of electricity to chemical processes have up to the present not received in this country the full share of attention which they seem to merit, and during the next few years we shall probably witness considerable progress in these directions. The same remarks apply to power distribution by multiphase alternate-current motors.

It is easier to look back upon the past than to peer into the future. Yet one cannot but help looking forward to many important changes which future inventions and discoveries will work upon present-day practice. Looming large above all other problems is the one which is already engaging the attention of many able workers—the problem of "electricity direct from coal." It is probably rash to say that the day is not far distant when electrical energy will be got by the direct oxidation of carbon, and with an efficiency of conversion which will altogether outstrip all present-day indirect methods, in spite of all the sensational announcements of too sanguine inventors and the jubilant articles singing their praises (somewhat prematurely) in popular monthlies. But although we have not yet learnt *how* to do it, we have, at any rate, gained some knowledge as to how *not* to do it, and future workers will at least have some beacon lights to guide them in their arduous task. The quest is a difficult one, but the prize is high, and we can only hope that there will be found a Sir Galahad to whose enraptured gaze will be revealed the secret of what, when found, will undoubtedly prove one of the greatest achievements of modern science.

THE FUTURE OF SELF-CONTAINED MOTORCARS.

BY KILLINGWORTH HEDGES, M.I.C.E., M.I.E.E.

It has of late been the fashion to expatiate on the great development of the steam and gas propelled motorcar, and to consider the electrical type to have been quite put aside by its more up-to-date competitors. The question of self-propelled vehicles has interested me from a very early date, my first practical experience taking place in 1868, when I was directed by Messrs. Easton and Amos, the firm of engineers with whom I was serving my time, to conduct a road-roller, which had been used in Hyde Park, to Rochester for repairs. My readers will think this a very simple task, but road-rollers in those days differed as much from the modern Aveling and Porter type as the bone-shaker differs from the modern safety bicycle. It consisted of a portable engine supported on three enormous wheels, the width being too great to enable it to enter an ordinary gate, and its weight sufficient to seriously damage the bridge over the Serpentine on the one and only occasion when it was allowed to cross. However, with the help of crowbars and sundry planks, the various turnings through the Borough were negotiated, and we arrived, with our boilers empty and steam blowing off, early one Sunday morning in front of a police station at Eltham, and were practically placed under arrest until my fellow pupil, the driver, told the sergeant that he could not answer for the safety of the station unless we were allowed to resume our journey, as the firebox was getting red hot, and there was no means of running the feed-pump unless we kept on the move. I have a vivid recollection of the way we were assisted to fill our tanks by the constable on duty, the sergeant almost beseeching us to go on.

My first run on a motorcar of modern design was in 1878, and those who remember the Blackburne dogcart will endorse my opinion that this invention quite forestalled the up-to-date steam-propelled vehicle of the present day. The Blackburne boiler consisted of a copper tube wound spirally, through which a small quantity of water was forced by a pump to be flashed into steam; after being used in the engine the steam was condensed in a very compact air-condenser, also of tubes through which air was circulated by means of a fan. A petroleum lamp was used for heating purposes, and the engine ran constantly, but without the terrible vibration which is a leading characteristic of the modern gas-propelled car.

With regard to electric motorcars, one was surprised to find them singularly absent in the parade to Brighton, the reason given by those inventors who are working at the subject being that there was no time to arrange for the necessary relay of batteries. I can only say that I rode more than the distance between London and Brighton on the occasion of my visit to M. Bailly some eight years

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ago, and shall not forget my first experience of his electrically-propelled vehicle. I was met at the station, some 20 miles from Paris, by M. Bailly's coachman or motorman, who put my luggage into a very stylish dogcart, which had the usual appearance, but in place of the quadruped in the shafts a small steering-wheel was fixed, to which were attached a pair of reins. These the man placed in my hands, after showing me how to start the motor by pressing my foot on a pedal, and stop it by removing the pressure. We made a good start, but did not negotiate the station exit very cleverly, and in the village found that working a steering-wheel by reins was a far harder task than driving a horse—in fact, our course was like the load curve of an electric tramway generating station—and I was relieved to find M. Bailly waiting outside the village. Several of these vehicles were made, and, as far as the accumulators were concerned, gave no trouble at all. The cells were of celluloid, shaped something like bottles; these were dropped into holes in a wicker basket similar to those used by wine merchants and slid under the seat. To my knowledge the batteries were not recharged during the next two days, when we took long drives into the country.

After a careful investigation of the systems which have been recently exhibited, I have great confidence in electrical motors for pleasure carriages, but for vans and vehicles to take heavy loads steam appears to be most suitable; and when a history of the motorcar industry is written, I hope that the honours will be given to Mr. Blackburne as the pioneer of the modern steam-driven carriage, and I think it would be a graceful act if those gentlemen who have taken up the subject commercially and boomed almost every foreign invention would recognise our English *confrère*, who, although in his eighty-sixth year, is still hale and hearty.

SOME FURTHER NOTES ON THE USE OF HIGH-VOLTAGE LAMPS.

BY G. L. ADDENBROOKE.

As a commencement I may say that the last year's experience has not altered the views expressed in the paper I read before the Institute in March, 1896. The paper was based on the possibility of using lamps of 220 volts, which it was assumed could be got at a certain price, and which would last on the average a certain time. The rest of the paper was occupied with the results which would logically follow from these premises. Now, the opinion of the lampmakers in the discussion was that I had given the lamps a shorter life than they could be made to have, and that I had put a full price on them. Further experience has demonstrated the correctness of their statements. There is no doubt now that the average life of high-voltage lamps is higher than I assumed, and the price is a good deal lower, having been very appreciably reduced in the course of the year for the best lamps. The position of the high-voltage lamp is consequently now even sounder than I ventured to assume it to be then, and the reasons for its adoption are so much the stronger. When my paper was sent in last year, so far as I am aware, with the exception of Bradford, and St. Pancras, where Mr. Baynes did his pioneering work, there was not a single central station using publicly high-voltage lamps in Great Britain or the Colonies, though several were experimenting.

What, however, is the position now? Within a few days of sending in my paper Prof. Kennedy's report recommending high-voltage lamps for Edinburgh was published—of course, quite independently; and the Westminster Company within a month or two followed suit by offering advantages to any of their customers who would adopt the higher voltage. Since then the Kensington and Knightsbridge Company have arranged to give any of their customers a reduction of ½d. per unit who will adopt the higher voltage, and they have already a number of such installations. The St. James and Pall Mall Company have not actually adopted higher voltage yet, I believe, because their means are still of such ample section for their load; but they have experimented with it from the first, are strongly convinced of its practicability, and are prepared to adopt it as soon as it suits their purpose. In the provinces, Birkenhead has been carried out on these lines; Chester has just been most successfully opened with a three-wire system and 220-volt lamps; Guildford is following suit; Edinburgh and Bradford have already been mentioned. The lamps are supplied at Croydon on an alternating system, and a number of other places are using high-voltage lamps on a smaller scale, but of which I have no definite particulars. In the Colonies, Coolgardie, the central town of the West Australian goldfields, has been lit with 220-volt lamps for more than six months.

The above is simply a list of towns which I can personally call to mind at the moment as using high-voltage lamps; were a full list published of all the places where they are installed it would, I believe, create a good deal of surprise. That the movement should have gained such strength within a year is certainly a wonderful testimony to its soundness. This year should, however, see a much further expansion for several reasons; the lamps are now cheaper than they were, several firms are supplying them, and nearly all the leading makers of fittings are just putting on the market special holders, cut-outs, ceiling roses, and switches adapted for the higher voltage. The extra cost of these special fittings will be only nominal in an installation, while there is no doubt that a good many engineers have hesitated to adopt high-voltage lamps so far because of their doubts as to being able to procure reliable fittings which were not costly and unsightly. When there is also added a year's satisfactory experience to the above reasons I think it is pretty safe to anticipate that high-voltage lamps will be even more in evidence this year than they were last, and that they will gradually become universal on central-station circuits.

As to what the lamps will stand I do not think I can do better than instance Coolgardie, as mentioned above. When asked to act as consulting engineer for this installation about 18 months since I agreed with some trepidation on several accounts, one of which was that the engineer on the spot advised that the only feasible motive power, at any rate for some time, would be oil-engines, on account of the scarcity of water. On the other hand, I knew from my experience in similar towns in Australia that to be successful this installation should be simple, free from danger, and should need little regulation. After consultation with several leading firms of lampmakers, I obtained assurances which seemed good enough to commence on, especially as I was not under the necessity of using anything under a 16-c.p. lamp; and accordingly a plant suited for 220-volt lamps was designed, and left England in December, 1895, while lighting was commenced last June. As regards the general design of the plant, the description of the recently opened station at Chester seems to concur with it almost identically, except as regards the motive power.

The lamps—220 volts—were procured from the Zürich Incandescence Lamp Company. They came to England from Germany, and were transhipped here to West Australia. On arrival there they had a railway journey up the country of 300 miles, the last part of the track having only just been completed by the contractors. Lastly, for the final 50 miles or so they had, I believe, to be carted across the open country. I have no actual return of the breakages, but the local manager has made no complaints. The lamps have now been in use six months, partly working from oil-engines and partly from a steam-engine procured locally to meet the demand till a larger steam plant, now on its way out, could be installed. The regulation, therefore, cannot have been good, as the accumulators sent out had only just been installed at the date of my last advices. In a letter from the manager, however, he characterises the high-voltage lamp "as the greatest advance in central-station lighting for several years." If, then, high-voltage lamps will satisfactorily stand such treatment as this, it seems clear that there need not be much hesitation in adopting them at home.

I have also found no practical difficulty with the higher voltage in an elaborate house in London where everyone of the fittings in the reception-rooms were of antique character, and formerly intended for candles, or gas, and which the owners insisted on retaining. Some had to be arranged

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with the 5-c.p. lamps of 66 volts in series, which is from an engineering point of view objectionable, but still they do very well, and the whole installation has a very good appearance; the lamps are evenly incandesced, and I think one sees less of the hairpin effect with the double filament. I mention this to show that it is not only in warehouses and shops that high-voltage lamps can be supplied, but that there need be no fear in introducing them in private houses with the most artistic surroundings.

It may be asked is this change to be a final one, or are we to look for lamps being introduced of still larger voltages? Unless a new lamp altogether should come into use, of which there appears no sign at present, I think the voltage to which we now have got will be approximately final for a long time. Lamps up to 250 volts are, indeed, now in the market, and the general pressure for new installations may be gradually raised to this point in time, but the difference between this and 220 volts is not great, and need not cause any hesitation in established stations adopting 200 volts. With nearly 500 volts between the outer wires of a three-wire system, we are fairly approaching the limits of safety for house installations, and this alone is a strong reason for not going further forward. Lastly, the extra precautions and insulation which would have to be adopted with voltages above 500 would go a good way towards discounting any further saving in mains.

Then again, looking at the subject from another point, we have the adaptability of 500-volt continuous-current generators for tramways and power work. No one with any serious experience would, I suppose, attempt to run tramways and lighting off the same circuit, but there is no reason why the generators in the same station should not be employed for both purposes, being coupled to whichever circuit they are needed on. In many cases marked economy would be secured in this way if accumulators were used to a considerable extent for the lighting. In doing this it is necessary, however, to bear in mind that in the future the watt-hours output for tramway and power work will probably in many cases considerably exceed the watt-hours required for lighting. The tramway and power load may, therefore, be the more serious question of the two, and it is likely that if one station is used for all purposes it may be best located where it is most convenient for tramway and power work, the lighting being largely done by accumulators in suitably located sub-stations charged during the night hours or when the tramway or power demand is slack.

WHAT ARE TRAMWAYS?

We should have thought that everyone would be able on short notice to give a reasonable definition of a tramway as compared with a railway, taking the meanings usually assigned to the terms in this country, and not employing such an Americanism as "street railway." The main difference is, of course, that the former is unfenced throughout, and runs, at a maximum speed of eight miles or so per hour, upon a highway or public road along its entire course. A railway, *per contra*, is wholly or partly fenced in, and runs, at almost any speed, generally upon its own ground. Between the two, however, there comes the class of "light railway," partaking, perhaps, at different points of the characteristics both of tramways and railways. For this reason probably, no official effort has been made to give any exact status to light railways until we have more of them in existence and are able to see exactly what they amount to. If light railways are thus under certain circumstances tramways, may not tramways, on the other hand, be called light railways? And if not, why not? It seems, at any rate, that we are going to see some lively fun during the next parliamentary session in connection with the various Bills and provisional orders for tramways then to be brought forward, unless, indeed, the powers that be come down like a thousand of bricks and nip a very ingenious little plot in its first budding state.

All this comes from the fact that no definition of the term railway, or light railway, is given in the Light Railways Act placed on the statute book in the year of grace 1896. Consequently there is no particular reason why ordinary tramways should not be promoted under this Act instead of the cumbrous and troublesome (some call it "iniquitous") statute of 1870, and therefore it is at once being done. Whether the authorities will refuse to license new lines that are tramways pure and simple, under the Light Railways Act, without incorporating all or part of the 1870 Act, yet remains to be seen; though from the information at our disposal we are inclined to believe that, at any rate to begin with, no special obstacles will be put in the way.

Imagine the difference between tramways built and worked under these different Acts! A tramway undertaking started according to the Light Railways Act is a semi-annual feast—that is, one doesn't need to spend a first year in promoting the matter locally, a second year in getting it through Parliament, and a third in laying and equipping the lines—but "failure at one examination" still leaves hope for the next in six months' time. Then there is no difficulty with the frontagers, who very often have it in their power (as we have actually seen) to cause a tramway line to corkscrew its way along a street as though it had been keeping a perennial merry Christmas. Finally, the purchase clauses "at the then value"—so obnoxious to the tramway interests—are done away with, or are, at any rate, replaced by very different provisions allowing a much fairer *modus vivendi* as between tramway company and local authority. Forty-two years do not represent too long a period of lease of life for a tramway company if it has to equip the entire system throughout. On the Continent the period of lease averages out fully as high as this, and the example of companies holding electric lighting powers, etc., might well be followed. Probably it will be due to a feeling of this kind that we may see in the early future a marked leniency on the part of Government to these applications for tramway undertakings according to the Light Railways Act.

For all that, however, tramways strictly so called can hardly be said to have any right of existence under the Light Railways Act: to promote them in this way is equivalent to driving, not a coach-and-four, but an electric tramcar through the 1870 Act. Probably no one would regret it, for local authorities are still sufficiently safeguarded, and the time is gone by when single individuals shall have it in their power to inconvenience the public by vetoing what is an undoubted public benefit.

In the meantime, then, we may fall in with the mode, and whatever logical instincts we may have which point out that the whole is more than the part, that the greater includes the less, or, at any rate, that the two circles representing the ideas of "light railway" and "tramway" are not absolutely coincident (although they may slightly overlap), yet, in view of the apparent difficulty of arriving at the intersecting part, we will cheerfully assume with the promoters of a good many Bills and orders now before Parliament that tramways and light railways are tolerably synonymous; or if not, then it is the duty of the authorities to point out the qualities which may enable us to tell "t'other from which."

We have in the above paragraph used the words "apparent difficulty" because, as a matter of fact, it seems to us quite easy to lay down a boundary at once. A tramway is such when it runs with other traffic entirely upon a public road and is unfenced; undoubtedly there are lines of this nature which are called light railways, though as a matter of fact they are still tramways. But let a tramway line run for even a few yards across a field between fences, and with regard to that section at least it is a railway. Obviously it is awkward, if not impossible, to own and operate different sections of a line according to different Acts, so that a line of this kind would, one would think, still be called a tramway. But under the Light Railways Act—which would very fairly apply to such a case—it would have all the great advantages already enumerated applying to its entire length. To our mind it is for hybrids of this kind—tramways at one point, railways at another—that the Light Railways Act is especially intended.

If, however, it is also meant to include in its embrace the lines following wholly along public roads, such as those

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so frequent in Belgium and France, then we do not see how a separation is to be made between these lines and the ordinary street tramway of the kind hitherto kept back rather than promoted by the Tramways Act of 1870. We hope certainly to find that this is the case, and then we shall suggest as a more suitable title for last year's Act the "Better Promotion of Tramways by a Side-Door Act," rather than the Light Railways Act of 1896!

THE MECHANICAL CONSTRUCTION OF ELECTRICAL MACHINERY.

BY F. M. WEYMOUTH.

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The Dynamo.

The dynamo is correctly called a machine, for, in common with what is usually called machinery, it possesses this attribute, that it is absolutely rigid in all its parts. Thus, in a well-made machine, to the unaccustomed eye the rotating parts, from their perfect steadiness, may appear quite motionless. It is the purpose of the following remarks to consider some of the general principles involved in the mechanical construction of a dynamo, and we may straightway commence with the

Bed-plate.—The bed-plate is the base of the machine, and is that part which, having other parts attached to it in detail, bears and connects them all so that they form one whole rigid structure. Sometimes a dynamo and engine are both built on the same bed-plate; sometimes the engine complete with its own base is placed on a prolongation of the dynamo bed-plate; and sometimes, though less frequently, mostly when both are very large, each having its own bed-plate, the two are bolted together end to end. We cannot find or recall any case of a dynamo with its own bed-plate complete being put on the prolongation of the engine bed-plate. The reason for this latter is no doubt that while it is essential to build an engine on its own base, the dynamo parts, consisting of one bearing and the magnets, can easily be made and affixed when and where convenient.

We propose now, however, to review some of the points requiring consideration in the design of a bed-plate. It has already been intimated that rigidity is an essential element. But in order properly to shape the bed-plate to secure this quality, we must know precisely what are the strains to which it will be subjected. Hence, the better to arrive at some definite conception of these, we may take the case of a combined plant with engine and dynamo on the same base. Let us further assume that the bed-plate is weak and narrow, and that the centres of gravity of both engine and dynamo are high: their centres of gyration will also be high. It is obvious that on running at any speed both the engine and dynamo will tend to rock; or, at least, the engine will, if we assume the dynamo kept steady by the weight of its magnets. Hence we observe that, if both rock or vibrate, the chances are they will not vibrate synchronously, and the result will be a twisting strain on the bed-plate between the engine and dynamo at those instants of time when they oscillate in opposite directions. The same effect would of course arise if the engine vibrated only. Thus, in the case assumed, the torsional strain would be one of the most severe to which the bed-plate would be exposed. The writer recollects hearing of a case such as this, where, owing to a bed-plate being too light and narrow, the engine and dynamo had both to be shored up with timber on account of the rocking that set up when running. We thus find that one of the first duties of a bed-plate is to preclude vibration, and to resist the conduction of any vibration set up in one piece bolted down to it to any other piece. Other strains, such as might be imagined by regarding the bed-plate in some sense as a loaded girder, may be also borne in mind, though the import of this latter must depend on circumstances.

Coming to the consideration of how to meet these strains, it may be noted at the outset that, on the principle that prevention is better than cure, the best method is to commence by reducing the strains themselves as much as possible. Thus, as to vibration, this would clearly be greatly diminished by having a wide bed-plate and a low centre of gyration—the contrary to our assumption above. If, also, the plant is bolted down to a solid foundation of concrete or other firm base, whereon it will be fairly supported for its whole length, its being strained as a loaded girder may likewise seem of less comparative consequence. It is, however, perhaps doubtful if it can be considered good engineering to trust to the foundation for any quality that should be contained in the bed-plate itself. The simple belt-driven dynamo, however, is not free from a tendency to vibrate; for the belt joints are apt to be one source, and the slightest want of balance in the armature may be another source, of such vibration.

It will be sufficiently clear, however, that, notwithstanding their possible reduction, the strains as above set forth will be those requiring to be met; and we may now consider the best method of attaining this end. In doing so we have to remember that economy of metal is an important factor, not only from a directly mercenary point of view, but also in order to keep down the weight. Bearing these points in mind, therefore, it becomes obvious that, whether the bed-plate is regarded as a loaded girder or as a body subjected to torsion between its extremities, a hollow box shape will be the most appropriate to meet the strains. This requires examining more closely to ascertain the full advantage. Thus we know that if we have a solid bar and a tube, and let us assume them both square, each having the same sectional area of metal, necessitating thereby that the tube will have larger cross dimensions than the bar, the tube will stand safely a much greater torsional strain than the bar; and, further, for any given torsional strain, the larger the tube the less need be its sectional area of metal. In other words—and this is the important point, which may be demonstrated mathematically—as the periphery of the tubular section is extended, *so may the total sectional area of metal decrease*, and thus make the casting lighter and more economical. Hence we perceive that for a given degree of strength to resist this one strain, a wide deep tubular casting will be more economical than one of smaller over-all transverse dimensions. But to meet strains also as a loaded girder, depth will tend to economy of metal; for to resist any downward transverse strain, the deeper the section strained the less need be its total area. The conclusion would therefore seem to be that the best form for a bed-plate would be a tube having its sides parallel with the dynamo shaft. But other considerations following, we find that to resist transverse oscillation of the whole machine or plant *en bloc*, which would collapse a mere thin tube, we must close the ends, or rib it across. This gives a thin metal box without opening. As this is not very practicable, and even an approximation would be expensive and inconvenient, we finally arrive at a compromise—namely, a thin cast-iron box open on one side, which side is placed downwards. This may seem to effect a serious defalcation in the argument; but this would not be so, for the main point will still hold good that, whether the section has three sides or four sides, for any given degree of strength, economy will attend its extension. A parenthetical note that may hence be made is that, should a design of bed-plate prove too weak, the better way to strengthen it would be to increase its transverse dimensions rather than thicken its walls.

This latter point, however, requires comment in any case, inasmuch as there are limits to thinning the metal. If too thin a casting is ordered, there will be a risk that the quality of the metal mixed in order to pour thin may also be weak. Thus the *raison d'être* of the fine casting would be upset, and the whole object sought would not be attained. A somewhat thicker casting of smaller outside dimensions, and of a better mixture, would give more satisfactory results as regards combined strength and economy. It is doubtless a question of foundry practice: but a sound casting of reasonably good metal is of course essential. Though some makers will venture on much thinner and lighter casting than others, it will probably be safe to say that in ordinary practice $\frac{5}{8}$in. thickness would be quite a minimum for a bed-plate 6ft. long, $\frac{1}{2}$in. for a length of 4ft. to 5ft., and $\frac{3}{8}$in. for about 3ft. length; while $\frac{1}{4}$in. would be the lowest minimum reserved for only the

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smallest castings in iron. It is perhaps doubtful whether many makers would care to put less than $\frac{3}{4}$in. metal in the 6ft. bed-plate, though, in accordance with our intimation, examples of this size, and even larger, may be found with metal only $\frac{1}{2}$in. or $\frac{7}{16}$in. thick.

We may now, however, proceed to consider some special examples. In so doing, it may be mentioned, we propose not to omit drawing attention to various minor points.

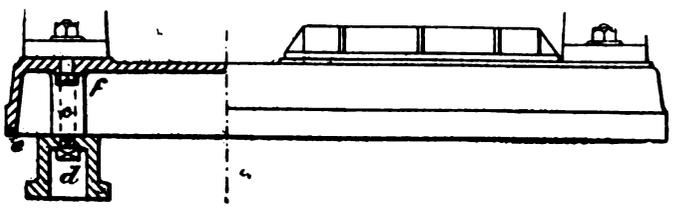

FIG. 1.

For though these may seem sometimes trivial, they are not alway so trivial as they may appear, and are not without their relative importance as regards ultimate results. To commence, therefore, with the simplest, we may turn to Figs. 1 to 4. We find here, agreeable to foregoing remarks, a simple inverted box—a type closely approximated, at least in outside appearance, by Messrs. Siemens Bros., as shown on p. 509 of the fourth edition of Prof. S. P. Thompson's "Dynamo-Electric Machinery." On its upper surface are facings level with one another, so that they can all be planed in one operation. These facings take a bearing at each end of the casting, and gunmetal or brass shoes to carry the magnets

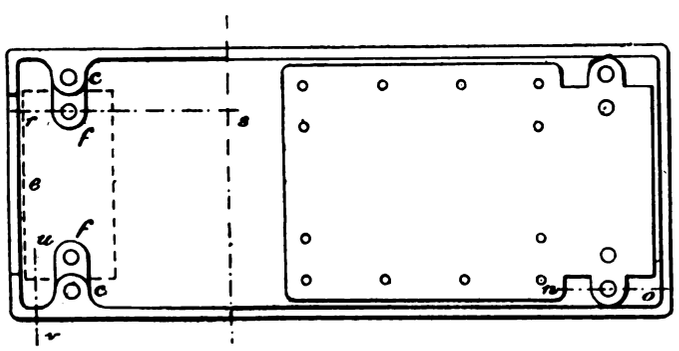

FIG. 2.

will come on the intermediate facing, as indicated in Fig. 1. The bottom edges on each side will be planed also, omitting gaps, *e e*, at the ends, which latter saves expense, inasmuch as such a casting would be planed lengthways. Further, if put on "rails," which would bear inside the ends, as shown at *d* (Fig. 1), facing at the ends would not be required; or if placed directly on to concrete or other foundation it will stand with more stability, as regards sideways vibration, resting on the side edges only. It will be perceived that the sides slope a little so as to facilitate drawing the pattern out of the mould: and the lower edge is strengthened all round by being made thicker,

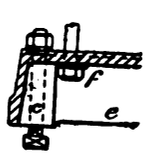

FIG. 3.—Section on *u v*.

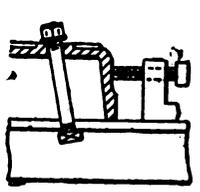

FIG. 4.—Section on *o n* without boss.

which is some compensation for the omission of the bottom side of the "tube" as above expatiated on. Such thickening also enhances the appearance. The bosses, *c c*, for the holding-down bolts are shown the full depth of the casting. This has the effect of keeping the bolt always upright when the machine is on rails, and maintains it in position thereon: besides which, it prevents the very undesirable effect which might take place as shown (Fig 4), where the bolthead has caught in the rail, thus preventing further movement; and the trouble of releasing the bolt is increased if it is not also bent. Yet another advantage is that by machining the lower end of the boss flush with the edges, the grip of the bolt is brought to bear on surfaces in contact exactly between the bolthead and nut, and thus undue transverse strains on the casting are avoided which would be otherwise set up. The corners will be observed shown rounded; for the metal in cooling assumes a crystalline structure, which, if the corners are cast to a sharp and square angle, leaves a weak section in the plane precisely through the inner and outer angles. This is a little point often disregarded by beginners, and one sometimes comes across drawings purporting to represent "matured" designs, and yet with all the corners of castings shown square. For the bearing bolts, facings are required, as at *f*, to be tooled true with a revolving cutter. These holes, as shown, being for smooth-turned bolts, should be drilled, though to this matter we shall return later. On the other hand, the holes through the deep bosses should be cast, or "cored," to use the technical term, and should be $\frac{1}{16}$in. or $\frac{1}{8}$in. larger diameter than the bolt, which latter may be "black"—that is, not turned up in the lathe. It would be expensive to drill such deep holes, and for this there is no sufficient warrant. These holding-down bolts should also have square necks loosely fitting the slot in the rail, as shown at *d*, so that they do not turn round when the nut is tightened up: this is indicated by the diagonal lines in the sketch, which similarly show the head square to suit. All facings should rise an ample amount above the rough unmachined surfaces; for most castings are liable when cooling to warp slightly out of shape, and the pattern also may slightly warp in the first instance. Perhaps a safe rule may be to say that facings should rise not less than $\frac{1}{4}$in. in a bed-plate about 6ft. long, $\frac{3}{16}$in. if two or three feet long, and $\frac{1}{8}$in. only in small iron castings.

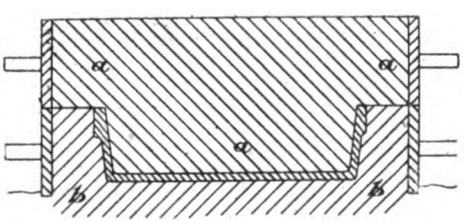

FIG. 5.

Another intimation that may here be given, not without advantage, is the following. It is one that especially applies when light castings are desired. Thus, in Fig. 5 the pattern is shown in the mould, and inverted with a view to casting it in that manner. It will be observed that on the upper box, *a a*, being lifted, the sand mould therein will withdraw from the pattern, leaving the latter revealed in the box, *b b*, below. The pattern now requires to be raised from *b b*—our point is just here—and in order to do so the more readily without breaking the mould, the moulder will rap the pattern all round so as to loosen it in the sand. Now this rapping increases the outside dimensions. Some moulders will loosen the pattern only slightly, but others will rap heavily and thereby increase the outside dimensions more considerably, while the inner portion of the mould, *a a*, remains unaltered. Thus, the sides of the casting come out in much thicker metal than intended. This is a point that sometimes requires attention, though representing an evil more liable to arise when moulders receive any kind of profit on the total weight of castings turned out in the week. The inducement to increase this profit by a little extra rapping on the pattern is too obvious. We may now consider briefly some other types of bed-plate.

(To be continued.)

Forthcoming Events.—There are few appointments for next week, owing to the Christmas holidays. Prof. Silvanus Thompson's lecture at the Royal Institution to-morrow (Saturday) afternoon is on "Polarisation," and the remaining dates are January 5, 7, and 9, the lectures dealing with the ultra-violet, infra-red, and Röntgen rays respectively.—We have to acknowledge the receipt of notice of meetings of the Franklin Institute, but as they take place in Philadelphia it seems hardly useful to include them in the weekly list.

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THE LOCAL DISTRIBUTION OF ELECTRIC POWER IN WORKSHOPS, ETC.

BY ERNEST KILBURN SCOTT.

PART I.

The advantages of transmitting power for long distances have been pointed out so often that there is a tendency to consider electricity as only applicable to long-distance work. In the following the writer wishes to emphasise the fact that there is a large field open for the economical application of electric transmission of power to isolated points comparatively near together, as are the tools or machines in a workshop or factory; also that the application of electricity to factory driving has already made considerable progress; and, lastly, that as the special peculiarities and requirements of the machines become known there will be an ever-increasingly intimate blending of electro-technics with general machine design.

Briefly stated, the advantages of electric transmission of power in factories and workshops may be said to be as follows:

1. There is absolute control over the economical running of machines and works generally, owing to the self-indicating nature of electric motors and the immediate detection of any of the undue losses which may so often occur in mechanical transmission.

2. The concentration of the generating plant in one central position, and considerable economy in coal consumption by using one or two highly efficient engines or dynamos.

3. In laying-out new buildings the walls and roofs may be of much lighter construction, and there is also considerable saving in ground floor space, and a greater amount of head room.

4. Extreme flexibility of the transmitting medium, and the ease of installing the cables and motors.

5. The low cost of repairs, lubrication, and maintenance.

6. The possibility of running one machine, or group of machines, on special or overtime work without wasting power by having to turn round a large amount of heavy shafting and belting.

7. The electric motor only consumes energy in proportion to the work it does, without any governing mechanism being called into play; the losses in transmission being also proportionately reduced.

8. The speed of the machinery can be kept uniform with great variations of load.

9. Owing to the turning moment on the rotating part of the motor being practically constant, the rotation is not subject to periodic vibrations such as occur with an engine, and there is consequently less wear and tear on the machinery, and better work is turned out.

10. The high speeds at which motors may be run enable them to be coupled direct to such machines as emery-wheels, buffing-wheels, etc.

11. The employment of motors and cables in place of a mass of belting and pulleys improves the general orderliness of a workshop, and this reacting on the employés improves the quality and quantity of the work turned out.

12. The general all-round efficiency at low loads of an electrical plant is higher than with any other system of working.

13. Belt holes between floors are avoided, and there is a lessened fire risk.

There are also the special advantages peculiar to the electric motor of simplicity of construction and fewness of working parts; freedom from waste products, heat, or fumes; rotation almost noiseless, and being readily adapted for driving any kind of machine, whilst requiring little or no foundation.

There are *two main divisions* into which factories may be placed. There are, first, those which have been recently or are about to be erected, and which, therefore, contain no existing shafting, etc., and there are, secondly, those places in which the whole paraphernalia of steam-pipes and auxiliary engines, shafting, pulleys, belts, etc., is already at work.

In regard to the first, there can now be hardly any doubt that the introduction of electric motors suitably proportioned to the duty required of them will show marked economy, besides giving great facilities in handling work. With those factories coming under the second division the question is, however, rather more involved, and the advisability of putting in an electric power installation will depend on the financial capabilities of the firm to look at the question broadly as an advisable capital outlay, and also on the exact details of the factory or workshop in question. Of course, the latter varies considerably, but, generally speaking, there are very few places of any size in the engineering and allied trades but which require power intermittently at many points more or less wide apart. Most works have gradually grown from small beginnings, and one addition after another has been made until there are a number of separate shops inconveniently placed in regard to one another for the purposes of power transmission by simple shafting and belting. We have therefore to deal not merely with one engine and simple lines of shafting, but with several main driving engines, with their boilers and steam-piping, besides small auxiliary engines for cranes, foundry blowers, etc. The boilers are naturally scattered about so as to make the steam-piping to the various engines as short as possible. Such, then, are the conditions daily met with in engineering works, etc., and it does not require much arguing to show that a central station with all the boilers concentrated in one battery, placed in some central position for the ready delivery of coal and removal of ashes, and manned by one set of stokers, is going to show a considerable saving in wages and coal. Everything nowadays tends to show the benefits of *centralisation*; and logically it should be almost as advantageous for the power supply of a factory to be distributed from one point as it is for a company or corporation to establish a gasworks or electric light works for the public supply of a town.

With regard to the steam-engines, the steam-eating propensities of the ordinary single-cylinder engine is proverbial; and if only the proprietors of large works would take the trouble to test their smaller engines for steam consumption and mechanical efficiency, they would readily admit that the laying down of one or two highly efficient triple-expansion condensing engine sets to form the nucleus of a small electric power station would be a step in the right direction. The coal consumption per indicated horse-power per hour would be under 3lb., whilst with the old scattered arrangement and many small engines the coal consumption might be anything between 6lb. and 15lb., the average steam consumptions being respectively 16lb. and 55lb. It is a fact that in large engineering works, etc, where a number of small engines are employed, whilst elaborate precautions are taken to see that the main driving engines are working efficiently, the question of the efficiency of the smaller engines is generally winked at, and it therefore often happens that an engine is employed which is very much too large for the power of the tool it is driving.

In this, as in all cases of considerable change, there is considerable difficulty in obtaining data, but judging from the great success which has met the efforts of those who have thus far had the courage to introduce the change (in most cases involving considerable expenditure of capital), there is plenty of encouragement for others to follow on the same lines. A few particulars at this stage may be interesting.

The adoption of electric driving at Messrs. Gray's shipbuilding yard, West Hartlepool, has resulted in a saving of 34 tons of coal per week, and also in a saving estimated at £3,000 per annum at Messrs. Dorman, Long, and Co.'s works. The National Arms Factory at Liège manufactures a rifle in 10 hours with an expenditure of 1½ h.p. per hour, whilst in other factories with mechanical transmission more than double this power is required in the same period. Mr. Anderson has shown that the substitution of electricity for the cranes at Messrs. Easton, Anderson, and Goolden's works at Erith has proved most beneficial; and a like experience has resulted from the adoption of electricity on all the cranes at Messrs. Joseph Adamson and Co.'s, boiler-shops, Hyde. Messrs. Denny and Co., shipbuilders, Dumbarton, and Hawthorn, Leslie, and Co., marine engineers, Newcastle-on-Tyne, besides many others, have laid down electrical plant; and this list is sufficient proof of itself that those who are engaged in the heaviest branches of constructive engineering work are satisfied that the small auxiliary steam-engine and heavy line shafting is doomed to disappear. The

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shipyard and engineering works which are being established at Nicolaieff, in South Russia, under the auspices of the well-known Cockerill Company, of Seraing, are also lighted throughout by electricity and all the machinery driven by electric motors. The electric light station in connection therewith has a total capacity of 1,000 h.p, the plant consisting of five sets of 200 h.p. each. Each set comprises a multitubular boiler, a 200-h.p. de Laval steam-turbine, and a large Desrozier dynamo.

In the United States, electricity has been very extensively applied in rolling-mills and steelworks. Such works generally cover a considerable area of ground, and are comprised of several detached buildings, in each of which different operations are carried on. Power must be available almost everywhere, and a large number of cranes are necessary to handle the hot masses of metal. There is also generally a machine shop for turning rolls, for constructional repairs, and for such machine work as may be required on the product of the works. Although all the above points are favourable to the application of electricity, yet the adoption of the electric motor is remarkable when we think of the rugged character of rolling-mill work and the sledge-hammer type of men employed. Even so recently as six years ago no one would have thought of predicting that electricity would find this, one of its most appropriate and useful fields of work; for with the then supposed delicacy of electrical apparatus and necessity for favourable surroundings and skilled attendance, such applications were not considered feasible.

Yet we find to-day that the most extensive example of electric driving in the world is in the Carnegie Steel Company's works, Pittsburg, where there are upwards of 400 motors, aggregating 3,500 h.p., whilst another steelworks has 94 motors at work, and is going to double the number this year. At the Carnegie works there are an immense number of electric cranes, and also very complete arrangements for conveying the billets to and from the furnaces, rolls, etc. In the first place, a machine is travelled on rails, by a motor, along the front of a line of furnaces. It is known as a "traversing drawer," and the billets are charged into the furnaces and withdrawn by a horizontal bar worked by another motor. When the billet has been reheated, it is pulled out on to an electrically-driven trolley or bogie, the billet resting on three live rollers on the top. When the bogie has reached the end of the live road connected with the rolling-mill, a motor attached to the rollers on which the billet rests is set in motion in the required direction, and the billet is thus dropped on to the live road, which conveys it to the rolling-mill. Even then, however, electricity has not done with it, because with the three high rolls used at these works the elevating tables on either side of the rolls, although they are raised and lowered by hydraulic power, are traversed across from one set of rolls to the next by means of motors; and the live rolls on these tables are also driven by motors. The whole of the operations are controlled by men stationed at switches wherever it has been found convenient to place them; very few, if any, men coming near the red-hot masses of metal.

This wholesale introduction of the electric motor for work which has hitherto been largely dependent on skilled labour is to a great extent due to the unsettled condition of the labour market. As the demands of labour increase it becomes all the more necessary to keep up-to-date with the machinery, and it may be taken as an established economic fact that no one single cause has done more to hasten the introduction of automatic machinery in operations where a certain degree of skilled labour has hitherto been considered indispensable, than labour disputes and strikes. There are many instances besides the one above mentioned where large manufacturers have on account of strikes cheerfully expended large sums of money in laying down improved machinery, not primarily to effect economy in wages, but as an assurance against future danger from such causes.

The recent bad trade has also made employers look round corners to see in what way they could improve their methods of production, and it is a significant fact that in the United States, at any rate, any extensions or alterations that have been made have been in this one direction of electric driving in one form or another. If, therefore, we wish to keep our share of the world's trade we shall be bound to follow these lines, because the universal application of machinery has had the effect of levelling up industrial conditions, and our handicraftsmen are by no means so superior to those in other parts of the world as they formerly were.

Although the majority of works do not require so many small engines or units of power scattered about as those above mentioned, yet we find that there are few factories with less than three or four engines, besides boilers and piping, and therefore in considering the question of the relative economy of the electric transmission of power these engines, etc., form a considerable factor in the question. Thus, when Messrs. Siemens, of Charlton, reorganised the driving of their factory, they not only did away with a considerable amount of shafting and belting, but they also superseded quite a number of small engines (with steam-piping and boilers) which were dotted about the place, the saving in space and the attendance on which formed a not inconsiderable item in the sum of advantages which were attained by distributing the power electrically.

So much, then, for the steam-engine. When we approach the question of simple shafting and belting *versus* electric driving, we get on to more debatable ground. For example, it is often stated that the capital outlay involved in putting down electric motors is more than that required for a simple arrangement of shafting and belts, and this is put forward as a reason why motors should not be adopted. As a bare statement it may be true in the case of smaller installations, but such matters as these must be looked at from their broadest standpoint. A proprietor putting up new works is prepared to go to the expense of a large first cost if he is assured that by so doing he can make a saving in his annual working expenses, and if, as will be shown, he can benefit in other ways. Very often, too, the costs of foundations and structural works in connection with erecting main lines of shafting are overlooked because they get included in the building account, but there is no doubt that they sum up to a considerable amount. The light construction of walls, roofing, pillars, etc., in such workshops as those at Bushbury and the new works of Thomas Parker, Limited, which have been laid out from the commencement with complete systems of power transmission, cannot fail to impress the visitor.

TABLE I.

Table giving Power Transmitted and Weights, etc., for Shafting within Ordinary Working Limits.

Diameter of mild-steel shafting.	Horse-power transmitted at 100 revs. per minute.	Approx. weight in tons per 200 lineal feet.		Approx. number of bearings required in 200 lineal feet.
		Shafting alone.	Shafting, pulleys, and stress on belts.	
2	11	1	1⅜	24
2½	21	1½	2⅝	22
3	38	2	3½	19
3½	60	2⅞	5	17
4	90	3¾	6½	15
4½	128	4¾	8¼	14
5	170	5⅝	10¼	13
5½	230	7	12¼	13
6	300	8½	15	12
6½	380	10	17½	12
7	480	11½	20	11
7½	590	13	22¾	11
8	710	15	26¼	11

The second column of weights includes shafting, pulleys, and downward stress on belts, and is taken at 75 per cent. more than the weight of shafting alone. The numbers of bearings are got out allowing for a distance of bearings apart varying from 8½ft. with the 2in. shafting to 18½ft. with 8in. shafting.

In Table I. some figures are given showing the relation between the power, total dead-weight, and number of bearings for different sizes of shafting. With a 5in. shaft, for example, there is a total dead-weight of about 10 tons in a length of 200ft., and this is supported by 13 bearings, which gives rather less than a ton to each. This of itself would require a good, strongly constructed wall or heavy pillars, but it must be remembered that the load is very far from being a "dead" one; in fact, it is more than likely to be very much "alive." The pulleys, etc., used in millwright work are very seldom in exact balance, and the belting, etc.,

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tends to throw it out still further, the consequence being that even at 100 revolutions there is a good deal of vibration or tremor, which the architect in designing a building must necessarily allow for in getting out his quantities. It is hardly necessary to say that an electric cable, besides being considerably lighter, does not set up vibration.

At Messrs. Campbell's clothing factory, Leeds, there are several hundreds of sewing machines, besides band knife saws, etc., driven by electric motors, the motors and countershafting being under the floors. The factory was built with this idea from the outset, and the result has been a lighter building with practically no visible moving machinery, whilst it is computed that £2,000 was saved in the cost of the building alone.

In very many cases this question of power should not really be dealt with by itself, because (in engineering establishments, for instance) the same generating plant, mains, and secondary batteries can be and are used for electric lighting, electro-chemical, and electric welding processes, as well as for power.

(To be continued.)

THE PRINCIPLES OF ALTERNATE-CURRENT WORKING.*

BY ALFRED HAY, B.Sc.(EDIN.), A.I.E.E.

(Continued from page 656, Vol. XVIII.)

114. We shall now consider the case of a circuit similar to that described in Art. 108, and suppose that a simple harmonic E.M.F. is applied to it. We may imagine the circuit to be made up of a length of concentric main, consisting of two tubular copper conductors, s_1 and s_2 (Fig. 80), separated by some dielectric. Instead, however,

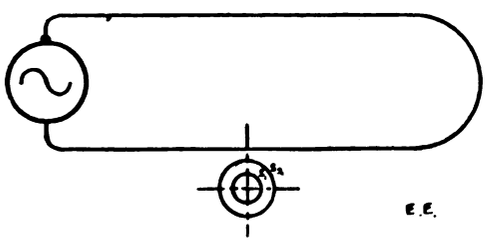

FIG. 80.

of using one of the tubular conductors as the forward, and the other as the return main, we shall suppose the outer and inner shells joined together at their ends, and connected to a source of simple harmonic E.M.F. We thus have, as in Art. 108, the case of two circuits the mutual inductance of which is equal to the (self) inductance of one of them.

Let r be the resistance of each circuit (the two shells being supposed to have the same cross-sectional area); L_1 the inductance of the inner shell, and M the inductance of the outer shell; M will also be equal to the mutual inductance of the two shells. Further, let i_1 and i_2 stand for the instantaneous currents in the inner and outer shells respectively, and let e be the instantaneous impressed E.M.F. By the principles explained in Art. 105, the equations of the currents in the two shells are

$$r\,i_1 + L_1\,i_1' + M\,i_2' = e,$$
$$r\,i_2 + M\,i_2' + M\,i_1' = e.$$

Subtracting the second equation from the first, we find

$$r\,(i_1 - i_2) + (L_1 - M)\,i_1' = 0,$$

whence
$$i_2 = i_1 + \frac{L_1 - M}{r}\,i_1'.$$

115. The two currents being simple harmonic ones, we may represent i_1 by the projection on the vertical axis of a rotating vector O A (Fig. 81) of length I_1 (where I_1 is the amplitude of i_1). The rate of change of i_1—*i.e.*, i_1'—would be represented (Art. 22) by the projection of a rotating vector of length $p\,I_1$, drawn at right angles to O A. Hence the term $\frac{L_1 - M}{r}\,i_1'$, which is the second term on the right-hand side of the last equation in the preceding article, may be represented by the projection on the vertical axis of a rotating vector O B, of length $\frac{p\,(L_1 - M)}{r} I_1$. By the equation of last article, i_2 is equal to the sum of the projections of O A and O B on the vertical axis—*i.e.*, to the projection of O C, which is the resultant of O A and O B. Now if we denote the amplitude of i_2 by I_2, then

$$I_2 = O\,C = \sqrt{O\,A^2 + O\,B^2}$$
$$= I_1\sqrt{1 + \frac{p^2\,(L_1 - M)^2}{r^2}}$$

so that

$$\frac{I_2}{I_1} = \sqrt{1 + \left\{\frac{p\,(L_1 - M)}{r}\right\}^2}.$$

Hence the current in the outer shell is always greater than that in the inner shell. Further, a glance at Fig. 81 shows that *the current in the inner shell lags behind that in the outer shell.*

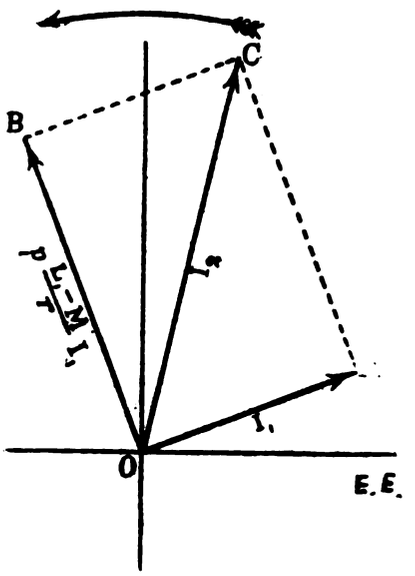

FIG. 81.

As an example, let us suppose that $r = \cdot1$ ohm, $L_1 = \cdot0015$ henry, $M = \cdot001$ henry, and let the periodicity be 100 ~ per second. Then $p = 2\pi \times 100 = 628$ approximately, so that

$$\frac{I_2}{I_1} = \sqrt{1 + \left(\frac{628 \times \cdot0005}{\cdot1}\right)^2};$$
$$= \sqrt{1 + 9\cdot86};$$
$$= 3\cdot29.$$

In this case, therefore, the current in the outer shell is more than three times as great as in the inner shell. One effect of this crowding of the current towards the outer shell is to increase the rate at which energy is being dissipated, so that the resistance of the two shells joined in parallel to an alternating current is very much greater than their resistance to a continuous current. In order to compare the two resistances, let us suppose that a continuous current of i amperes is sent through the two shells. The resistance of each shell being ·1 ohm, their joint resistance (to a continuous current) is ·05 ohm. The rate at which energy is being dissipated is therefore

$$\cdot05\,i^2.$$

Next, let an alternating current of i amperes be sent through the shells; of this, $\frac{i}{4\cdot29}$ amperes will pass through the inner shell, and $\frac{i \times 3\cdot29}{4\cdot29}$ amperes through the outer shell. The total rate of dissipation of energy with an alternating current of i amperes is therefore

$$\cdot1 \times \frac{i^2}{4\cdot29^2} + \cdot1\,\frac{i^2 \times 3\cdot29^2}{4\cdot29^2} = \cdot0643\,i^2;$$

* Based on a series of evening lectures delivered at the University College, Liverpool.

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i.e., the combination of the two shells joined in parallel behaves as if its resistance to an alternating current were ·0643 ohm instead of ·05 ohm, the resistance offered to a continuous current.

116. The equation

$$\frac{I_2}{I_1} = \sqrt{1 + \left\{\frac{p\,(L_1 - M)}{r}\right\}^2}$$

indicates two more facts which are of considerable interest and importance.

In the first place, we see that for given diameters and thicknesses of shells the ratio of the two currents will depend on the resistivity (specific resistance) of the material used. The lower the resistivity the smaller will be r, and hence shells made of a highly conducting material will exhibit the effect better than those made of a poorly conducting substance.

In the next place, we see that the ratio of the two currents will depend on the magnetic permeability of the medium separating the two shells. We have supposed the permeability to be unity. If, however, we imagine an iron shell interposed between the two shells conveying the current, the iron shell being insulated, then it is obvious that the value of $L_1 - M$ will be enormously increased, owing to the high permeability of the iron. The mere interposition of a highly permeable substance will therefore greatly increase the ratio of I_2 to I_1. The iron shell acts as a sort of screen to the inner shell, diverting a large portion of the current from the inner to the outer shell.

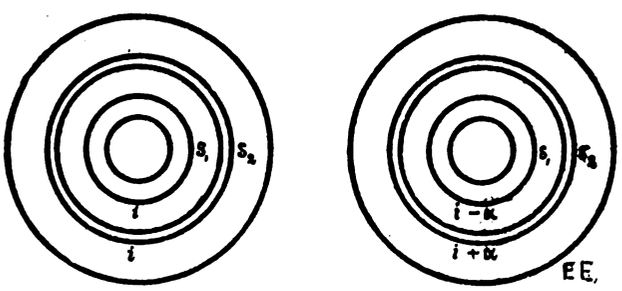

Fig. 82.

117. It is, of course, at once obvious that the ratio $\frac{I_2}{I_1}$ will depend on the periodicity. As the periodicity is increased indefinitely, this ratio increases indefinitely. For very high periodicities, the term $\frac{p\,(L_1 - M)}{r}$ will be very great compared with unity, so that we may write approximately

$$\frac{I_2}{I_1} = p\,\frac{L_1 - M}{r},$$

and we see that the ratio of the two currents, for very high periodicities, is in direct proportion to the periodicity.

118. Instead of considering two thin cylindric shells, we may next take the case of a solid cylindric conductor. Imagine the conductor split up into a large number of thin concentric cylindric shells. If we take any two shells, then, from the results deduced above, it follows that the outer shell will carry more current than the inner one. Each shell will, in fact, be subjected to the screening action of all the shells lying outside it. Hence the current will be unequally distributed over the cross-section of the conductor, being crowded towards the outer portions of it. This crowding of the current towards the surface of the conductor produces a twofold effect: *it increases the resistance and diminishes the inductance* of the conductor. For let us consider two equal cylindric conductors conveying the same total current, and let the current density be uniform over the cross-section of the first conductor, while it increases from the centre outwards in the second conductor. Consider two cylindric shells, s_1 and s_2 (Fig. 82), of equal resistance r, in the two conductors. Let i denote the current passing through each shell in the first conductor, and let $i - \alpha$ and $i + \alpha$ denote the currents in s_1 and s_2 respectively in the second conductor. The total rate of dissipation of energy in s_1 and s_2 is

in the first conductor, $2\,r\,i^2$,

and in the second, $r\,(i-\alpha)^2 + r\,(i+\alpha)^2 = 2\,r\,i^2 + 2\,r\,\alpha^2$.

Hence the second conductor behaves as if it had a greater resistance than the first.

Again, by transferring a current α from the inner shell s_1 to the outer shell s_2, we diminish the magnetic flux due to that current, for the whole of the lines *between the two shells* which were due to the current α while it was flowing in s_1 have disappeared on its transference to the shell s_2. We thus see that a crowding of the current towards the outer portions of the conductor results in a reduction of the total magnetic flux due to the current—*i.e.*, the inductance of the conductor is thereby diminished.

119. The unequal distribution of an alternating current over the cross-section of a conductor is a matter of considerable importance from a practical point of view. With conductors of large size this effect becomes so serious that the inner portions of the conductor practically contribute nothing towards its current-carrying capacity. Hence, conductors intended to carry large alternating currents frequently take the form of tubes or flat strips. It may be mentioned that for ordinary periodicities, ranging from, say, 80 to about 150 ⁓ per second, this "skin effect" does not become appreciable (for copper conductors) until a diameter of about ½in. has been reached. Beyond that, the effective resistance of a conductor to an alternating current

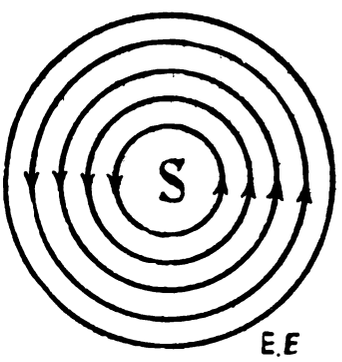

Fig. 83.

appreciably exceeds its resistance to a continuous current, and the increase of resistance increases rapidly with the diameter. Thus, a copper conductor ·75in. in diameter offers about 17 per cent. more resistance to an alternating current of periodicity 130 ⁓ per second than it does to a continuous current.

In the case of *iron* conductors the "skin effect" is enormously magnified owing to the high permeability of the material (Art. 116), so that even with comparatively thin wires the effect is appreciable at ordinary periodicities.

For currents alternating with very great rapidity, such as the oscillatory discharges of Leyden jars, or oscillatory lightning discharges, the only effective portion of a conductor is an extremely thin surface layer. If it is desired to reduce the resistance as much as possible, the shape of the conductor must be so chosen as to offer a large *surface*. A thin flat ribbon, for example, would offer much less resistance to a rapidly varying current than a cylinder of equal cross-section.

Instead of using tubular or flat conductors, we may ensure a uniform distribution of current over the cross-section by stranding the conductor, each strand being *insulated* from the others, and the stranding being carried out in such a manner that the portion of each strand which lies on the surface of the conductor is about the same for all the strands. This is the method of stranding adopted in Lord Kelvin's current balances intended for the measurement of large alternating currents.

120. Closely allied to this subject is the unequal distribution of magnetic induction over the cross-section of a mass of iron which is subjected to an alternating magnetic force, and this effect we now proceed to consider. The problem is very much simpler and more easily understood than the one we have just investigated.

Let us suppose that a mass of iron is suddenly subjected to the action of a steady magnetic force. During the

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growth of the magnetic induction, currents will be induced in the mass of iron, the direction of these currents being such that they tend to oppose the growing magnetic induction. Each current-sheet will exert a demagnetising effect at all points lying within its boundary. Hence the demagnetising effect produced by the currents will increase as we proceed from the surface of the iron towards its interior portions. We thus see that the magnetic induction will propagate itself from the surface inwards, just as a current diffuses itself from the surface of a conductor towards its central portions when a steady E.M.F. is applied to the conductor.

If, for example, we take the case of a cylindrical rod of iron, shown in section in Fig. 83, and suppose that a steady magnetic force, having a direction from front to back of the plane of the paper, is suddenly applied to it, then the growing magnetic induction will give rise to cylindrical current-sheets, having the direction indicated in Fig. 83. The demagnetising effect produced by these current-sheets will obviously increase as we proceed from the surface towards the centre of the rod. Hence, the magnetic induction will reach its steady value in the surface layers first, and then gradually diffuse itself over the whole cross-section of the rod.

Instead of supposing the magnetic force to remain constant, let us assume that it varies according to the simple harmonic law. The varying magnetic induction* in the iron will give rise to alternating-current sheets which will exert a demagnetising effect on the central portions of the iron core. With a very rapid rate of alternation the induction will be practically confined to the surface layers of the iron. This is the analogue of the "skin effect" obtained with a conductor conveying a rapidly alternating current, and it has an important bearing on transformer design.

(To be continued.)

VARIATIONS IN THE E.M.F. OF CLARK CELLS WITH TEMPERATURE.†

BY W. E. AYRTON, F.R.S., AND W. R. COOPER, M.A., B.SC.

The present position of the Clark cell as a standard of E.M.F. is one of such great importance that it is highly desirable to study its behaviour under all working conditions. From time to time during the last few years the Board of Trade has issued specifications relating to its preparation, each one of which was modified according to the results obtained by the use of the one that preceded it. This led finally to the adoption of the cell as a standard, the specification being included in an Order in Council of last year. More recently, in a slightly different form, it has been legally adopted by the United States of America, and it is probable that other countries will soon follow in the adoption of a standard which may already be regarded as universal. In this paper the authors deal with temperature variations and their effect upon the accuracy of this standard. When employing a Clark cell for electrical measurements, it is often difficult to avoid changes of temperature which are sufficient to cause appreciable error if a corresponding correction is not applied. For example, in comparing such cells between themselves at frequent intervals, the differences are generally observed to change from test to test, and in order that the figures obtained may be of any value, it is of some importance to know how readily variations of temperature are reproduced as variations of E.M.F. in any particular cell. It is very usual to assume that the temperature coefficient amounts approximately to 0·077 per cent. per degree centigrade, or that the E.M.F. is diminished by 0·0011 volt per degree rise of temperature. There is no doubt that such is often the case, at least for considerable changes of temperature at a slow rate. But we have always felt that a good deal of uncertainty might exist as to the extent of this correction, according as the temperature variation is very slow or comparatively rapid. Of course, large variations of temperature would always be avoided, as they must necessarily be accompanied by a lag in the corresponding changes of E.M.F.; but although ordinary precautions may be taken, small variations generally occur.

The question then arises, Are we justified in applying in full the correction given above for variations of temperature such as occur in practice, or should its value be materially diminished, except when the cells have been subsequently kept at a steady temperature for a very considerable time? It was with a view of obtaining more definite information upon this matter than could be found in any work upon the subject that the experiments described below were begun more than two years ago. It also appeared desirable to ascertain to what degree of accuracy temperature coefficients could be determined by observing the changes in E.M.F. during a continuous change of temperature.

The tests were in all cases carried out upon cells set up in accordance with the specifications of the Board of Trade. Those employed in the preliminary experiment were set up according to the specification of October, 1892, but the remainder were made according to the final specification of the Board of Trade.

The authors proceed to describe the arrangement they used to give to the cell a slowly increasing or decreasing temperature. The E.M.F. was compared with a standard by the potentiometer method. The various results are plotted in curves convenient for reference, and the authors conclude that, in general, Clark cells are very sensitive to changes of temperature, but are subject to a lag which is variable in value even when these changes of temperature are small. For that reason it is generally impossible to apply a correction which shall be accurate to $\frac{1}{10000}$th of a volt for even very slow variations of temperature. Of course, in work involving a knowledge of the absolute E.M.F. of the cell, this is of no great importance, as we do not know the value of the E.M.F. to greater accuracy than 0·1 per cent. in true volts, but it may be of importance when dealing with comparisons.

If we suppose a cell to be placed in a water bath the temperature of which is 3·0deg. different from that of the cell previously, we may conclude that after the lapse of half an hour the lag will not amount to more than 0·1 per cent. of the E.M.F., and will generally be less. In such cases the temperature coefficient should be diminished somewhat in value when correcting for actual variations, unless these take place with extreme slowness. In fact, it would appear that a more suitable value for the temperature coefficient, for use under ordinary working conditions, would result from actual curves, such as those given in the paper, although it would not be the true value. It must, however, be remembered that cells differ among themselves somewhat as to the value of the coefficient. The cells were carefully examined, but, although small differences were apparent, their appearance furnished no characteristics by which the observed phenomena might be accounted for. As already mentioned, the majority of the cells were constructed at the same time, and many were precisely alike as far as could be judged.

It has for some time past been suspected that the lag of the E.M.F. of a Clark cell behind the temperature was due not merely to the mean temperature of the cell itself lagging behind that of the bath, but to time being necessary for the variation of the amount of crystals in solution and for diffusion to take place. How far this cause of lag is diminished by the use of the type of cell where there is only one horizontal surface of contact between metal and liquid the authors are about to determine experimentally.

There appears to be a general tendency for the E.M.F. of cells set up in accordance with the final specification issued by the Board of Trade to fall somewhat below the normal value after the lapse of some months. For example, the E.M.F. of cells set up in October, 1894, although, as a rule, not differing from 1·434 volts at 15deg. C. by more than 1 part in 3,000 when tested soon after construction, was in October, 1895, low by fully 1 part in 1,000. But the E.M.F. of cells constructed in June, 1895, although falling in October, 1895, was still not low by more than about 1 part in 2,000.

* The magnetic induction will *not* vary according to the simple harmonic law, but will follow one much more complex.

† Abstracted from the *Proceedings* of the Royal Society, vol. 59.

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THE

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TO CORRESPONDENTS.

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1897.

It would be entirely contrary to the spirit of Englishmen were we to neglect to greet our readers with heartfelt wishes that each one may have a "Happy and Prosperous New Year." Friends of old standing will know that this is no idle wish, and we can assure our numerous younger friends that our aim always has been, is, and will be to further, to the best of our abilities and opportunities, the welfare of the profession. We do not agree—we cannot agree—with all the business methods of the day, nor do we agree with all the scientific teaching of the day, but our criticisms in both directions are *bonâ fide* criticisms, with no mental or other reservation, and with no personal ends to serve. For many years it has been our custom to obtain and give a general *résumé* of the work of the past year, but after careful consideration of the subject we have this year decided against the old custom. Give your conclusions, but not your reasons, was the sound advice given by a judge to a judge. This warning does not frighten us from giving the broad reasons for the change. In the early days of the electrical industry—and probably our experience of the industry is as extensive as any—we felt it was necessary to show, and as far as possible to prove, to the general public that there was a reality in electrical work—that it had come to stay, and was no ephemeral production. The few who could afford it patronised the light as a luxury; but we know that what to-day is fashionable in the drawing-room will to-morrow be the fashion downstairs. There are those who always try to follow the fashion. Show them the tendency of fashion and they follow. Well, we tried, and we have reason to know succeeded in showing what was the fashion; and the moral is clear—the fashion has prevailed. Electric lighting has long since passed the point where it was considered a luxury, and among a considerable portion of the community—a portion rapidly extending—is looked upon as a necessity. The installations of the year in those early days numbered scores where they now number thousands. The bare recapitulation, now, of work done is merely doing what business men ought not to require. Consider for a moment the position of a business house that supplies fittings, lamps, oil, waste, not to speak of conductors and the heavy machinery. They employ travellers, they circularise possible customers, and their point is to do this to the best advantage. We certainly can suggest nothing better than making for themselves a directory from the business notes in the technical papers. These notes give hints as to hundreds and thousands of installations, and guide the searcher after such things to hundreds and thousands more. For example, when ships first began to be lighted notices of such installations were frequently given, but now shiplighting is so common that it is necessary to direct attention to it only at less frequent intervals. Similarly with hotel lighting. One of the best class of customers to electrical work is the hotel class, and there is no necessity to be constantly saying this. The wholesale houses will not only have a directory of installa-

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tions, but tabulated accounts of the number of customers in given districts, and maps of the districts. They circularise where the number of users is few, and appoint local agents as quickly as possible, their trade growing in any district with the prosperity of the industry in that district.

It seems a convenient season to call the attention of readers, and especially of new readers, to a series of papers we shall from time to time give in our pages. The majority of the papers will no doubt be contributed by the assistant editor of this paper, Mr. R. W. Weekes, Whit.Sch., A.M.Inst.C.E.; and as he collects and arranges the information, to him should credit be given. The idea is to visit the older installations, to describe them in their developed state, to give the fruits of their experience, so that the whole benefit of that experience may be reaped by the profession generally. It must not be thought that there is little to be learnt from the changes in detail that take place in all stations. It is to details that the greatest possible attention should now be paid; and while text-books describe what was—they cannot avoid it—practice has made many of those details ancient history. The first station to be described will be that of Kensington, over which has been the presiding genius of Mr. Crompton, ably seconded by Mr. Miller, who has kindly supplied information and given every facility for investigation. It is well known that a few engineers are as close-fisted with regard to information as Mr. Crompton is the contrary. Such individuals forget that it is scarcely honest to take and never to give. We may be wrong, of course, in our views as to the value of experience, but we share those views in common with nearly all the best engineers of the day. The results of the older stations now obtained—when those stations have been kept to the front rank by introducing details of working as found necessary—are of more importance than the details of a newly-opened station. It may be thought that the latter would embody all such details, but it does not. The designers of central stations have not always a free hand, and the result is frequently a compromise. Especially is this the case when the engineer is not a strong man. Our readers will know what we mean. The strong man will have his own way and do what is right, while his weaker neighbour will defer to the wishes of influential members of the council. With regard to these influential members we may venture to say that while the paying of visits to stations at work, the reading of some elementary book or books, and the talking with men who know is commendable and gives a smattering of knowledge, it really does not fit a man to initiate or interfere in a design. The broad features of a design may be such as every educated man can understand, but it is only the trained engineer who can see the interdependence of every detail with every other detail, and realise how interference with the details may lead to expense, future troubles, and lack of economy. As a rule, the men who compose the councils of large towns are sufficient men of business to know how far they can suggest with propriety and benefit. Their view is generally to give the engineer information to assist him to learn peculiarities of the district—to give him, in fact, information which none but a resident can supply. They are satisfied when they find the engineer acquainted with these things, and then leave him to work out the best scheme for such a district. Unfortunately, here and there, and especially in smaller towns, men are met with who have a higher opinion of their own merits, and here it is that conflicts of opinion are most frequent. But enough; on the whole, our central stations are good examples of that class of work. Mistakes have been made, mistakes have been rectified; and if the truth needs to be told, the resident engineers must tell it at some future date. They have borne the brunt of the troubles, they have set themselves energetically to work to overcome difficulties, and have succeeded in so doing to a far greater extent than we ever thought possible. We congratulate them on their achievements.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

FREE WIRING.

SIR,—Referring to your leading article in the issue of the 25th inst., with which I quite agree, it may interest you to know that (acting in the capacity of consulting engineer) I have advised a system for the town of Fermoy, co. Cork, somewhat similar to that you mentioned, as I fully realised the drawback to the adoption of the electric light by small tradesmen to be the outlay for the wiring and fittings, especially where gas is already installed.

The systems of free wiring hitherto proposed are apt to press too heavily upon the consumer who consumes a large number of units per lamp installed. It is this consumer who should be encouraged. It is, in my opinion, wrong to charge extra per unit for free wiring; the charge should be a fixed one per annum. The fittings should also become the property of the consumer, and this is provided for in the system I have recommended for adoption at Fermoy, which is briefly as under. The installation will be undertaken for those who desire it on the following terms: A charge of 6 per cent. on the cost of installation will be made per annum for interest on capital and maintenance of installation in good repair, and a further charge of 5 per cent. as a minimum will be made for the sinking fund per annum. The wiring will become the property of the consumer when the whole amount has been paid off. A greater amount than 5 per cent. can be paid in any year or years, enabling the amount to be paid off sooner. The fittings will be kept in repair by the undertakers, excluding breakage due to wilful damage or carelessness.

Example.—Ten lights; estimated cost of installation, £7: (*a*) 6 per cent. for interest, etc., and 5 per cent. for sinking fund; annual payment = 15s. 4d.—total payment, £15. 6s. 8d. (fittings become property of consumer after 20 years). (*b*) 6 per cent. for interest and 20 per cent. for sinking fund; annual payment = £1. 16s. 4d.—total payment, £9. 1s. 8d. (fittings become property of the consumer after five years).

I have also recommended a system of supplying lamps to consumers to obviate the difficulty of bad lamps. The consumer to pay for one lamp per annum per lamp-holder; all lamps required over and above that will be supplied free, if the lamps blacken badly, or are broken owing to being defective. If there is any doubt about a lamp being bad it will be tested, and if the candle-power is 30 per cent. less than the declared, or if the watts per candle-power have increased 30 per cent., it will be taken as defective. It is hoped by this arrangement to prevent a great deal of

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dissatisfaction, and also to encourage to some extent those consumers who use their lamps a large number of hours per annum; but the arrangement will be quite optional. I believe that this system is exactly the reverse of that proposed at Bradford, and I would be pleased to hear the opinion of your readers on it.—Yours, etc.,

F. J. WARDEN-STEVENS.

PIONEER ELECTRIC LIGHT STATIONS.

THE KENSINGTON COURT STATION.

The Kensington and Knightsbridge Electric Light Company may be considered as the first company to successfully supply electricity in London on the low-tension system. The works were commenced in 1886, and some of the original machinery may still be seen running in the Kensington Court station. Being so early in the field, it follows that the engineers responsible for the design and arrangement of the plant had practically no central-station experience to guide them, but had to solve by original thought the many problems arising. Subsequent stations have hence been designed from experience gained at Kensington, and the facts on which Mr. R. E. Crompton fought the battle of low *v.* high pressure were also gleaned from the same source. It follows also from the early start made by this and other pioneer stations that they often suffer from details in equipment which their experience has shown to be defective. A system of mains or of machinery cannot be changed suddenly and without expense. The engineers in charge have to make such changes slowly, and at the same time the supply has to be kept constantly going, whereas a new station started with the information gained, can adopt these necessary economies from the start. Mr. W. H. Miller, the able engineer of the Kensington Court station, has had many difficulties to encounter, and has shown, as our readers will gather from the following, great resourcefulness and energy in dealing with the same. Thus at the commencement the station was worked without any economiser or condensers, and with a new and untried system of bare copper mains. That some faults would be found in details of the design was certain, but in spite of these and the destructive fire of 1895 a regular supply has been given which has warranted the increase shown in the output. The following is a brief *résumé* of detailed improvements, either added or now in the course of construction, in the various departments.

Steam Generating Plant.—The boilers used throughout have been of the Babcock-Wilcox type. The first difficulty arising was due to the sudden fogs often experienced in the winter months at Kensington. At such times there was found to be need for rapidly increasing the output of the boiler under steam to take up the load while other boilers were getting up pressure. For this purpose a system of liquid fuel was added. Holden oil-fuel injectors are used to spray the oil by means of a steam jet on to the fire. The liquid fuel used is either Russian astatki or oil-gas tar. A most intense heat can be obtained in this way. Orders are given, however, that the oil blast shall only be used when urgency requires it, and not as a regular fuel. The noise caused by the steam jet is silenced by enclosing it in a tube leading to the space under the grating in the front of the boilers.

The next device added to the boiler plant was the Johnson system of smoke consumption. This consists of a nest of hollow asbestos balls placed on the fire-bridge. Air is admitted at this point from an inlet at the side of the boiler seating. The gases are thus rekindled at this point, consuming all the smoke coming from the grate. The asbestos balls become incandescent, and act both as a source of radiant heat and as an equaliser. The flames, which without this addition are practically extinguished at or a little beyond the bridge, with it extend right through to the flue. We cannot do better than quote from Mr. R. E. Crompton's report to the Economic Smoke Consumer Company on the effects of their apparatus. He says that "his own opinion, after seeing the apparatus at work for some months, is that Mr. Johnson has been the first to hit upon the extremely happy idea of fitting inside the flue of a boiler in the most effective position a small regenerative furnace which acts as a flywheel or equaliser of the temperature of the flue gases—*i.e.*, at the time that the fire-door is open for the purpose of supplying fresh fuel to the fire, the heat stored up in the bed of incandescent asbestos is sufficient to complete the consumption of the carbon monoxide given off by the green coal, and it does so without any great diminution of its own temperature; such loss in temperature, however, as it sustains in doing this is given back to it immediately the fire-door is closed, and hence the supply of cold air above the surface of the fire is reduced. During this period the temperature of the asbestos bed is considerably increased, ready to

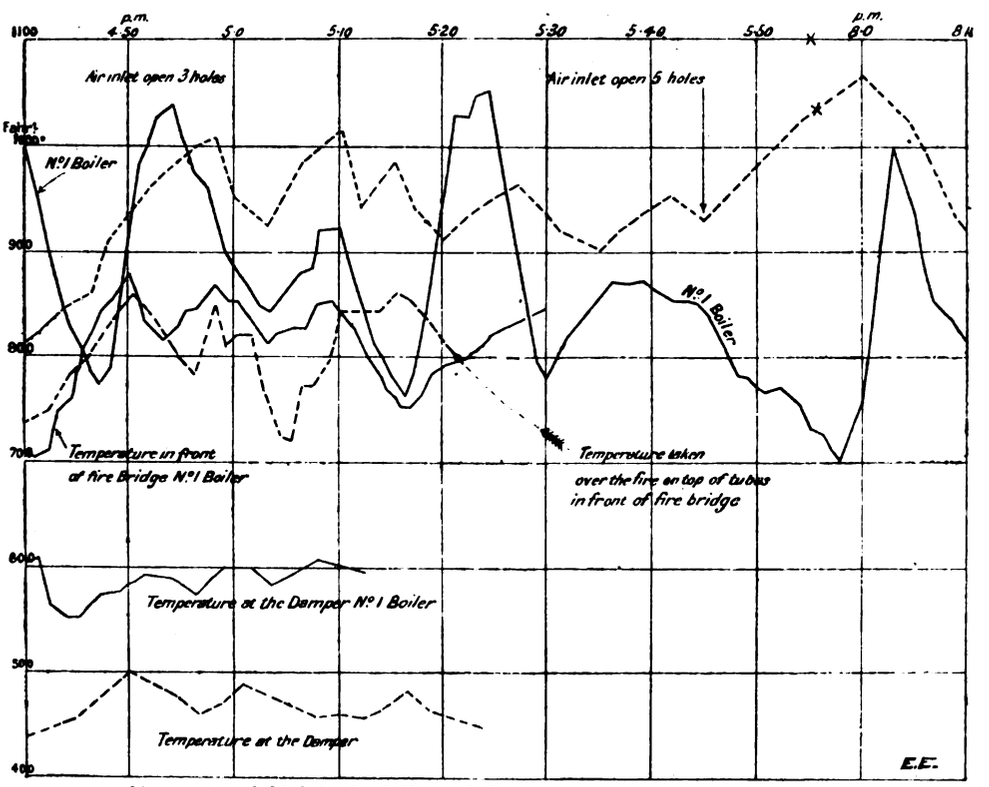

FIG. 1.—The two upper curves are of temperatures behind the fire bridge. All dotted curves were taken on a boiler fitted with the Economic smoke-consuming device, while full curves are taken in an ordinary boiler.

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yield up part of its heat during the succeeding period of firing. He also is a great believer in the efficiency of radiant heat in a steam-producing apparatus, and thinks that one of the reasons why the output of the boiler is so greatly increased is that, instead of the water immediately surrounding the flues only receiving radiant heat from the actual 5ft. of the incandescent fuel, in Johnson's apparatus it is influenced by radiant heat for more than double this length—in fact, that the great length of incandescent asbestos evaporates a very much larger amount of water than the corresponding amount of flaming gas would do acting on the same length of flue. But over and above this, the effect of Johnson's apparatus is to increase the length of the flaming gases to an enormous extent; in many cases they have been traced to points 40ft. distant from the end of the grate."

We are also able, through the courtesy of Mr. W. H. Miller, to give the curves (Fig. 1) showing the increase in temperature at different points due to the addition of this smoke-consuming apparatus. By comparing the curves showing the variation of temperature before and after the asbestos blocks have been fixed, the equalising action can be appreciated. Mr. Miller assured us that a smoky coal no longer caused him any trouble, and that the output of the boiler per given weight of coal was much increased. This increase he estimates to result in a saving of 27½ per cent. in the cost of fuel, and this saving has been confirmed elsewhere.

exhaust steam heaters, which are too small for the work. A new three-throw feed-pump, electrically driven, is now on order from Messrs. Ernest Scott and Co., of Newcastle-on-Tyne.

Generating Plant.—The present position of the steam dynamos, as seen from the plan, shows the station in a transition stage. The three small sets, figured A, B, and C respectively, are the original engines and dynamos installed by the company when first starting. The next plans in date show that all the sets were to be placed side by side parallel to the engines and dynamos (figured F and G). When some four of the two-crank Willans and one engine of another maker had been erected in this way, trouble arose from vibration. The complaints came from houses near the station and extending some 50 yards from the engines. Mr. Miller immediately took steps to ascertain what vibration actually did occur, and found it necessary to design an instrument for recording these vibrations. We reproduce in Fig. 4 some records obtained in this way. The actual vibration is about one-hundredth of the amount shown. It was found that the two-crank engines were the chief offenders, and hence the three-crank type have been adopted. It was also thought advisable not to place the engines all parallel to each other, so that the vibration could be cumulative, but rather to arrange them with their axes in different directions as shown. That such synchronising of vibration can be observed is shown in two of the records above.

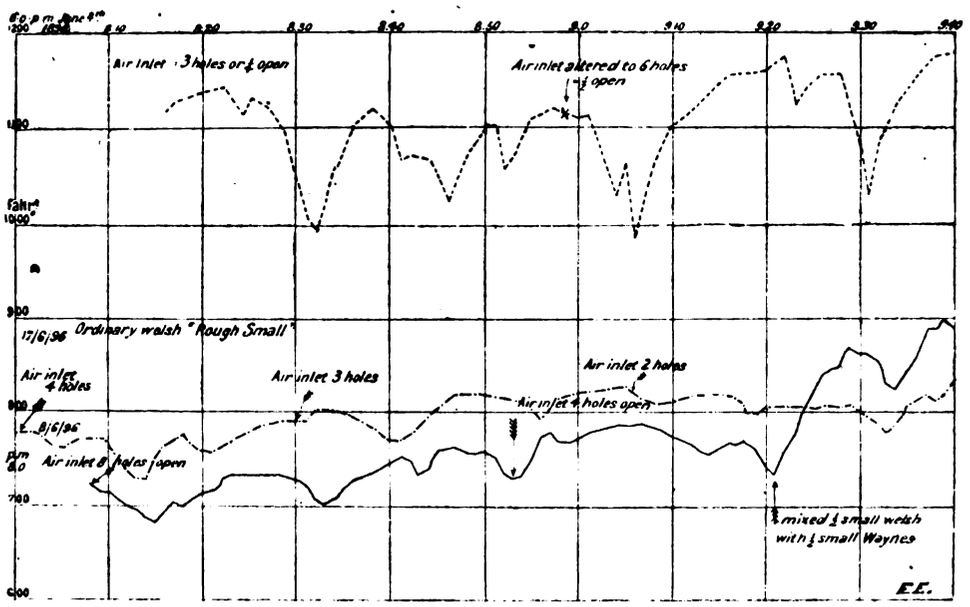

FIG. 2.—Coal Trial. All temperatures taken behind fire bridge. The upper dotted curve is for Waynes Merthyr coal.

Mr. Miller has also experimented somewhat largely on the quality of the coal to be used, and the curve Fig. 2 shows how great a difference can exist between the so-called best Welsh coals. The lower temperature curve was taken when a coal which has a good reputation was being used, and yet the Waynes Merthyr gave temperatures about 25 per cent. higher, as shown by the curve above.

There are at present five boilers in the station, arranged as shown in the general plan (Fig. 3). Four of these are together able to take the maximum load when the dynamos receive assistance from the accumulators. The flue at present runs direct into the shaft, which is only 100ft. high. A rather poor draught is obtained, equivalent to about ⅜in. of water. Alterations are now nearing completion for the addition of an economiser and a settling-chamber. The new flue passes round two sides of the shaft (Fig. 3) and into a chamber. This chamber is a 15ft. cube, and in it the engineer hopes to retain the fine grit coming from the boilers when anthracite is being burnt. The gas will then pass through a Green economiser and into the stack. We shall not be surprised to hear that the next improvement in this department will be an induced-draught plant. With the present arrangement, small coal, giving a saving of 5s. per ton, cannot be burnt at periods of full load.

The boilers are fed at present by four Worthington steam pumps, and the feed-water is slightly warmed by two

These records also show how much more intense the vibration caused by people walking in the room are than those caused by the dynamos. It was found that although the three-crank engines did not give the pounding action of the two-crank, they set up a distinct longitudinal rock. This affected the main steam-pipes, as the copper bends were not capable of taking up the vibration. To get over this, Mr. Miller had some new copper connections made of the kettle-handle shape, which have successfully damped the vibration. In fact, with the alterations made, all complaints have ceased, and the vibration difficulty is practically overcome.

The plant at present in use at the station consists of three two-crank Willans engines (A, B, and C) coupled to 50-kilowatt Crompton dynamos, two three-crank engines (D and E) of the same type coupled to 155-kilowatt Siemens dynamos, and two three-crank Willans engines (F and G) at right angles to the above, also coupled to 155-kilowatt Siemens dynamos, giving a total output of 770 kilowatts.

Accumulators.—The old accumulators were ruined by the fire in February, 1895, and the new set has been erected in one-half only of the old accumulator-room. The necessary space has been found by placing the cells in two tiers. There are now some 112 Epstein cells in use, having a normal capacity of 2,000 ampere-hours. At 222 amperes discharge rate the battery will supply for nine hours,

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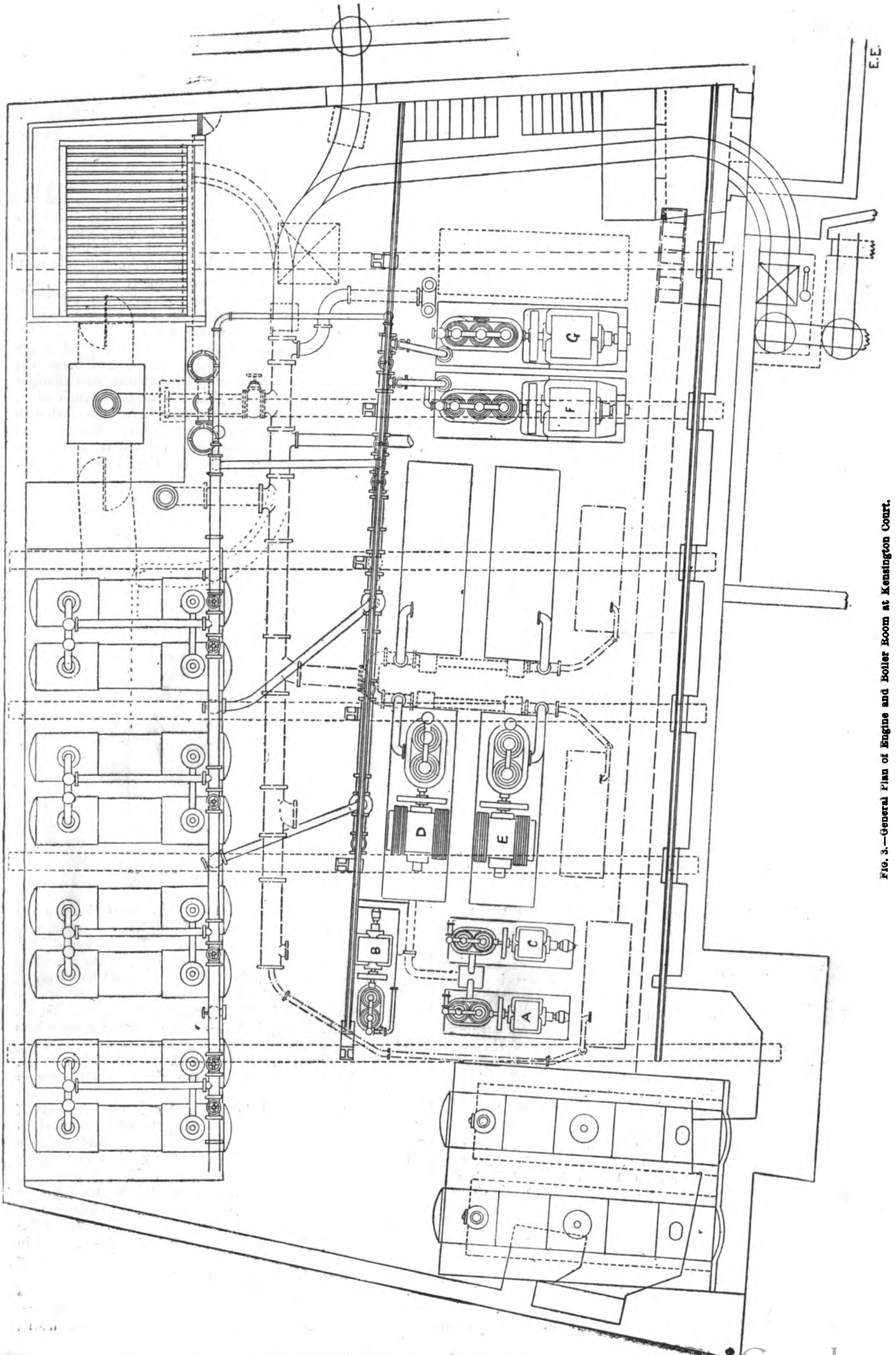

FIG. 3.—General Plan of Engine and Boiler Room at Kensington Court.

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while for four hours a discharge of 400 amperes can be given. The charge given to it is regulated by meters of the Aron type, placed under the switchboard. These meters record ampere-hours, and are graduated up to 2,500 ampere-hours on a circular dial. When fully charged the needle stands at zero, and the discharge or amount left in can be read at a glance. By means of a shunt to the voltage coils of the meters the constant of the instruments is changed when charging, so that 7½ per cent. more is put into the battery than taken out. This excess has been found on trial to be enough to keep the battery in perfect order. The density of acid of 16 cells is taken each day, and the record most carefully kept. In this way incipient faults are found and checked before they do damage to the plates. A small direct-current transformer, with a ratio of 100 volts to three volts, is used to charge individual cells. This small set, made by the Electric Construction Corporation, has a four-pole field. Its output on the low-tension side is 350 amperes and it runs at 1,000 revolutions.

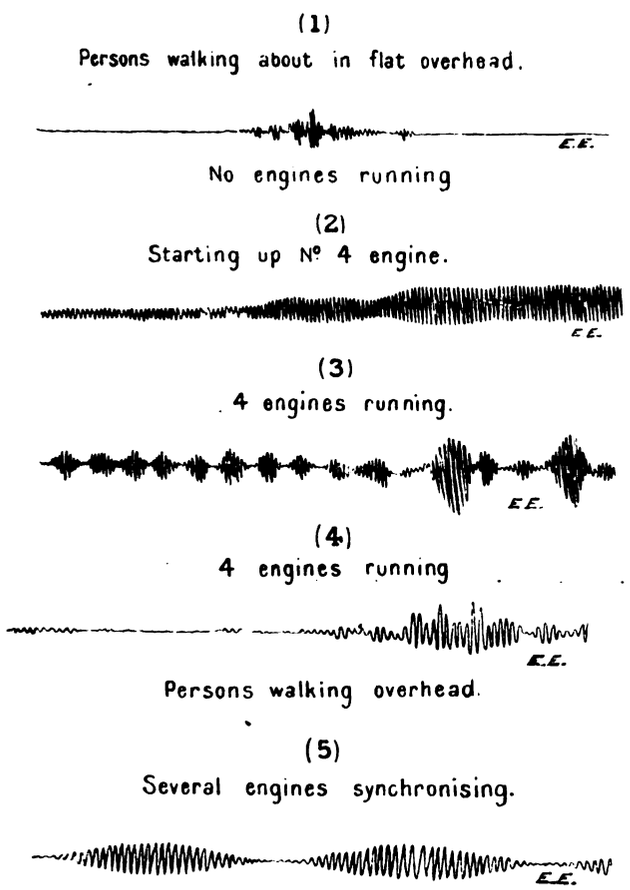

FIG. 4.—Vibration Curves taken in a house near the station. The left-hand part of the fourth curve shows the extent to which the vibration has been reduced by using three crank engines.

Mains.—The Kensington and Knightsbridge Company were certainly first in the field as regarded underground mains. Their first type consisted of a conduit containing insulators, shackles, etc., as for an overhead wire with an extra heavy conductor. This system, used in 1888, was successful, certain sections being still in use. The shackles were awkward to fix and to strain to. This led to the invention of the Crompton system, in which heavy copper tape is strained up in conduits. The details of this conduit have been very frequently described, and our readers will remember that insulators were used to support the copper strip between the straining points. These insulators were of glass, and did not give satisfaction. The defects found on working led to the adoption of the insulators (Fig. 5) for this purpose. Great changes have also been introduced by Mr. Miller in the form of the straining apparatus. It will be remembered that in the original conduit the straining clamp rested on two insulators placed on two cross wooden bearers. With this type, if one insulator broke, the heavy brass block was likely to cant sideways, causing a short-circuit to its next-door neighbour. Another point worthy of notice was the fact that at the point of support the conductor was at the centre of the conduit. Hence the height available for sag before the conductors touched the bottom of the conduit was comparatively short. Again the straining boxes were almost full of apparatus, making it difficult to inspect the conduits from the end. The new arrangement is as follows: The upper oak crossbar only is used, the lower one being removed. The insulators are made cylindrical, the section of the cylinder being an elongated H laid on its side. One circular edge (the outside) rests on a rubber pad on the oak crossbar, while the brass straining clamp rests on the inner edge of the opposite end of the insulator. Holes are bored through the oak concentric with the insulators, and through both of which the conductor passes. In this way the apparatus is self-centring, and no part of the brass clamp projects beyond the porcelain insulator. As a rule, two copper tapes at least are used for each conductor, and between them, at the clamp, a wedge is driven in, so that even if the set screws work loose the conductor would not slip appreciably. This arrangement brings the conductor much higher up in the conduit at the points of support, so that longer spans can be used. With this new type spans of 25 yards are possible, where before 16 to 18 yards was the maximum allowable. A clear space at the bottom of the box is also given, so that

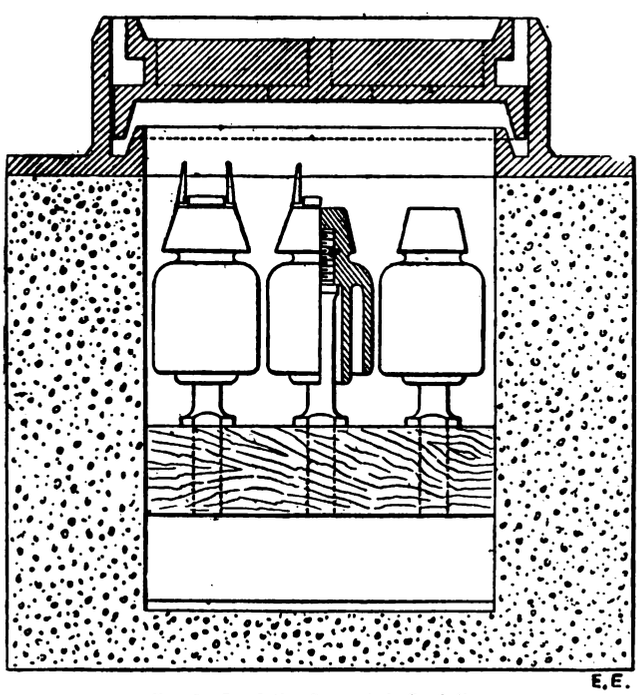

FIG. 5.—Insulation Supports in Conduit.

the conduits can be inspected by the aid of a looking-glass. All feeders are laid in the same way as the mains. Where there is not room for the conduits, Henley's rubber cables are used, and are drawn into wrought-iron pipes.

The whole of the network of mains throughout the district are interconnected. There are some seven feeders from the station to different parts of this network, and five feeders from the battery station at Queen's-terrace. These feeders are two-wire only, and feed on to the outside conductors of the three-wire system. The zero wire is brought back to the station from three directions, and care is also taken in connecting houses to get as good a balance as possible. At present no arrangement is used for hitching up the voltage given to particular feeders, but additional copper is drawn in when any feeder is found to be overloaded. In this way equality of pressure throughout the district is obtained.

Battery Station.—This station, referred to above, has two sets of accumulators in it, giving a total capacity of 2,500 ampere-hours. It is always charged from the Kensington Court station, a local motor-generator being used to charge the end cells.

Load on the Station.—The curves given in Fig. 6 show the maximum day's output for the past 10 years. A comparison of these from year to year shows how well the company have catered for and obtained a day load. The following is a brief *résumé* of the system of charges tending

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to produce this result: Until July, 1895, a charge of 8d. per unit was in force; now the charge for lighting purposes is 6d. to consumers taking supply at 100 volts, and 5½d. to those who will be connected across the outside wire. In this way a number of 200-volt connections are being made.

cent.; if 60 units, 12½ per cent.; if 72 units, 15 per cent. The motor load now connected is estimated to be about 50 h.p. in the aggregate. It will be noticed that this year the day load reached a mean value equal to about 25 per cent. of the maximum load.

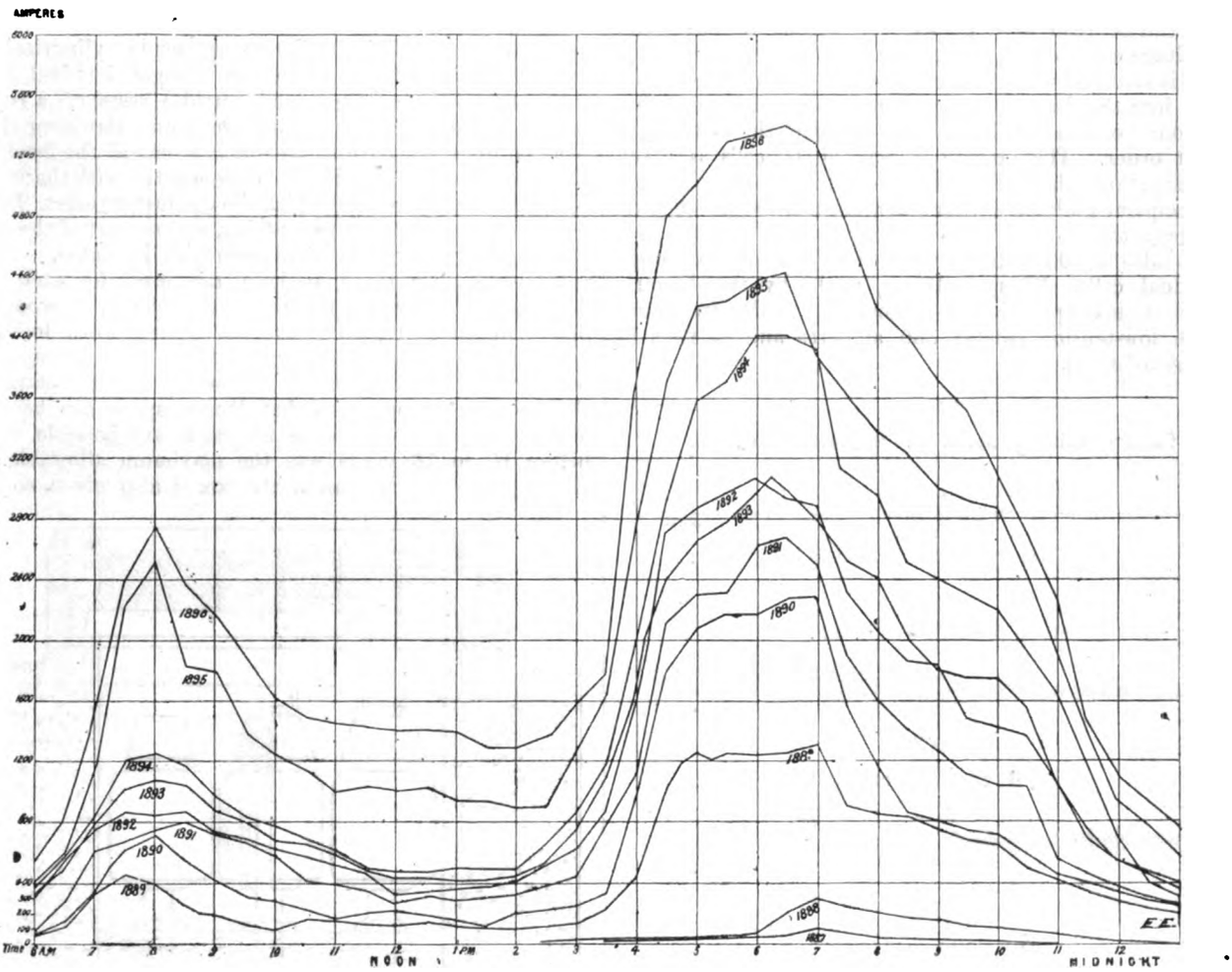

FIG. 6.—Load Curves taken on the day of Maximum Output each year.

The charge for heating and power is 4d. per unit, and in a few places a similar reduction is made for day lights. In this case two meters are installed with a controlling switch, so that the main lights cannot be switched on without throwing the 6d. meter into circuit. A rebate is allowed to consumers paying the company over £500 per annum,

The next set of curves (Figs. 7 and 8) show how the load curves alter with the seasons; and here it will be noticed that the areas and shapes of the curves are not determined

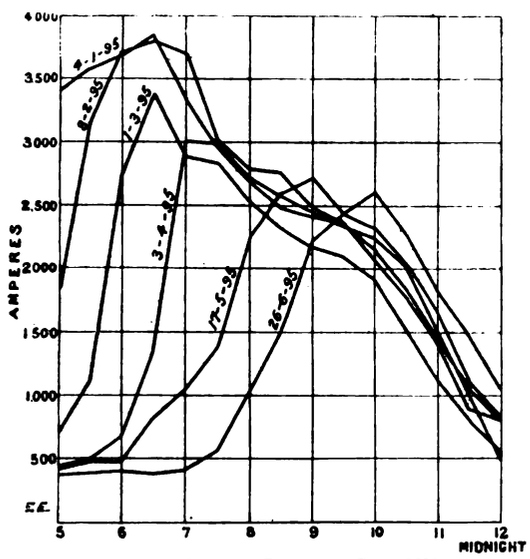

FIG. 7.—Load Curves, January to June, 1895.

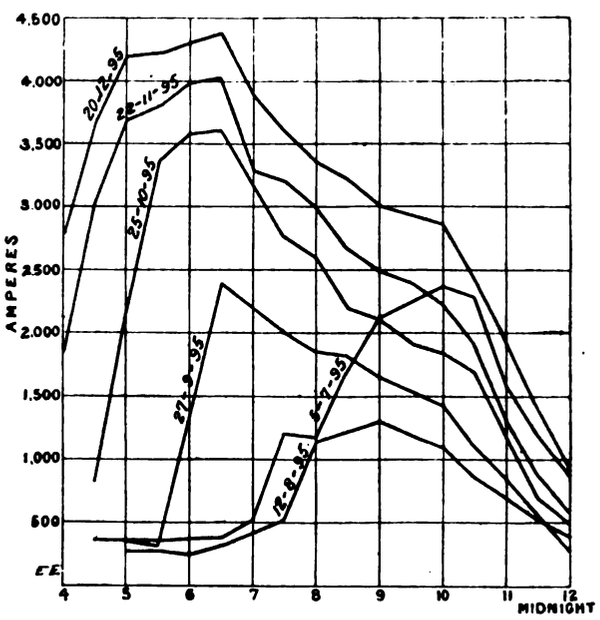

FIG. 8.—Load Curves, July to December, 1895.

and also to regular consumers as follows: If the consumer's annual consumption of electricity for each 8-c.p. lamp fixed in his premises (or its equivalent) shall be equal to 24 units, he shall be entitled to a rebate of 5 per cent.; if 36 units, 7½ per cent.; if 48 units, 10 per

solely by the time of sunset. A regular progression or retrogression of the hour of maximum supply can generally be seen, but the effect of the August holiday season is most plainly marked.

The greatest addition to the outfit of this station now

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in course of erection is a condensing plant. A Ledward evaporative condenser is placed on the flat roof of the station, which is about 35ft. above the level of the exhaust main in the engine-room. A 4-h.p. Crompton motor, driving a Gwynne centrifugal pump, will supply the water to cool the deeply-ribbed pipes of this condenser. The air-pump will also be electrically driven, and will be placed in the engine-room. It is found that the rising exhaust main causes the oil in the steam to separate out, so that pure water comes away from the condenser. The height of the condenser above the floor-level of the engine-room will allow this water to be drawn off without the aid of the air-pump. The drainage of the exhaust-pipe will, however, be introduced in the suction to keep the buckets lubricated.

We have to thank Mr. W. H. Miller for the above information, and Mr. R. E. Crompton for permission to publish the same, and trust to be able to give at a later date the figures of the economy resulting from this latest addition to the plant.

DYNAMOS AND MOTORS — MAINTENANCE AND CONSTRUCTION.*

BY J. B. HALL.

As a great many commutators are constructed a slight blow on the surface will produce a flat, *a* (Fig. 1), which can only be removed by turning off the surface in a lathe. An excellent method of prevention is to leave the space below segments, *b* (Fig. 1), vacant, and after assembling drill two holes, *c* (Fig. 1), in the sleeve, *d*, and washer, *e*, and after

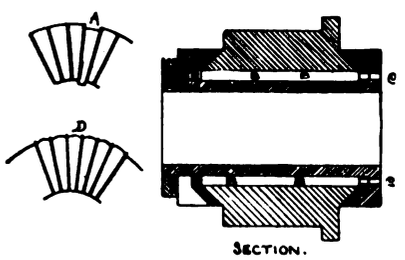

FIG. 1.

warming the commutator to about 212deg. F. pour molten sulphur in one hole until it is full, jarring the commutator to cause adhering air bubbles to escape. Thus the possibility of developing a flat is minimised; in fact, some prepared thus have been struck with a hammer and nothing occur but a dent in the segments.

A great many machines on the market have hastily-filled-up commutator bars which are not true to gauge, the mica insulation between having the same fault, and as a result there is a shifting of the neutral point backward and forward over a small space, which, though not very important alone, in connection with a distorted field at full load (caused by the armature reaction) greatly aggravates the evil of sparking. Sometimes the bars pinch. In that case, when the bars have worn some depth, they become slightly loose, and the friction of the brushes, with the pull of the connecting wires, throws the bars on a stagger, *a* (Fig. 2), causing two bars to be short-circuited under each of the brushes at a time, thus doubling the tendency to spark. Bars pinching on their inner side are not so bad as the case just mentioned, for in a machine running in one direction the bars cant over in the direction of rotation (*b*, Fig. 2) as far as the washers will permit; then the leading edge (in the direction of rotation) is slightly raised, although in time it will wear down. Some faint sparking generally sets in, which increases the trouble as the area of brush contact is diminished, increasing the resistance, causing a greater loss of watts, which manifests itself in heat. Mica over 0·05in. thick is likely to wear less than the copper segments between, and create ridges which will make the brushes jump and cause a spark at *d* (Fig. 1), which will gradually increase until the whole surface is pitted, and the only remedy is to turn the commutator n a lathe. When the trouble is slight, the mica can be levelled by backing a piece of 000 sandpaper with a smooth piece of wood, and rubbing it over the surface until no irregularity of the surface is perceptible to the touch.

Another source of loss in certain makes of machines is in the brush-holder. This brush holder has nothing to recommend itself except its cheapness of manufacture. Fig. 3 shows

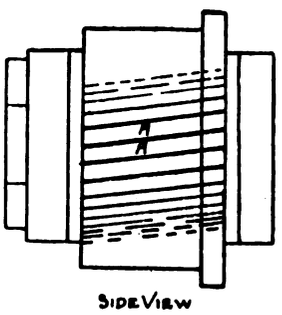

FIG. 2.

its appearance. The passage of the current to the carbon is almost altogether through the spring and pressure plate, *b*, *c*, and with large currents the resistance of the spring, even if it is of large wire, is material; but the worst point is that the moment of inertia of the spring is too great to permit it to press the carbon evenly when passing over slight irregularities in the commutator's surface, therefore increasing the friction loss. Or, if the spring is of fine wire, the tendency to buckle out of shape is manifest, and the resistance to the current soon heats up the wire, and its temper soon leaves it, the resistance of the sliding contact increases and sparking sets in, and the commutator shows the loss by a rise of temperature.

Quite a number of armatures are constructed with a very low magnetic flux and a large number of turns of wire; the latter in certain machines whose rated capacity is about twice the safe limit, both as regards sparking, heating, and torque. Most of these are rated from 1 h.p. to 10 h.p., have a loss of over 25 per cent., and have a rise of temperature of 130deg. F. above the atmosphere, and these are sometimes pointed out as successes and they command a large sale. The only reason of their failing to break down is that they are seldom loaded to their full rated capacity, and if that should occasionally happen, the sputtering, sparking, and steaming of the commutator and bearings scare the user, and he hastens to lighten the load.

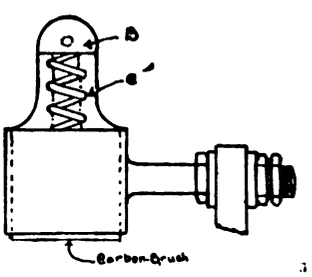

FIG. 3.

A very liberal rule to go by when examining a motor is to note the decrease of speed when loaded, and if the difference is more than 80 in 1,000, a rejection of any of that kind should follow as being unsuitable for any purpose. Motors should be so designed to sustain their full load without movement of the brushes, for not one person out of a thousand would care to take the trouble to do it by hand. In dynamos, failure to adjust the brushes on a machine of the kind noted shows itself in the dimming of the lamps.

In regard to the ultimate heating of a machine, 212deg. F. should never be exceeded. Taking the maximum temperature of the room in which the machine is at 100deg., 112deg. F. is the greatest allowable rise of temperature of any machine, and although such a temperature is safe as

* From the *Canadian Engineer*.

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far as charring the insulation is concerned, most lubricating oils vaporise below that temperature (212deg. F.), and the resistance of the electrical circuits increase, roughly, about 20 per cent. more than an 80deg. rise. While such a high temperature is allowable, yet it is generally safe to assume that a machine having a rise of over 85deg. F. is very inefficient. Bearings are now generally well proportioned by all manufacturers, and in considering them, a rough and ready rule is to allow for machines having over 1,000 revolutions per minute length of bearing (actual surface in contact with the shaft) = 4 times the diameter of shaft, and for speeds under 1,000 R. p.m. length of bearing = 3 times diameter of shaft. Oil rings are to be preferred to chains if they are seamless, as chains have a tendency to stick. The oil should be changed at the greatest interval of time of one month, and the reservoir cleaned out of all brassdust that may have accumulated. The small amount of trouble involved in so doing will save the replacing of bearings at frequent intervals.

Motor and isolated dynamo users have a very wise (?) plan of placing their machines in an out-of-the-way corner where dust gathers in quantity, and neglecting to pay attention to the requirements until some day the motor fails to "mote" and the dynamo fails to "pick up"; then in hot haste they send for the maker, and with the "finger of scorn" upraised, they, by their language and gestures, blame the machine for failing to operate under treatment that they would be ashamed to give a steam or gas engine, or even a water-motor.

CALCULATION OF ELECTRIC MOTORS.*

BY ALFRED E. WIENER.

While the subject of generator design has received abundant treatment in the technical Press, that of motor calculation is very seldom approached from a practical standpoint.

It is a well-known fact that a properly designed generator will also be a good motor, and the general calculation of an electric motor therefore can be resolved into the calculation of a generator, provided the capacity of the latter is such that, when run as a motor, it gives the required power at the proper speed. Hence, the most practical way to proceed in a motor design is to first determine the output and the voltage this motor would produce when driven as a generator, at the given speed, and to then determine the dimensions and windings of that generator in the ordinary manner by employing the usual rules and formulæ. This being done, the calculation is completed by computing the speed attained at, and the current required for, various loads.

1. *Capacity of Generator Corresponding to a Motor of a Given Output.*—Considering a given dynamo as a generator, its output, P_1, in watts at the terminals is the total energy, P′, generated in its armature by electromagnetic induction due to the relative motion between the conductors and the magnetic field, diminished by the amount of energy absorbed between the armature conductors and the machine terminals—that is, by the loss due to internal electrical resistances. In other words, the output is the total electrical energy produced in the armature multiplied by the electrical efficiency of the dynamo. The output, P_2'', of the same machine when run with the same speed as a motor is the useful electrical energy, P′, active within its armature in setting up electromagnetic induction, less the energy lost between armature and pulley—that is, less the loss caused by hysteresis, eddy currents, and friction, or is the product of electrical activity and gross efficiency. Conversely, the power, P_1', to be supplied to the generator pulley must be the total energy, P′, produced in the armature, increased by an amount equal to the magnetic and frictional losses, or must be P′ divided by the gross efficiency. And the energy, P_2, finally required at the motor terminals in order to set up in the armature an electrical activity of P′ watts is found by adding to P′ the energy needed to overcome the internal resistances of the motor, or by dividing P′ by the electrical efficiency. Designating the electrical efficiency of the machine—*i.e.*, the ratio of its useful to the total electrical energy in its armature—by η_e, and its gross efficiency, or efficiency of conversion—*i.e.*, the ratio between the electrical activity in the armature and the mechanical power at the pulley—by η_g, we therefore have

Output of machine as generator:

$$P_1 = \eta_e \times P' \quad . \quad . \quad . \quad . \quad . \quad (1)$$

Output of machine as motor:

$$P_2'' = \eta_g \times P' \quad . \quad . \quad . \quad . \quad . \quad (2)$$

Power to be supplied to machine when run as generator (driving power):

$$P_1'' = \frac{P'}{\eta_g} \quad . \quad . \quad . \quad . \quad . \quad . \quad (3)$$

Energy to be supplied to machine when run as motor (intake of motor):

$$P_2 = \frac{P'}{\eta_e} \quad . \quad . \quad . \quad . \quad . \quad . \quad (4)$$

Where P_1, P_2 = electrical energy at terminal of machine, as generator and motor respectively;
P′ = electrical energy active in armature conductors, being the same in both cases;
P_1'', P_2'' = mechanical energy at dynamo pulley, for generator and motor respectively.

By transposition of (2) the electrical capacity of the machine can be expressed by the motor output—thus:

$$P^1 = \frac{P_2''}{\eta_g},$$

which is to say that, in order to find the dimensions and windings for a motor of $hp = \frac{P_2''}{746}$ horse-power, it is necessary to figure a generator which at a given speed has a total capacity of

$$P' = \frac{P_2''}{\eta_g} = \frac{746 \times hp}{\eta} \text{ watts.} \quad . \quad . \quad . \quad (5)$$

The E M.F. for which this generator is to be calculated, or the counter E.M.F. of the motor, is the voltage at the motor terminals diminished by the drop of potential within the machine, or

$$E' = E - I \times (r + r_{se}) \quad . \quad . \quad . \quad . \quad (6)$$

in which

E′ = E.M.F. active in armature, in volts;
E = voltage supplied to motor terminals;
I = current intensity at motor terminals;
r_a = armature resistance, at working temperature, in ohms;
r_{se} = resistance of series field, warm, in ohms, for series and compound machines; in case of shunt dynamo $r_{se} = 0$.

Formula (6), though theoretically accurate, is not practically so, since for the same excitation, armature current, and speed the counter E.M.F. of a motor is greater than the E.M.F. when used as a generator for the following reasons: in the generator the proper position of the brushes is determined by the sum of the influence of armature reaction and of self-induction, while in a motor it depends on their difference; in a motor, therefore, the shifting of the brushes is less than that in a generator by double the effect of the self-induction. As the weakening of the field by the armature increases proportional to the angle of lead (or lag), it follows that in a generator the armature current weakens the field more than in a motor. The magnetic field due to the eddy currents is less in the generator than in the motor on account of the diminished waste field, and has the opposite effect upon the useful field. The eddy currents in the generator weaken the field, while in the motor they strengthen it. Finally, in the generator the self-induction diminishes the E.M.F., while in a motor it strengthens the counter E.M.F. For the purpose at hand however, formula (6) gives the required counter E.M.F. with sufficient accuracy, particularly because neither the current strength nor the resistances usually being prescribed, the drop must be estimated. The latter is best done by

* From the *Electrical Engineer* (New York).

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means of the following Table I., which gives the average percentage of drop in shunt, series, and compound dynamos of various capacities :

TABLE I.—Drop of E.M.F. due to Internal Resistances.

Capacity in kilowatts.	Drop of potential in per cent. of output E.M.F.		
	Shunt dynamos.	Series dynamos.	Compound dynamos.
	Per cent. Per cent.	Per cent. Per cent.	Per cent. Per cent.
Up to ·5	20 to 12	40 to 25	30 to 20
,, 1	12 ,, 10	25 ,, 20	20 ,, 15
,, 2·5	10 ,, 8	20 ,, 16	15 ,, 12
,, 5	8 ,, 7	16 ,, 14	12 ,, 10
,, 10	7 ,, 6	14 ,, 12	10 ,, 8
,, 25	6 ,, 5	12 ,, 10	8 ,, 7
,, 50	5 ,, 4	10 ,, 8	7 ,, 6
,, 100	4 ,, 3½	8 ,, 6	6 ,, 5
,, 200	3½ ,, 3	6 ,, 5	5 ,, 4
,, 500	3 ,, 2½	5 ,, 4	4 ,, 3
,, 1,000	2½ ,, 2	4 ,, 3	3 ,, 2½
,, 2,000	2 ,, 1½	3 ,, 2½	2½ ,, 2

By dividing the electrical activity, P′, as obtained from formula (5) by the E.M.F., E′, the current capacity of the corresponding generator is found :

$$I' = \frac{P'}{E'} \quad . \quad . \quad . \quad . \quad . \quad . \quad (7)$$

For the purpose of simplifying this conversion of a motor into a generator of equal electrical activity the accompanying Table II. is given, which contains the average efficiencies and the active energy for motors of various sizes :

TABLE II.—Average Efficiencies and Electrical Activity for Electric Motors of Various Sizes.

Output of motor, $h.p.$, in horse-power.	Electrical efficiency, η_e.	Gross efficiency, η_g.	Commercial efficiency, $\eta_c = \eta_e \times \eta_g$.	Electrical activity in armature, $P' = \frac{746 \times h.p.}{\eta_g}$, in kilowatts.
½	·75	·80	·60	·5
1	·82	·82	·67	·9
2	·85	·84	·72	1·8
5	·87	·86	·75	4·0
10	·89	·88	·78	8·5
15	·90	·89	·80	12·6
20	·91	·90	·82	16 6
25	·92	·91	·84	20·5
30	·93	·92	·86	24·5
40	·94	·93	·87	32
50	·945	·935	·88	40
75	·95	·94	·89	60
100	·955	·9425	·90	80
150	·96	·945	·91	118
200	·97	·9475	·92	158
300	·98	·95	·93	236
400	·9825	·9525	·935	318
500	·985	·955	·94	391
750	·9875	·9575	·945	585
1,000	·99	·96	·95	777

As an illustration of the use of the above formulæ and tables, let us take a dynamo capable of developing a total electrical activity of P′ = 10,000 watts and having an electrical efficiency of $\eta_e = ·9$, or 90 per cent., and a gross efficiency of $\eta = ·88$, or 88 per cent. Then by (1) its output as a generator—

$$P_1 = ·9 \times 10{,}000 = 9{,}000 \text{ watts ;}$$

and by (2) its power as a motor—

$$P_2'' = ·88 \times 10{,}000 = 8{,}800 \text{ watts} = 11·8 \text{ h.p.}$$

The driving power required at the pulley when run as a generator is by (3)—

$$P_1'' = \frac{10{,}000}{·88} = 11{,}364 \text{ watts} = 15·25 \text{ h.p.,}$$

and the intake to be supplied to its terminals when run as a motor by (4) :

$$P_2 = \frac{10{,}000}{·9} = 11{,}111 \text{ watts.}$$

If the output as a motor, $P_2'' = 11·8$ h.p., is given, and the problem is to find the electrical activity in the armature of the corresponding generator, formula (5) is employed, and we obtain

$$P' = \frac{746 \times 11·8}{·88} = 10{,}000 \text{ watts.}$$

The same result could have been received from the preceding Table II. by taking the value of η_g for the nearest horse-power, provided the efficiency of the motor is not otherwise given.

Supposing the above motor is to be series wound, and to be run from 200-volt mains. Table I. gives an average drop of from 14 to 12 per cent. Taking the lower limit, we obtain a drop of $·12 \times 200 = 24$ volts, or, by (6), the E.M.F. active in the armature of the corresponding generator :

$$E' = 200 - 24 = 176 \text{ volts.}$$

Formula (7) finally gives the current capacity of the generator having equal electrical activity with the given motor, as :

$$I' = \frac{10{,}000}{176} = 57 \text{ amperes.}$$

II. Speed Calculations of Electric Motors.—If a generator which at a speed of N_1 revolutions per minute produces a total E.M.F. of

$$E_1' = E + I' \times (r_a + r_e) \text{ volts}$$

is run as a motor, having same current of strength in armature, the motor armature, in order that no more nor less than this current, I′, its full load as a generator, shall flow, must generate a counter E.M.F. of

$$E_2' = E - I' \times (r_a + r_e) \text{ volts.}$$

The speed necessary to generate this back voltage, speed being proportional to voltage, is

$$N_2 = \frac{E_2'}{E_1'} \times N_1 = \frac{E - I' \times (r_a + r_{se})}{E + I' \times (r_a + r_{se})} \times N_1 \quad (8)$$

which is the speed of the motor at full load, provided the E.M.F., E, supplied to its terminals is equal to the voltage when run as generator.

The speed of the motor for any given E.M.F. applied to its armature terminals depends (1) upon the load impressed upon the motor armature, or the torque, τ, it has to exert; (2) on the electrical resistance $(r_a + r_{se})$ of the armature and the series field; and (3) upon its specific generating power, or its capability of producing counter E.M.F.—*i.e.*, the number of volts, e, it produces at a speed of one revolution per second.

The specific generating power of the motor being

$$e = \Phi \times \frac{N_c}{n_p} \times 10^{-8} \text{ volts at one revolution per second} \quad (9)$$

where Φ = useful flux in webers ;

N_c = number of conductors on armature ;

n_p = number of pairs of armature circuits electrically in parallel,

the total counter E.M.F., at the required speed of N_2 revolutions per minute, will be

$$E_2' = e \times \frac{N_2}{60} = \frac{\Phi \times N_c \times N_2}{60 \times 10^8 \times n},$$

and the current flowing in the armature, therefore, is

$$I' = \frac{E - E_2}{r_a + r_s} = \frac{E - e \times \frac{N_2}{60}}{r + r_{se}} \quad . \quad . \quad . \quad . \quad (10)$$

The activity of this current expended upon the counter E.M.F. will be their product, $E_2' \times I'$ watts, and this must be equal to the total rate of working, which is the product of circumferential speed and turning moment, or torque—that is, it must be equal to

$2\pi \times N_2 \times \tau \times \frac{746}{33{,}000}$ watts, where the torque, τ, is calcu-

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lated from

$$\tau = \frac{11{\cdot}74}{10^{9}} \times I' \times \frac{N_c}{n_p} \times \Phi \text{ foot-pounds} \quad . \quad (11)$$

hence we have :

$$\left(e \times \frac{N_2}{60}\right) \times \frac{E - e \times \frac{N_2}{60}}{r_a \times r_{se}} = 2\pi \times \frac{N_2}{60} \times \tau \times \frac{746}{550},$$

from which

$$N_2 = 60 \times \left(\frac{E}{e} - 8{\cdot}52 \times \frac{(r_a + r_{se}) \times \tau}{e^2}\right) \quad . \quad (12)$$

From (12) follows that, if either the internal resistance or the torque is zero, since the second term in the parentheses then disappears, the speed of the motor is

$$N_2 = 60 \times \frac{E}{e} = \frac{60 \times E \times n_p \times 10^8}{\Phi \times N_c} \quad . \quad (13)$$

This reduced formula (13) indeed holds very nearly in practice for very large motors (in which the internal resistance is very small) and also is approximately followed in case of motors running free (the torque then being only that necessary to overcome the frictions).

(To be continued.)

REVIEWS.

Transformers for Single and Multi-Phase Currents. By GISBERT KAPP, M.I.C.E., M.I.E.E. Whittaker and Co. 6s.

The author in his preface states "the object of the present book is to enable the reader to judge the design of transformers and to design such apparatus for himself." With this view in end, rather than that of providing a scientific treatise, the details of researches of the purely scientific order have been omitted. Engineering students wishing to get up the practical methods of transformer design will not regret these omissions, which enable a smaller volume to be presented. One feature of the book before us is the liberal supply of illustrations. Some 133 diagrams, drawings of transformers, and details are given in the 241 pages, and these form a most valuable adjunct to the letterpress. The first chapter describes the principles involved in transformer working, and in it the fundamental equations are devoloped. Following on this, the second chapter is devoted to the question of the losses and the influence of the design on these quantities. It is here that the author initiates the student into the trial and error method of design, which, after all, is the most reliable course to pursue. So in comparing the relative values of core and shell types a series of five extreme cases are taken. In these five designs, all for equal output, it is assumed that the current density and the density of induction are kept the same, and then the effect of altering the shape of the core and coils is very apparent. Although neither of these designs may be the best possible, a student gains a hold of his subject by following the method through and by checking the figures given. The author then puts another nail in the coffin of the Hedgehog transformer, and shows the fallacy of its supposed low iron loss. In the third chapter the details and proportions of common types of transformers are described, followed by some pages on the heating question. Two curves are given for final temperature rises in terms of square centimetres of transformer cooling surface per watt lost. The curves apply to transformers in cases with and without oil, but no reference is made to the area of the cases themselves. As these are the ultimate radiators, and the contact between the case and transformer affect the result, we must warn the reader against relying too much on the curves in question. It is extremely difficult to obtain any firm figures for the heating of such apparatus. The author treats of the influence of the linear dimensions of a transformer on its output, and concludes that for equal heating the output is always proportional to the weight. The efficiency of transformers on this basis, however, rises considerably with the output. In the next chapter the graphical methods of combining alternate currents and pressure are commenced, and followed by a determination of the no-load current. The question of the best distribution of copper between the primary and secondary circuits is solved by differentiation, and the well-known result obtained that the losses should be equal in each circuit. The economy in working both for lighting and power work is also carefully treated. Chapter VI. contains the most interesting features of the book for those who are already conversant with transformer work. It consists of a full graphical treatment by clock diagrams of the working of transformers. The diagrams include leakage effects, and the method of predetermining the drop at full load will be found to be most useful. The author points out the misleading figures often obtained for the full-load drop due to the load used in testing. He then details a method of practically ascertaining what the drop would be with various power factors. This is followed by a collection of different methods of testing transformers which will be found to be handy for reference. In the eighth chapter a *résumé* of the safety appliances required in transformer working is given, and also details of the use of boosters, choking coils, compensating coils, and balancing transformers. We should like to have seen some figures as to the magnetising forces required for open-circuit choking coils, as little information on this subject has been published. The book is completed by a series of illustrated descriptions of commercial transformers of all the principal manufacturers. It includes both Continental and American designs, as well as those of all the best makers in England. There is one feature in the book which shows that it was written in another country, and that is, that metres, centimetres, and kilogrammes are used throughout instead of their English equivalents. This is somewhat confusing to the student at first. On the whole, the volume is the most complete and practical book we have seen on the subject.

ELECTRIC LIGHTING PROVISIONAL ORDERS.

The following is a complete list of applications for provisional orders deposited with the Board of Trade up to December 21, 1896, under the provisions of the Electric Lighting Acts, 1882 to 1890 :

Title of Order and Description of Area.	Name of Promoters.
Ambleside Electric Lighting Order.—The Urban District of Ambleside.	The Urban District Council
Ballymena Electric Lighting Order.—The Township of Ballymena.	The Town Commissioners.
Bangor Corporation Electric Lighting Order.—The Municipal Borough of Bangor and portions of the Parishes of Llandegai and Pentir.	The Corporation of Bangor.
Barking Town Electric Lighting Order.—The Urban District of Barking Town.	The Urban District Council
Bexhill Electric Lighting Order.—The Urban District of Bexhill.	The Urban District Council
Bexhill Electric Lighting Order.—Portion of the Parish of Bexhill.	Earl de la Warr and Robert Kersey, Esq.
Brighouse Corporation Electric Lighting Order.—The Borough of Brighouse.	The Corporation.
Bury St. Edmunds Electric Lighting Order.—The Municipal Borough of Bury St. Edmunds.	The Corporation.
Darwen Corporation Electric Lighting Order.—The Borough of Darwen.	The Corporation.
Denton Electric Lighting Order—The Urban District of Denton.	The Urban District Council
Dorking Electric Lighting Order.—The Urban District of Dorking.	The Urban District Council
Droylsden Electric Lighting Order.—The Urban District of Droylsden.	The Urban District Council
Dudley Corporation Electric Lighting Order.—The Municipal Borough of Dudley.	The Corporation.
Dundalk Electric Lighting Order.—The Borough of Dundalk.	The Town Commissioners.
Epsom Electric Lighting Order.—The Urban District of Epsom.	The Urban District Council
Farnworth Electric Lighting Order.—The Urban District of Farnworth.	The Urban District Council
Galway Electric Lighting Order.—The Urban Sanitary District of Galway.	Galway Electric Company.
Hoylake and West Kirby Electric Lighting Order.—The Urban District of Hoylake and West Kirby.	The Urban District Council

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Title of Order and Description of Area.	Name of Promoters.
Garston Electric Lighting Order.—The Urban District of Garston.	The Urban District Council
Ipswich Corporation Electric Lighting Order.—The Borough of Ipswich.	The Corporation.
Kearsley Electric Lighting Order.—The Urban District of Kearsley.	The Urban District Council
Leatherhead Electric Lighting Order.—The Urban District of Leatherhead.	Leatherhead Electric Lighting and Power Company.
Leith Corporation Electric Lighting Order.—The Burgh of Leith.	The Corporation.
Levenshulme Electric Lighting Order.—The Urban District of Levenshulme.	The Urban District Council
Lincoln Electric Lighting Order.—The County of the City of Lincoln.	The Corporation.
Llandrindod Wells Electric Lighting Order.—The Urban District of Llandrindod Wells.	Llandrindod Wells Electric Light and Power Company.
THE COUNTY OF LONDON.	
Blackheath and Greenwich District Electric Lighting Order.—The Parish of Greenwich and portions of the Parishes of Charlton, Eltham, Kidbrook, Lee, and Lewisham.	Blackheath and Greenwich District Electric Light Company.
County of London (East) Electric Lighting Order.—The Parishes of St. George-in-the-East, and St. Matthew, Bethnal Green, the Hamlet of Mile End Old Town, and the Districts of Limehouse and Poplar.	County of London and Brush Provincial Electric Lighting Company.
County of London (Northern Extensions) Electric Lighting Order.—Portion of the District of the Holborn District Board of Works, the Liberty of the Charterhouse, and portions of the Parish of St. Leonard, Shoreditch.	County of London and Brush Provincial Electric Lighting Company.
Fulham Electric Lighting Order.—The Parish of Fulham.	The Vestry.
London Electric Supply Corporation.—Electric Lighting (Westminster) Order. Portion of the United Parishes of St. Margaret and St. John the Evangelist, Westminster.	London Electric Supply Corporation.
Newington Electric Lighting Order.—The Parish of St. Mary, Newington.	The Vestry.
Morecambe Electric Lighting Order.—The Urban District of Morecambe.	The Urban District Council
Morley Corporation Electric Lighting Order.—The Borough of Morley.	The Corporation.
Moss Side Electric Lighting Order.—The Urban District of Moss Side.	The Urban District Council
Newmarket Electric Lighting Order.—The Urban District of Newmarket.	The Urban District Council
Northwich and District Electric Lighting Order.—The Township of Northwich and portion of the Rural District of Northwich.	Northwich Electric Supply Company.
Poole and Branksome Electric Lighting Order.—The Municipal Borough of Poole and the Urban District of Branksome.	Bournemouth and District Electric Supply Company.
Prescot District Electric Lighting Order.—The Urban District of Huyton-with-Roby and the Parishes of Rainhill, Whiston, Knowsley, and Eccleston, in the Whiston Rural District.	British Insulated Wire Company.
Ramsbottom Electric Lighting Order. The Urban District of Ramsbottom	The Urban District Council
Redditch Electric Lighting Order.—The Urban District of Redditch	The Urban District Council
Reigate Corporation Electric Lighting Order.—The Borough of Reigate.	The Corporation.
Rottingdean and District Electric Lighting Order.—The Parishes of Rottingdean and Ovingdean and the Village of Woodendean, within the Rural District of Newhaven.	Rottingdean Electric Lighting and Power Company.
Southampton Electric Lighting Order. Portion of the County Borough of Southampton.	The Corporation.
Stretford Electric Lighting Order.—The Urban District of Stretford.	The Urban District Council
Swadlincote Electric Lighting Order. The Urban District of Swadlincote.	The Urban District Council
Tonbridge Electric Lighting Order.—The Urban District of Tonbridge.	The Urban District Council
Ventnor Electric Lighting Order.—The Urban District of Ventnor.	The Urban District Council
Wallasey Electric Lighting Order.—The Urban District of Wallasey.	The Urban District Council
Walton-on-Thames Electric Lighting Order.—The Urban District of Walton-on-Thames.	Walton-on-Thames Electric Lighting and Power Company.
Watford Electric Lighting Order.—The Urban District of Watford.	The Urban District Council
Wilmslow Electric Lighting Order.—The Urban District of Wilmslow.	The Urban District Council
Wimbledon Electric Lighting Order.—The Urban District of Wimbledon.	The Urban District Council
Withington District Electric Lighting Order.—The Urban District of Withington.	The Urban District Council
Wrexham Corporation Electric Lighting Order.—The Borough of Wrexham.	The Corporation.

COMPANIES' MEETINGS AND REPORTS.

WEST COAST OF AMERICA TELEGRAPH COMPANY, LIMITED.

An extraordinary general meeting of this Company was held on Wednesday at Winchester House, E.C., Mr. J. Denison Pender presiding, to consider resolutions authorising the directors to create and issue 5 per cent. debentures for securing principal sums not exceeding in the aggregate £20,000, to be issued either as security for any existing or future debts, or at any price, and generally on such terms as the directors may deem expedient, the new debentures, however, to rank after the £150,000 of existing debentures.

The **Chairman**, in proposing the resolutions, said that at their last general meeting he stated that they were then unable to meet all their engagements, but that the Brazilian Submarine and the Eastern Telegraph Companies, who were interested in the traffic, had made up the deficiency, as the directors were not prepared to carry on the Company without balancing the accounts for the year, which was at the time under review. It was then contemplated that they should go on for another year, and see what the result would be, but he regretted to state that, after continuing for six or seven months only, they had arrived at a period just before the debenture interest was due (that day), and they found that they had not funds to meet it. The Brazilian Submarine Company, however, was prepared to meet the coupons, and therefore the debenture-holders would not be at any loss for the interest due. The directors would have to consider the position of the Company, and they would shortly call the shareholders together again and submit some proposition to them. He could give them no idea at present what this proposition would be, but something would have to be done as they did not intend to carry on the Company as a losing concern. It must shortly either be wound up or arrangements be made by which they would not have to come before the shareholders in such a condition as they were now and as they were in at their last meeting.

Mr. F. Walters seconded the resolutions, and they were carried unanimously.

SOUTH STAFFORDSHIRE TRAMWAYS COMPANY.

The sixth ordinary general meeting was held at the Cannon-street Hotel yesterday (Thursday), Mr. W. Somers L. Schuster (chairman of the Company) presiding. There was a large attendance of shareholders.

The **Chairman**, in proposing the adoption of the accounts and balance-sheet for the year 1895, said the delay in the issue of the report had been due to a combination of quite unavoidable circumstances mainly connected with the litigation in which the Company had been involved. The total receipts for the year amounted to £29,667, being a decrease as compared with the previous year of £572, but the total receipts per car mile were 12·45d. as against 11·61d. The expenditure for the year showed a decrease of £373. The directors had now concluded a satisfactory provisional agreement with the Electric Construction Company which they hoped would enable the affairs of the Company to be placed upon a permanent basis. The litigation had been long and costly, but they hoped they had now nearly come to the end of it.

Mr. S. R. Blundstone seconded the motion, which was carried.

Mr. Blundstone was re-elected one of the directors, and the auditors, Messrs. Spain and Hardcastle, were also re-elected.

The **Chairman** said that practically concluded the business of the meeting, but there was another matter he should like to bring before them. As they knew, the Company had not paid its debenture interest for a long time, and had practically never paid its preference nor its ordinary. If the Company were to have 140,000 4½ debentures, and had its original 86,000 preference shares, and those preference shares were reduced in interest from 6 per cent. to, say, 5 per cent., that would require annually £10,600 to pay both classes. During 1896 the profit on the steam section amounted to £4 000, and the electric section would show, if they took over the works occupied at the present moment by the Electric Construction Company, a profit of £4,500. If they worked the steam section by electricity, and worked it at the same rate which the Electric Construction Company could do, that would show an extra profit of £3,500. In other words, their profit for the year would be £12,000, which, after paying the full interest on the debentures and preference, would leave a margin for the ordinary. These were only rough figures, but it was an estimate based on facts,

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because the profits were on the books. He had made absolutely no allowance for increased traffic or increased mileage, nor improved form of traction. It was a scheme which he felt would be a great success. Their steam license ran out next March, and they had an option from the Electric Construction Company to take over the whole of their undertaking and of compounding in full for the whole of their claim against the tramways company. That option expired at the end of June. Some such scheme as he had foreshadowed would soon be put before the shareholders, and when they were called upon he asked them to put their money into it and pull the thing through. There was no doubt about the concern. It was true they were largely increasing their capital, but then they would be increasing their profit fourfold.

The meeting appeared to be rather in favour of the scheme on a show of hands. There were none held up against it, but the majority preferred to remain neutral.

A hearty vote of thanks to the chairman and officers concluded the meeting.

ELMORE'S AMERICAN AND CANADIAN PATENT COPPER DEPOSITING COMPANY, LIMITED.

The report of the directors for the year ended March 31 last, presented at the general meeting held in Leeds yesterday (Thursday), states that the total working expenses for the year amount to £110, compared with £165 and £230 for the two preceding years. The Company's income for the year is £558, which, after defraying the expenses for the same period, has enabled the Board to write off the balance of £452 standing to the debit of the administration account, and allows a small net profit to be carried forward. A new method of very rapidly operating the Elmore process has been discovered, and the directors are of opinion that its acquisition will greatly enhance the value of the Company's rights in America, and practically ensure the satisfactory realisation of the objects of the Company. The directors expect to acquire this new process for the United States and Canada at an early date on excellent terms, involving no expenditure of capital.

GUILDFORD ELECTRICITY SUPPLY COMPANY.

The fifth annual general meeting of this Company was held on December 24 at the County and Borough Hall, Guildford, when Dr. F. R Russell presided.

The annual report of the directors, which was read by **Mr. Perkins**, commenced with an expression of regret at the loss by death of the chairman, Mr. May Colebrook, during the year. The Company's subscribed ordinary capital had been increased to £6,770, and the whole of the 500 founders' shares had been allotted. The distributing mains had been completed, and works capable of enabling the directors to couple up to the mains a total of 2,500 8-c.p. lamps, or their equivalent in other power lamps or motors for electric lighting or power, were completed. Contracts for the supply of energy had been entered into with 17 customers already, and the number of lamps to be supplied to the customers already obtained was equivalent to upwards of 600 8-c.p. lamps. The total receipts were £4,603. 15s. 2d., and the balance in hand £364. 5s. 9d.

The report was adopted.

BRITISH ELECTRIC TRACTION COMPANY, LIMITED.

An extraordinary general meeting of this Company was held on Tuesday at Winchester House, E.C., Sir C. Rivers Wilson presiding, to confirm the resolutions passed at the meeting of December 14, approving the proposed Crewe Norwich and District, and the Potteries Light Railway Orders. The previous meeting was duly reported in our columns, and the proceedings on Tuesday were only of a formal character, the resolutions being unanimously confirmed as special resolutions, on the motion of the **Chairman**, seconded by the **Earl of Suffolk and Berkshire.**

CONTRACTS FOR ELECTRICAL SUPPLIES

CONTRACTS OPEN.

Arlon (Brussels).—Tenders will be received on January 7 at Arlon, rue de la Station 36, for an electric generating station building at the Marbehan railway station.

Kattowitz.—Tenders will be received on January 11 by the Prussian State Railways (Königliche Eisenbahn Direktion) at Kattowitz for the supply of electric lighting carbons. Particulars are obtainable for 50 pfg. (6d.).

Santiago (Chile).—The City Authorities of Santiago de Chile have published conditions under which offers will be received for converting the existing tramways to electric traction, and for lighting the city by electricity.

Saint-Yvon (France).—Tenders will be wanted on January 31 for an electric lighting installation (to replace 1,500 gas lights) at the lunatic asylum at Saint-Yvon, in the Seine Inferieure. Application to the asylum authorities.

Breslau.—Tenders will be received on January 12 for the supply of porcelain insulators, telegraphic wire, etc., for the Prussian State Railways. Particulars are obtainable for 50pfg. (6d.). The address is Gartenstrasse 106, Breslau.

Brussels.—Tenders will be considered on January 8 by the Provincial Government for installing the electric light at the Office of Roads and Bridges. Particulars are obtainable at Brussels, rue des Augustins 17, and it is noted that tenders should be sent in on the 4th.

Hull.—The Corporation invite tenders for a lease of the tramways authorised to be constructed by the Tramways Orders Confirmation (No. 1) Act, 1896. Tenders to be delivered by February 1, endorsed "Tramway Tender," at the office of Mr. R. Hill Dawe, town clerk, Town Hall, Hull, from whom all particulars and conditions of tender may be obtained.

Dover.—Tenders are required by the Town Council for the construction of about three miles of the Corporation tramways—single line with passing places—including a concrete road bed, the laying of rails, tie-bars, etc., and paving with granite setts, for the Town Council. Forms of tender, specifications, and bills of quantities may be obtained on payment of £3. 3s., returnable on receipt of a bona fide tender, and conditions and plans inspected at the Borough Engineer's Office, Town Hall. Tenders to be sent in to Mr. E. Wollaston Knocker, town clerk, Town Clerk's Office, Castle-hill House, Dover, by 2 p.m. on January 12.

Dover.—The Town Council also invite tenders for the supply and delivery of steel girder rails, fishplates, fishbolts, tie-bars, points, crossings, and other accessories for about three miles of the Corporation tramways. Forms of tender, specifications, and bills of quantities may be obtained on payment of £3. 3s. (returnable on receipt of a bona fide tender), and conditions and plans inspected at the Borough Engineer's Office, Town Hall. Tenders to be sent in to Mr. E. Wollaston Knocker, town clerk, Town Clerk's Office, Castle-hill House, Dover, by 2 p.m. on January 12.

Bristol.—The Electrical Committee of the Corporation require tenders for the supply and erection at the Electric Lighting Station, Temple Back, Bristol, of five mild-steel Lancashire boilers, with fittings, etc. Plans and sections of the station may be seen at the office of the Engineer, Temple Back, and copies of the specification and form of tender seen and obtained at the office of Mr. Frank M. Prosser, secretary, Electricity Department, Temple Back, on payment of three guineas. Tenders, endorsed "Tender for Boilers," must be addressed to the Secretary, and delivered to him by 4 p.m. on 21st inst. Only boilermakers will be permitted to tender.

Blackburn.—Tenders are invited by the Board of Guardians for the laying of a service of electric fire-alarm communication between the various buildings of the workhouse. Plan and report showing the requirements of the Guardians may be seen and information with regard thereto obtained upon application to Inspector Simpson at the Borough Fire Station, Clayton-street, Blackburn, by appointment. Competitors are requested to inspect the workhouse premises, take measurements, and prepare their own plans and specifications, which, together with tenders, duly endorsed "Fire Alarm," must reach Mr. Robt. C. Radcliffe, clerk, Union Offices, Cardwell-place, Blackburn, by 10 a.m. on January 9.

Colwyn Bay.—The Urban District Council invite plans, particulars, and estimates, etc., for a scheme of electric lighting for their district, the powers for which they obtained last session. To the author of the scheme considered the best a premium of £30 will be paid, and in the event of the work being carried out such premium must be considered as part payment of the engineer's commission. To the author of the scheme considered second best a premium of £20 will be paid. Further information will be received on personal application to Mr. Wm. Jones, A.M.I C.E., the Council's surveyor. The schemes must be sent in not later than January 12, 1897. Further particulars are contained in an advertisement in another part of the paper.

Montevideo.—We have received information from the Foreign Office that the Uruguayan Government are calling for tenders for working the electric light system in the town of Montevideo, in accordance with Art. 25 of the law of liquidation of the Banco Nacional. The principal conditions are that the renting company shall take over the payment of all the private debts of the concern, which, on September 30, 1895, were as follows: Banco Hipotecario del Uruguay, mortgage in cedulas on the central station in Calle Yerbal, 63,865dol.; mortgage on the central station in Arroyo Seco, 71,411dol.; Ernesto Tornquist, for machinery, 29,332dol. To carry out the public lighting at a price 5 per cent. below that actually paid for the first five years, and 10 per cent. discount for the second five years. The rental to be for 10 years. The renter to take over the debts of the concern. The renter to purchase 400 shares at present in private hands. Tenders to be presented on January 15, 1897, at 2 p m. A guarantee of 10 000dol. to be given. Tenders are to be sent in sealed envelopes to the Ministry of Finance, and will be opened in the presence of the interested parties.

RESULTS OF TENDERS.

Brussels.—The contracts for the supply of wooden telegraph posts for the Belgian State Railways at Brussels on December 23 went to the following firms: Tysen, of Welryck; Constant and Co., of Liège; A. Lenaerts, of Turnhout; and H. Lemahieu, of Beernem-lez-Bruges.

Factory Lighting.—Messrs. Lambert and Butler have had their new export tobacco factory electrically lighted throughout. There is also an intercommunication telephone system between each floor. The work was carried out by Mr. T. H. Taylor, of West Kensington,

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BUSINESS NOTES.

Sheffield.—The Corporation's dispute with the old tramway company has been arranged, the directors agreeing to accept £27,500 in full settlement.

Kettering.—At the Urban District Council meeting the cost of obtaining the Electric Lighting Act for the town, amounting to £226, was ordered to be paid.

Derby.—The Electric Lighting Committee have decided to ask for sanction to obtain a further loan of £20,000 for the development of the electric lighting of the town.

New Year's Card.—Messrs. Hodges and Todd, of Hampstead-road, have sent out a novelty in the form of a New Year's card representing the switching on of a "prosperous new year."

Madeira Electric Lighting Company.—Interest coupons of the debenture bonds falling due on December 31 will be paid by the Halifax Joint-Stock Banking Company, Princes-street, Halifax.

Brighton.—The Brighton and Rottingdean Seashore Electric Tramroad Company have given notice of an extraordinary general meeting to be held on January 15 to authorise the raising of additional capital.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended December 27 amounted to £1,304, as compared with £941 in the corresponding week of the previous year, being an increase of £363.

Bristol Tramways and Carriage Company, Limited.—The traffic returns for the week ended December 25 were £2,138. 10s. 7d., compared with £1,986. 13s. 10d. for the corresponding period of last year, being an increase of £151. 16s. 9d.

Cheltenham.—The two street-lighting sub-circuits are so far completed that an experimental run of the lamps has been made, the test being in every way successful. The lamps are of the Brush-Vienna pattern, with alabastrine globes.

Telegraphists' Conference.—The Postal Telegraph Clerks' Association have accepted the offer of their Swansea colleagues to hold the annual conference at Swansea in 1898. The last conference held in this town was 14 years ago, and proved a great success.

City and South London Railway.—The returns for the week ended December 27 were £972, compared with £906 for the corresponding period of last year, being an increase of £66. The total receipts for the half-year 1896 were £25,075, compared with £23,459 last year, being an increase of £1,616.

Islington.—At to-night's Vestry meeting the Electric Lighting Committee will report that they have carefully reconsidered their suggestion to place an arc lamp on the refuge by St. John's Church, and they have come to the unanimous decision that it is advisable to erect it there, both on public and economic grounds.

Southend.—The Town Council have decided to construct a passing-place on the tramline, at a cost of £2,500, with £500 for improving the curves at each end; £620 for improvements in electrical plant; and £700 for a new train—a total expenditure of £4,320. They are also going to provide an engine-house and store for electrical plant.

Conduit and Insulation Company, Limited.—This Company has been registered, with a capital of £40,000 in £1 shares, to enter into an agreement with E. H. Johnson for the acquisition of certain patents relating to improvements in the manufacture of electrical conduits and other electrical fittings and apparatus, and to develop and turn to account the same.

The Proposed Tees-side Electric Trams.—The Middlesbrough Streets Committee have appointed a sub committee of five to consult with similar committees of the Stockport Corporation and Thornaby Corporation concerning the proposals of the Imperial Tramways Company to greatly extend their lines in the district, and to adopt the overhead electric system.

The Africa Trust.—The first general meeting of this trust has been held, Mr. H. Rider Haggard presiding. The Chairman referred to the object of the syndicate—namely, the utilisation of the Victoria Falls on the Zambesi in a somewhat similar way to what has been done at Niagara. Mr. W. A. Wells, the largest shareholder, seconded the resolution for the report, and it was carried unanimously.

Porcelain Electrical Fittings Company, Limited.—This Company has been registered, with a capital of £5,000 in £1 shares, to enter into an agreement with A. Bates and J. Meir for the acquisition of the undertaking of the North Staffordshire Porcelain Electrical Fittings Company, and to carry on and extend the same. Registered office: Shelton Works, Hanley, Staffordshire.

Birkenhead.—The second lecture of the series undertaken by the Science and Art Committee of the Corporation was given recently in the town hall, where there was a large attendance, including many councillors. Mr. W. T. Fiddes occupied the chair, and the lecture, entitled "The Evolution of the Electric Light," was delivered by Mr. J. E. Lloyd Barnes, M.I.M.E, science lecturer at the Holt School.

Dover.—The Surveyor reported at the Town Council meeting that the Coventry trams had run 234,060 car miles in the last six months. The company refused to state the cost of the current, but he believed it to be just under 2d. per car mile. It was, however, not fair to make it a comparison for Dover, as coal was much cheaper at Coventry. The company had paid a dividend on the first six months' working at 8 per cent. They produced their own motive force.

Rowley.—The General Purposes Committee reported at the District Council meeting that they had received a plan from the Birmingham, Wolverhampton, and District Tramways Company, which showed that they proposed to run a tramway from the Dudley boundary at Newtown to Cradley Heath, which would cross the Four Ways and proceed a short distance into Congreaves-road. They requested the clerk to procure a copy of the company's Bill as early as possible.

New Cable Stores.—Messrs. Johnson and Phillips inform us that owing to the very large increase in the demand for their make of vulcanised cables and wires, and in order to meet the requirements of those firms wanting a few coils at a few moments' notice, they have opened a cable and wire stores at their London address, 14, Union-court, Old Broad-street, E C. Special arrangements have been made to at once deliver emergency orders received by telephone or telegram.

Rhymney.—In the ensuing session of Parliament a Bill will be introduced "for incorporating the Rhymney and Aber Valleys Gas and Water Company, for conferring powers on them for the construction of works, the supply of gas and water, and the purchase of certain gas and water undertakings." Under Clause 90 the company may apply for a provisional order "to produce and supply electricity for public and private purposes, and may apply their funds for the purpose of such application."

Simla.—It is probable that the electric lighting of Simla will be worked by power obtained from the Sutlej. The tenders have been made over to Mr. Macdonald, executive engineer of the Simla Provincial Division, an *ex officio* member of the Municipal Committee, and it will probably be some time before his report is ready. Some eight or nine firms examined the proposals of the committee, and sent experts to examine the locality and report upon the scheme. Only two firms, however, sent in tenders.

Swansea.—A special meeting of the Borough County Council has been held for the purpose of approving or otherwise of the draft agreement entered into between the Corporation and the tramways company for the acquisition of the tramways. A motion that collateral security be obtained for the due carrying out of the agreement by the tramway company by having a charge on its rent of a minimum of £1,000 a year for running powers on the Mumbles Railway was negatived. Finally, the agreement was adopted by 19 votes to 14.

Lewisham.—The Works Committee reported at the meeting of the District Board of Works that they had considered the notice by the Blackheath and Greenwich Electric Light Company of their intended application to the Board of Trade for a provisional order to authorise them to supply electricity in certain parts of Lewisham, and the letter from the secretary of the company asking the Board to give their consent. They recommended that the Board object to the application for a provisional order, and that a letter be sent to the Board of Trade accordingly. This was agreed to.

Personal.—We understand that Mr. E. T. Oubridge, lately representative of the General Electric Company, Limited, and Messrs B. Verity and Sons, has been appointed London manager for Messrs. McGeoch and Co., of London, Glasgow, and Birmingham, who are opening large showrooms for high-class fittings and electrical accessories, etc, at 11, Charing Cross-road, London, W.C.—Messrs. Booth and Ravenshaw, 110, Cannon-street, E.C., ask us to publish the fact that their Mr. Ravenshaw has resigned his position as consulting engineer to Messrs. P. R. Jackson and Co., Limited, Manchester, and now holds no retaining fee from them.

Central London Railway.—At a meeting of the City Commission of Sewers it was reported that, acting on representations from the Lord Mayor, who had pointed out the extreme inconvenience of the position contemplated, immediately outside the Mansion House, for the excavating shaft of the Central London Railway, the Streets Committee had suggested an altered site lower down Walbrook at the junction of Bucklersbury, which would not interfere with the traffic to and from the Mansion House but yet admit of the railway operations being proceeded with. The Court adopted the new site, subject to the approval of the railway company.

Edinburgh.—A joint committee of the Town Council have agreed to prepare a memorial for counsel with the view of getting an opinion as to the legality of the proposals for the establishment of a fund for the purpose of making provision for those parts of the electric lighting plant which get worn out by an earlier time than would justify the committee in putting the expenditure to capital account, and yet which, by making the payment from current expenditure, would make too great differences between years. At the annual general meeting of the Calton Ward Municipal Liberal Committee the electric lighting of the city was discussed, and the hope expressed that it would be still further extended.

Wigston Electrical and Engineering Company.—Messrs. Girdlestone and Co., of 16, Davies-street, who are electrical engineers, have purchased from the liquidator the business of the Wigston Electrical and Engineering Company, Limited, and arranged to incorporate it with their business, under the title of "The Westminster Engineering Company, Limited." The services of Mr. F. V. Andersen have been secured as consulting electrical engineer for a lengthened period, and the firm will continue to manufacture the "Westminster" dynamo and motors, Andersen's arc lamps, and other specialities. The works, 27, 29, and 31, Regency-street, are conveniently situated for carrying out repairs. The firm will also give special attention to electric motors for traction purposes.

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Bath.—A specially-convened meeting of the Electric Lighting Committee have considered the reply received from the Local Government Board as to the outcome of the enquiry lately held by their inspector into the application of the Urban Sanitary Authority for power to borrow £58,000 for electric light purposes, including the purchase of the old company's works and plant. The Local Government Board sanction a loan of £45 000 for the purchase of the works (for 20 years instead of 30, as applied for), but the £13,000 required for the purposes of extension is refused, and must be made the subject of a future and separate application. The committee decided to take over the works early in January.

Minster.—The Rural District Council decided at their last meeting to send four delegates to a meeting to be held at Ramsgate *re* opposition to the proposed electric railway from Westgate to Ramsgate. Councillor Cook mentioned that on the previous Monday Mr. Murphy (the promoter of the scheme), with their engineer and solicitor, met a deputation from the Ramsgate Town Council. The Town Clerk at the outset said it would be impossible for the promoters to take advantage of the Agricultural Rating Act, as the scheme was promoted by private individuals, and not by the governing authorities. The solicitor at once agreed with this, and said further, that as to the repair of the roads, the promoters would have to deposit a sufficient sum to put them in sound condition if the scheme fell through after the roads had been broken up. The company would have to keep 9ft. of the road in good repair.

Norwich.—At a meeting of the Town Council, the Town Clerk reported that plans, etc., applicable to Norwich had been deposited with him by the New General Traction Company, Limited, and also by the British Electric Traction Company, Limited; the object of the former being to construct a comprehensive system of electric tramways in the city, and of the latter to lay down lines of light railway in some of the more populous parts of Norwich and to connect the city with the hamlets of Costessy, Thorpe St. Andrew, Trowse Newton, and Eaton. It having been agreed to receive the town clerk's report, Mr. Wild moved that it be referred to the Law and Parliamentary Committee. Mr. Loveday seconded the motion. Mr. M. Stevens moved as an amendment that it be referred to the General Purposes Committee. Mr. Breese seconded the amendment, which was negatived, and the original motion was adopted.

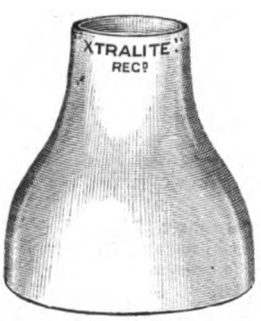
Hull.—A meeting of the Finance Committee was held on December 24. An extract was read from the report of the electrical engineer submitted at the last meeting of the Electric Lighting Committee, when it was decided to ask the Council to approve of an application to borrow £10,000 for extending the light to East Hull, making a total of £52,000 for new works. The borough treasurer (Mr. T. G. Milner) reported that the loans might be classed under the head of remunerative expenditure, as it was anticipated that the revenue would eventually meet working expenses. The treasurer gave figures showing the charges which the loans would entail and the periods for which they would be sanctioned, having regard to the nature of the work and previous experience. The Chairman moved, and it was resolved, that the report be submitted to the Council, and, if approved, application be made to borrow a further sum of £10,000.

Foleshill.—Communications were read at the Rural District Council meeting with respect to the proposed extensions of the Coventry tramways. The proposed route was mentioned, and the Council were asked to state if they had any opposition to such. In the course of a discussion it was urged that some years might elapse before the company carried their operations into effect, and would thus be preventing another company from constructing tramways. The general feeling, however, was that the trams would be a great boon to the rapidly extending portion of Foleshill, and the Chairman remarked that the Council desired to see the extension of the trams. Objections, however, might have to be offered to some of the details, and the Council would be acting wisely in entering their opposition to the scheme so that the matter could be thoroughly gone into. Eventually it was decided, almost unanimously, on the motion of Captain Oliver Bellasis, to oppose the scheme.

The New War Offices.—The necessary legal notices have now been lodged for the introduction of a Bill next session to obtain powers for the compulsory acquirement by the Office of Works of all that suitable ground known as the Carrington House (Whitehall) site, and of all rights in connection with it. The freeholds of the properties on this site are part of the hereditary estates of the Crown, and the Select Committee of the House of Commons which, under Mr. Akers-Douglas, considered the subject last session, reported at the end of July that it was, in their opinion, desirable to acquire the various interests in the property, subject to an actual or contingent recoupment of its value to the land revenues of the Crown. They advise the erection of the new War Office here. Among the occupiers of tenements and offices, let or leased, in the existing congeries of houses who will be affected are the Vestry of St. Martin's-in-the-Fields, the Metropolitan Electric Supply Company, the London Electric Supply Corporation, the Charing Cross and Strand Electric Supply Corporation, the London County Council, and the National Telephone Company.

Douglas.—An exhaustive report, prepared at the instigation of the Town Council by Mr. Thomas H. Nesbitt, town clerk, has been issued on the electric lighting of Douglas. Those members of the Town Council who favour electricity as an illuminant, and those who do not, as well as the public generally, are nearly evenly divided; but the report of Mr. Nesbitt is strongly in favour of electric lighting. A large quantity of information received from the town clerks of Liverpool, Manchester, and other important centres has been collected and analysed, and the report recommends the adoption of the electric system of lighting on grounds of cleanliness, by reason of the absence of deleterious fumes, and on grounds of purity, steadiness, and safety, as compared with other methods of lighting. The report is in favour of the municipalisation of all public undertakings, including electricity, workmen's dwellings, public baths, and waterworks. Nearly all the more recent electric installations were being carried out by municipal authorities by means of public funds. In Douglas, however, the report states, exceptional circumstances prevail, and the Isle of Man Tramway and Electric Power Company, who are known to be favourable, should be entrusted with the work of supplying Douglas with electric light on satisfactory terms being agreed upon.

New Reflector.—The "Xtralite" reflector is brought out by the General Electric Company. It is designed to drop on to a 5, 8, 16, or 25 c.p. lamp so as to rest on the bulb and throw the rays of light in a downward direction. The essential peculiarity of it is that it is made of white porcelain instead of metal, and can be easily removed for cleaning, and where the lamp is inverted a small spring attachment is provided to keep it in position. The point of a porcelain reflector is that it will not only bear washing in the way that a metallic mirror will not without tarnishing, but also gives a diffused reflected light similar to that through a ground-glass shade. This property will generally more than compensate for a somewhat smaller effective reflecting power than that of a brightly polished mirror.



Coventry.—A discussion took place at the City Council meeting on the proposed extension of the electric tramway system. In the city the extension will cover a distance of about six miles, and in the district over three miles. The General Works Committee reported in favour of the routes, which are as follows: Bell-green (Foleshill) to Hales-street, *vid* Stoney Stanton-road; Lower Stoke to Broadgate, via Gosford and High streets; Gosford-green to Hales-street, *vid* Payne's-lane, King William, Victoria, Primrose-hill, and White streets, *vid* Lower Ford-street and Ford-street to Hales-street; Chapel Fields to Broadgate, *vid* Smithford-street. The question of the terms of ultimate purchase by the Corporation to be provided by the Bill has formed the subject of negotiation, and the Corporation is to have the option of purchase at the end of approximately 21, 28, or 35 years on paying a price determined by a Board of Trade referee on the basis either (*a*) of the landlord's interest, or (*b*) of the value of the undertaking as a going concern after 42 years, Section 43 of the Tramways Act, 1870, or any general enactment then in force in its place to govern the purchase. The committee recommended the acceptance of these terms. In order to safeguard the interests of the Corporation, the committee instructed the town clerk to reply to the promoters' parliamentary notices by returning the Corporation as dissenting from their proposals. The report was adopted.

Pembroke.—At the meeting of the Town Commissioners the following letter was read from the Rathmines Township Commissioners: "Secretary's Office, Town Hall, Rathmines, December 21, 1896. Dear Sir,—Referring to your letter of the 14th inst., in which you state that your Commissioners have made arrangements with the Dublin United Tramways Company, and have decided to oppose our Bill, as my Board have no desire whatever that there should be any friction between your Board and themselves, their sole object being to benefit this township, I am directed to inform you that if your Board consent to the Dublin United Tramways Company making the line down Clyde-road to Ballsbridge, and the tramway company give an undertaking to construct same, my Board will at once strike out all reference to the Pembroke township from their Bill. An early answer will be esteemed a favour.—I remain, yours faithfully, F. P. Fawcett, secretary." Mr. Lidwell: I am sure this Board will not comply with the request in that letter. Mr. Manly, the secretary, said he had forwarded the following reply on the 22nd ult.: "Dear Sir,—I beg to acknowledge receipt of your favour of the 21st inst., and must ask you to be good enough to refer to my letter of 13th inst., in reply to yours of 11th inst., in which I stated that the Pembroke Commissioners cannot consent to or approve of the routes suggested in your letter above mentioned. It will be in your recollection that Clyde-road was one of the routes.—I am, dear sir, yours faithfully, J. D. Manly, secretary." The letter of Mr. Manly was approved of.

Neath.—A statutory meeting of the Town Council has been held in connection with the proposed purchase of the local tramways. The Mayor (Councillor A. Russell Thomas) moved that the Corporation should in the ensuing session of Parliament promote a Bill for an Act to authorise the Corporation to purchase the existing tramway undertaking; to construct and maintain additional tramways, and improve the existing system, and for generating electricity for the working of the tramways. Mr. Simcock Phillips asked what were the additional tramways proposed. Alderman Charles said there were to be extensions at Briton Ferry and Skewen, the Parade, and Windsor-road. Mr. Abraham George said that he had only been able to see the plans that afternoon in the Council-chamber. He would suggest that the meeting be adjourned to enable them to look over the plans. Mr. J. D. Llewelyn said that the question had been dealt

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with in the usual manner, and everything was open and above board. Mr. Law supported the adjournment. Eventually it was decided by a large majority to adjourn the meeting.—The new works of the Neath Sheet Steel and Galvanising Company have just had an installation of electric light completed at their works by Messrs. J. C. Howell and Co. This firm are also completing the following installations in the Neath district—viz., at the iron-works, Briton Ferry, plant for arc and incandescent lighting, and power for overhead cranes, etc.; Navigation Fuel Works, Briton Ferry, lighting plant; Briton Ferry Steelworks, lighting (extension); Vale of Neath Brewery, lighting and pumping (electric) plant.

Blackburn.—The deputation appointed by the Gas Committee of the Corporation to inspect the electric tramways worked on the overhead wire system at Bristol, Coventry, and Walsall, have presented their report to the committee. With regard to Bristol, where the system is the same at that proposed for Blackburn, the report says: "The whole of the system is worked by single poles or brackets (not cross wires) up one side of the road, with an arm sticking out, except where the road is very wide (similar to places like the front of the town hall or market in Blackburn), and in such places they put the poles in the centre, with an arm each way, and they have an electric light in the centre." After describing the Coventry and Walsall system, the sub-committee state that they regard the Bristol system with most favour, except they prefer a short arm from the pillar and a long trolley rod from the car. The report continues: "With regard to the overhead wire system generally, the sub-committee find that there is no noise nor flashing to speak of, and the cars run better than with either horse or steam traction. The sub-committee particularly noticed and are informed that these cars do not frighten horses, and they can be pulled up and started much sooner than in other forms of traction. For instance, they can be pulled up within a distance of a yard or two when going at a rate of 12 miles an hour, even on gradients of 1 in 14. Some of them, particularly at Coventry, have to ascend and descend very sudden and sharp gradients, much worse than any gradients on the Blackburn tramway lines—that is to say, the gradients at Coventry are not gradual gradients, but are sharp and sudden rises. When extraordinary traffic required it, trailer cars are attached to the ordinary cars, but the trailer car and the ordinary car combined are not longer than any ordinary steam tramcar. The Gas Committee met last week, and after consideration of this report, decided to proceed with the overhead system in Blackburn.

Bromley.—At the Rural District Council meeting, a letter was received from the Chislehurst Parish Council respecting a proposal for lighting by electricity in the parish of Chislehurst, excluding the lower borough, and approved of the Board of Trade granting a license to a company for the purpose. Mr. Edward Charrington, writing on the same subject, stated that a considerable number of the residents in Chislehurst had signified a desire to be supplied with electric light in their houses. It was proposed to form a local company for supplying the private consumers in the parish, not including the lower borough, for which purpose a license from the Board of Trade was necessary. The Board of Trade desired to know if there was any objection on the part of the local authorities to the license being granted. He was informed that the District Council would in the usual way refer the matter to the Chislehurst Council, and in order to save time he had already communicated with that authority. The required capital had already been promised. It would not involve the local authorities in any liabilities. The Clerk said the Parish Council having assented, it seemed to him that all they had to do was to agree to the scheme, subject to the work being carried out to their satisfaction, and any roads disturbed by the company being thoroughly restored and kept in perfect repair for, say, 12 months after the installation. It would also be necessary for them to be able to call upon the company to light public streets. If a private company made use of a public thoroughfare for their own advantage, they ought, in return, to be compelled to light the streets, if it became necessary, for the public advantage. The conditions would be (1) that the works should be carried out to the satisfaction of their officers; (2) the roads disturbed by the company to be properly made up again and kept in repair for at least 12 months; (3) that the Council should have the power to call upon the company to light the public lamps should it be deemed advisable to do so, upon terms to be settled by agreement or arbitration. The course suggested by the clerk was agreed to.

Halifax.—Amongst the Bills deposited last week in the Private Bill Office of the House of Commons is one to empower the Corporation of Halifax to construct tramways and for other purposes. The Bill recites that the laying down of tramways within the borough would be of local and public advantage, and that it is expedient that the Corporation be authorised to lay down, construct, and maintain them. The enacting portion of the Bill specifies the tramways to be constructed five in number, which run from Church-street through Horton-street and Commercial-street, to Silver-street; from Commercial-street along George-street, Bull Green, King Cross-street, to King Cross; from Commercial-street along Hall End, Crown-street, Swine Market, to Gibbet-street; from Commercial-street to Bull Green; and from Commercial-street to a point near Cheapside. The gauge of the tramways is to be 3ft. 6in., and the lines will be single or double, as convenient. The period taken for the construction of the tramways will be five years, and it is provided that animal power shall be used or "steam power or any form of mechanical power specially approved by the Board of Trade in writing." The Corporation ask for power to work the tramways themselves, and for power to charge a passenger fare at the rate of 1d. per mile or fraction of a mile. They also ask for power to use the tramways for sanitary purposes, "and for the conveyance of scavenging stuffs, road metal, and other materials required for the works of the Corporation free of all tolls and charges in respect of such use." Officers of the Corporation when on duty are to be carried free of charge; fares are not to be raised on Sundays and holidays, and borrowing powers for the purposes of the Act to the extent of £20 000 are taken. The Tramways Committee have decided that the Gasworks Committee be requested to instruct the electrical engineer to report on the feasibility of working a tramway system from the Corporation electricity works, and the mayor, the chairman, vice-chairman, Aldermen Patchett, Woodhead, and Spencer, and Councillors Baldwin and Fawcett have been appointed a sub-committee to report on the best system of traction to be adopted in Halifax.

Southampton.—The Electric Lighting Committee reported at the Town Council meeting that the resident engineer (Mr. J. H. Lee) had received applications from Mrs. Russell, East-street, and from Mr. Gange, corner of East-street and St. Mary-street, for electric light. The former request he had granted, and he had informed Mr. Gange, through his contractors (Messrs. Fippard and Cooper), that he expected to be able to supply him by the end of November. Enquiries had been made in East-street, Bernard-street, and Oxford-street, and several shopkeepers in East-street would take the light. Bernard street and Oxford-street were not so promising, but several said they would most probably have it. Mr. Dunsford wrote upon the subject of supplying electric light to his business premises in Prospect-place, and the town clerk was instructed to inform him that the committee were not in a position to immediately supply his premises with the electric light, but that the contract for extending the mains was about to be let and the extension works carried out in the near future. Mr. H. W. Miles (accountant and collector) submitted a statement showing that £614. 12s. 7d. was due from consumers for the quarter ended September 29. The engineer reported that Messrs. Ferranti had quoted £5 net for meters in lots of not less than 12, and that he had undertaken to extend the main near the pier to the old Grammar School, if required. This work would probably be necessary in any case, as he understood the Southern Yacht Club were about to extend their lighting. The town clerk was instructed to advertise for tenders for the erection of the new buildings and extension of the mains. The resident engineer further reported that the total number of units sold during October was 12 948; that, as an experiment, Messrs. E. Jones and Co. had practically promised to take current for lighting their windows in East-street; and that the committee should support the Municipal Electrical Association by joining it, the annual subscription being £1. 1s. The committee resolved to subscribe the sum of £1. 1s. per annum to the Municipal Electrical Association. Councillor Lemon, J.P., submitted a letter from Mr. F. E. Stuart, C.E., suggesting that as the Corporation were laying down underground wires, that wires should be put in the same pipes for a street fire-alarm service, and the matter was referred to the Fire Brigade Committee for reconsideration. The report was adopted.

Poole.—The sub-committee appointed to consider the draft of the Poole and Branksome electric lighting provisional order reported at the Town Council meeting as follows: "Your committee having, with the town clerk and borough surveyor, carefully considered the provisions of the draft of the Poole and Branksome electric lighting provisional order, beg to report as follows—viz: The order is promoted by the Bournemouth and District Electric Supply Company, Limited, and the area affected thereby, so far as it relates to this borough, is the entire borough. The undertakers bind themselves within two years after the commencement of the order to lay down distributing mains for purposes of general supply in the undermentioned roads and streets—viz., Poole and Bournemouth-road, Parkstone-road, and High-street—and also after the expiration of 18 months from the same time to lay down mains for the same purpose in any other street upon requisition being made in manner provided by the order, and other stipulations therein relating thereto being complied with. The Electric Lighting Act, 1888, contains provisions enabling the Council to compulsorily acquire the undertaking at the expiration of 42 years or such shorter period as may be inserted in the order. Your committee recommend that amendments should be inserted in the draft, the principal of which are to the following effect—viz.: In Clause 16 relating to alteration of electric wires in streets. That the provisions of such clause shall not apply to any alterations which the Council may desire to make in connection with the laying down, alteration, or repair of sewers in case of emergency, and also to add to such clause a proviso that in case the Council shall lay down, within 10 years, sewers in any part of the borough not at present sewered, and in so doing require to interfere with electric wires, the undertakers shall, at their own expense, execute all such alterations to such wires as the Council may consider necessary or expedient. To add a clause providing that the period after which the Council may exercise their powers of compulsory purchase shall be 25 years instead of 42 years from the date of the Act confirming the order. Subject to such amendments being inserted, your committee recommend that the consent of the Council be given to the draft order." The report was adopted in its entirety. At the meeting of the Board of Guardians the only matter of importance discussed was brought up on a report of the Assessment Committee relating to the appeal of the Bournemouth and District Electric Supply Company, Limited, to the special sessions for the division of Wimborne. The committee recom-

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mended the Board to empower them to appeal to the Quarter Sessions for the county of Dorset against the judgment of the magistrates at the sessions at Branksome. Mr. Budden proposed, and Mr. Habgood seconded, that the recommendation be adopted. Mr. Curtis raised an objection, and proposed an amendment to the effect that no further steps be taken in the matter. This was seconded by Mr. Abbott. On the amendment being put, it was lost, and the original proposition carried by a large majority.

Proposed New London Railways.—Among the schemes for new railways proposed for consideration during the ensuing session which have just been deposited in the Private Bill Office are the following: The Central London Railway Company promote a Bill proposing to empower them to vary the works authorised by their Act of 1891, and in connection therewith to acquire certain lands. They propose to alter the position of the station or station tunnel in or under Oxford-street, near Marylebone-lane. The North London Railway Company have a Bill mainly for improving access to the Poplar Dock, but empowering them to raise additional capital not exceeding £30,000. Another measure proposes to revive and extend the powers of the Charing Cross, Euston, and Hampstead Railway Company. By another Bill it is proposed to make a railway from Whitechapel to Bow, forming a junction with the Metropolitan and Metropolitan District Railways and with the London, Tilbury, and Southend Railway. The names mentioned in the Bill include those of Sir Myles Fenton and the Hon. Arthur Cornwallis Ponsonby. The traffic for the railway may be worked by means of steam power or electricity, and the capital powers are fixed at £660,000, with borrowing powers. There is also a line proposed to be made by a new company from Praed-street, Paddington, to Acton-lane, Willesden. The line will be four miles four furlongs and 1½ chains in length, and the traffic is to be worked by electricity or cable power. The capital is £350,000, with borrowing powers. There is a Bill to extend the powers for the purchase of land and the time for the completion of the railway authorised by the Great Northern and City Railway Act, 1892, and to amend some of the provisions of that Act; and another for incorporating the Brompton and Piccadilly-circus Railway Company, and empowering them to construct an underground railway between those points in two tunnels for separate up and down traffic. The latter line is to be worked by electricity or such other motive power (not being steam power) as the Board of Trade may sanction. The capital is £600,000, with borrowing powers. By the City and West-end Railway Bill, which has been deposited for next session, power is sought to incorporate a company for the purpose of constructing an underground railway over 6¼ miles in length, commencing under Bridge-road, Hammersmith, and terminating under Cannon-street at a point near Budge-row. The capital required by the company is £3,150,000, upon which it is proposed to borrow a further sum of £1,050,000. The promoters named in the Bill are Messrs. T. Davidson, R. E. Tarrant, J. H. Lukach, F. E. Warburg, E. Cassel, D. O. Mills, J. Rochefort Maguire, Carl Meyer, H. Oppenheim, H. C. Perkins, H. Smith, and Sir H. T. Farquhar. Of these promoters the first four will form the first board of directors. It is proposed to work the railway, if constructed, by means of electricity, and during the five years within which it is proposed to complete the line power is sought to pay interest out of capital to the extent of £166,000. The Bill for the District Deep Level Railway has been duly lodged. Mr. Charles Pond, who is understood to be the author of the scheme, has further plans in view if Parliament approves the Bill now lodged. He proposes cross lines from Clapham Junction to King's Cross and from New Cross to Paddington, centring at Charing Cross, and affording new and direct communication between the railways north and south of the Thames. The Metropolitan District Railway Company have deposited their Bill for next session. By the first material part of this Bill power is sought to construct the direct railway between their Earl's Court Station and their Mansion House Station, the object of which is to give an express service of trains between the West-end and the City. The up and down lines of this railway will pass for the most part in separate tunnels under the existing railway of the company, and will be worked by electricity from a generating station adjoining Walham Green Station. The railway will be constructed by means of metal shields driven forward by hydraulic pressure, thus reducing to a minimum any interference with the surface of the streets. For the carrying out of this scheme the company seek power to raise £1,200,000 ordinary and preference stock, and £400,000 by the creation of debenture stock. It is proposed to complete this railway within five years, and during that period power is sought to pay interest out of capital at 3 per cent., provided that the aggregate amount so expended does not exceed £150,000. By another part of this Bill the company seek power to work the whole of their existing railways by electricity, and for this purpose power is sought to raise £500 000 further capital, with further borrowing powers not exceeding £166,000. The electricity for the existing railways will be generated from the same station as that for the Earl's Court and Mansion House Railway. By subsequent parts of the Bill extensions of time are sought for the construction of the Ealing and South Harrow Railway and the Acton Junction Railway.

PROVISIONAL PATENTS, 1896.

DECEMBER 17.

28955. Improvements in means of telegraphing or telephoning without wires. Alfred Charles Brown and George Richard Neilson, 129, Algernon-road, Lewisham, London.

28973. Improvements in and relating to alternating electric current transformers. John Alexander McMullen, 124, Chancery-lane, London.

28983. Improvements in or relating to ship's telegraph apparatus. Peter Douglas, Harry John Beswick, and Herbert Middleton Ritson Maddick, 6, Lord-street, Liverpool.

DECEMBER 18.

29040. Improvements in means for automatically holding taut the communicating or conducting cord or chain of electrically-driven vehicles. Joshua Entwisle, 5, John Dalton-street, Manchester. (Luigi Della Beffa, Italy.) (Complete specification.)

29081. Improvements in incandescent electric lamps. William Everett Gibson, 82, Belsize park-gardens, South Hampstead, London.

29087. Improved electrical low-water alarm or indicator for steam-boilers. Thomas Hughes, 22, Heygate-street, Walworth, London.

29104. Improvements in winches and posts suitable for electric light lanterns. Theodor Petersen, 24, Southampton-buildings, Chancery-lane, London. (Complete specification.)

29107. Telephone exchange. Myron Francis Hill, 24, Southampton-buildings, Chancery-lane, London. (Complete specification.)

29115. Improvements in electric storage or secondary batteries. Frank King, 47, Lincoln's-inn-fields, London.

29120. Improvements in and relating to conduits for electrical traction. John Edward Waller, 1, Queen Victoria-street, London.

29121. Improvements in electrical fittings for conduits adapted to electrical traction. John Edward Waller, 1, Queen Victoria-street, London.

DECEMBER 19.

29191. Improvements in or relating to effecting electrical communication on railway trains. Frederic James Longton, 322, High Holborn, London.

29226. Improvements in dynamo-electric machines. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Cie. de l'Industrie Electrique, Switzerland.)

29227. Improvements in electric telegraphy. Carl Ritter von Blumencron and Benedict Schöffler, 45, Southampton-buildings, Chancery-lane, London.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	7⅞-8¼
Brush Company, Ordinary	2	¾-1
—— Non. Cum., 6 per cent. Pref.	2	1-1¼
—— 4½ per cent. Debenture Stock	100	110-113
—— 4½ per cent. 2nd Debenture Stock	100	94-98
Central London Railway, Ordinary	10	9¾-10¼ xd
——	4	3¾-4¼ xd
Charing Cross and Strand	5	9¼-9¾
Chelsea Electricity Company	5	8¼-8¾
—— 4½ per cent. Debentures	100	112-115 xd
City of London, Ordinary	10	15½-16¾
—— 6 per cent. Cumulative Pref.	10	16¾-17¾
—— 5 per cent. Debenture Stock	100	126-130 xd
City and South London Railway, Consolidated Ordinary	100	54-56
—— 4 per cent. Debenture Stock	100	136-138
—— 5 per cent. Pref. Shares	10	15½-15¾
County of London and Brush Provincial Co., Ordinary	10	8-9
—— 6 per cent. Cum. Pref.	10	13¾-14½
—— 4½ per cent. 2nd Debenture Stock	5	7½-8¼
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	1¾-2¼
—— 5 per cent. Debentures	—	95-100
Edison and Swan United Ordinary	3	1¾-2¼
—— 5 per cent. Debentures	5	3-4
—— 4½ per cent. Debentures	100	102-105
Electric Construction, Limited	2	1¾-1¾ xd
—— 7 per cent. Cumulative Pref.	2	2¼-3
Elmore's Copper Depositing	2	¾-1
Elmore's Wire Company	2	¾-1
W. T. Henley's Telegraph Works, Ordinary	10	17½-18¼
—— 7 per cent. Preference	10	18¼-19¾
—— 4½ per cent. Debentures	100	109-114
House-to-House Company, Ordinary	5	4¼-5
—— 7 per cent. Preference	5	8¼-9
India Rubber and Gutta Percha Works	10	20½-21¾
—— 4½ per cent. Debentures	100	105-108
Kensington and Knightsbridge Ordinary	5	10-10¼
—— 6 per cent. Pref.	5	8¼-8¾
London Electric Supply	5	1-1¼
Metropolitan Electric Supply	10	12½-13¼
—— 4½ per cent. First Mortgage Debenture Stock	100	119-122 xd
National Telephone, Ordinary	5	7¼-7¾
—— 6 per cent. Cum. First Pref.	10	17-19
—— 6 per cent. Cum. Second Pref.	10	17-19
—— 5 per cent. Non. Cum. Third Pref.	5	6¾-7
—— 3½ per cent. Deb. Stock	100	104-107 xd
Notting Hill Company	10	10-11
Oriental, Limited, £1 shares	1	1¼-2
—— £5 Shares	5	8¼-9
—— £4½ shares	4½	7¼-8
Oriental Telephone and Electric Company	1	11/16-13/16
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	103-105
Southampton Electric Company	5	4¾-5¼
St. James's and Pall Mall, Ordinary	5	12-13
—— 7 per cent. Pref.	5	9¼-10¼
Telegraph Construction and Maintenance	12	39-42
—— 5 per cent. Bonds	100	104-107
Waterloo and City Railway, Ordinary	6	7¼-8 xd
Westminster Electric Supply, Ordinary	5	11-12
Yorkshire House-to-House	5	7¼-8

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NOTES.

Obituary.—A telegram from Philadelphia announces the death of Mr. Theodore Wormley, the chemist.

Liverpool Engineering Society.—The annual dinner of the society will take place at the Adelphi Hotel, Liverpool, on January 28.

The Electrical Engineers.—The meetings of the Institution of Electrical Engineers begin again on the 14th, when Sir Henry Mance will deliver his presidential address.

French Civil Engineers.—The report presented at the annual general meeting of the Société des Ingenieurs Civils de France showed a present membership of 2,724. This is an augmentation of 133 during the year.

Northern Electrical Engineers. — Mr. C. M. Dorman, the new president, will deliver the presidential address to the Northern Society of Electrical Engineers on Monday next, at the Palatine Hotel, Manchester, at 8 p.m.

The Chamber of Commerce.—The Electrical Section of the London Chamber of Commerce meets to-day (Friday) at Botolph House, at noon, to elect a chairman, and discuss the Newcastle Exhibition, motor vehicles, light railways, and other matters.

Publication Received.—We have just received Mr. H. Scholey's "Electric Tramways and Railways Popularly Explained" (Alabaster, Gatehouse, and Co.). There are a number of excellent illustrations, but we have not yet had time to examine the little book thoroughly.

Woolwich Polytechnic.—At the annual prize distribution to the students at the Woolwich Polytechnic, the chair was taken by Sir William Anderson, K.C.B., Director-General of Ordnance Factories, and among the speakers was Mr. Alexander Siemens. Subsequently Mr. Beachcroft (of the London County Council), having praised athletics and other things, did the prize distributing.

Electrolytic Conduction.—According to experiments of Prof. Cardani, published in the *Nuovo Ciemento*, when an alternating current of high periodicity is transmitted through an electrolyte the current density is, so far as can be ascertained, the same in all parts of the cross-section, and not greatest at the surface and diminishing inwards, according to the well-known law for metallic conductors.

Society of Arts.—During the present session papers will be read at the Society of Arts by Mr. F. Bathurst on "The Prevention of Fires Due to the Leakage of Electricity," and by Mr. W. B. Esson on "The Transmission of Power by Alternating Currents." The dates are not yet fixed. On January 20 that queer affair the roller boat of Mr. Bazin is to be introduced to the society by Mr. Emile Gautier.

French Civil Engineers.—The Prix Giffard to be awarded in 1899 will amount to 3,000fr. (say £120). It is confined to members of the Société des Ingenieurs Civils de France, and will be given for the best memoir on motor-carts (Automobiles sur Routes). Competitors have until the end of 1898 to complete their memoirs, by which time possibly we shall know something definite of what the motorcart is and is not going to do in the world.

The New German Cable.—The German Submarine Telegraph Company's new German and Spanish (Borkum to Vigo) cable has been laid and is working. At Borkum it connects by the Borkum and Greetsiel cables with the Imperial German lines, and at Vigo with the Eastern Telegraph Company. The Berne *Journal Télégraphique* says it is to be worked from the German end by the German Government Telegraph Department at Emden, and at Vigo by the German Submarine Company.

Pacific Cable Conference.—It is understood that the Pacific Cable Conference, which has been deliberating in private at the Colonial Office, on and off, since last mid-summer, has completed its labours, and will report in favour of a speedy completion of a Trans-Pacific cable from Vancouver to Australia. That much was pretty certain beforehand, but whether the cable is to be a Government one, or to be laid and worked by a private company receiving a subsidy, has not at the time of writing been definitely ascertained.

Faraday House.—We have to acknowledge the receipt of the January number of the Faraday House *Journal*. It contains a note on the variation of resistance with temperature by Mr. Campbell, and an abstract of a lecture on Röntgen radiations (surely one might now drop the clumsy expression X rays) by Mr. Harrison. There are also illustrations of machinery and works. The old students' dinner is announced to take place at the Imperial Institute on January 27. Lord Castletown of Upper Ossory will preside.

Impounded Pigs.—The New York *Electrical Review*, in a paragraph which has no appearance of being otherwise than serious, says: "It is proposed to dispose of impounded and unredeemed hogs in Macon, Ga., by electrocution; successful experiments have been made on rats." Georgia is not the most advanced State of the Union; but in this benighted country we are still satisfied to use the knife, on the ground that it is cheaper and has the advantage of not rendering the pork uneatable. No one has asked the pigs which way of going out of life they really prefer.

More Than Mere Mischief. — At the monthly meeting of the Derby Town Council on Wednesday the deputy chairman of the Electric Lighting Committee reported a remarkable series of outrages in connection with the electric lighting of the borough. The street boxes had been broken and the current cut off, the result being that on two occasions half the lamps in the town had been extinguished for an hour and a half. It was added that the perpetrator must have been a skilled person and have understood perfectly well what he was about, but who he was and why he did it are just what the Derby people would like to ascertain.

The Fluorescence of Sugar.—It is not in the least electrical, but it is so curious that it is worth noticing that Mr. McKissick states that in experimenting in Becquerel radiations he has discovered that, after being exposed to sunlight, ordinary sugar gives off an invisible radiation which on a long exposure will affect a photographic plate. It is, of course, well known that under certain circumstances sugar gives a visible phosphorescence; but the radiations discovered by Mr. McKissick would seem to resemble the uranium radiations of Becquerel, since they pass through wood. If anyone desires to repeat the experiment with an ordinary dark slide, it may be said that the exposure is something like three days.

Terrestrial Magnetism. — Reference has already been made to the endeavours made by Dr. Folgheraiter to obtain information as to the direction of the earth field in Italy in classical and pre-classical times by examining the traces of magnetism in vases, bricks, etc.; this should be that which the vase would acquire at the time it was fired. It is obviously not easy in this way to acquire any knowledge of the horizontal component, but Dr. Folgheraiter's investigations have led him to the startling conclusion that at the time the early Etruscan vases were fired the dip was negative. At a later period there is nothing to show that

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it was not zero. We presume that it has been ascertained beyond question that the vases were fired the right way upwards, and not upside down on a central support.

The Motorambulator.—Our neighbour, Mr. *Punch*, has joined the ranks of the motorcart designers. His invention is a motorcar-perambulator, and it is to be said that the illustration looks more like a possible vehicle than some we have seen. The habit of the accompanying nurse inclines rather to the hospital than to the domestic variety. Possibly this is a result of specialisation for accidents. Probably a lingering reluctance to regard Mr. *Punch's* organ as an entirely serious publication will prevent the companies taking up the new vehicle, so that the cynical onlooker will not enjoy the spectacle of the collapse of statute, by-law, and local authority when the nurse decides that she is not going to drive her motorambulator in the road so long as there is a nice clean pavement at the side of it.

Electricity in the Dairy.—According to a paragraph in a Chester contemporary—we have not been to Sweden to see—Dr. Gustaf de Laval, a name which dairymen will recognise, not only runs his separators at the Lilla Ursvik Farm, near Stockholm, by an electric motor, but has also adapted electric driving for a cow-milking apparatus. The paragraph is written in a somewhat frivolous spirit, and looks as though it came originally from across the Atlantic, but, seriously, if people will use a mechanical milker and sit on a stool to watch it instead of doing the work themselves, a small motor and a conductor is ever so much better a method of driving than any form of flexible shaft. Although the scene of operations is in Scandinavia, the power is not derived from a waterfall, but from a 10-h.p. steam-engine.

Tramway Passing-Places.—Mr. W. S. Browne, of New York, has patented an electrically-operated switch mechanism designed to automatically switch tramcars from one track to another without action on the part of the motorman. An account of the invention is given in the *Scientific American*, but as the description is in what may be called patentee's English (American variety), and even if rewritten would probably be unintelligible without the accompanying illustration, it must be sufficient to say that a contact made by the trolley completes a circuit, by which the trolley-wire current is used to make an electromagnet shift the switch ahead of the car. So far as can be judged apart from practice, the arrangement looks a good and workable one, but some device of the sort is obvious whenever the occasion for its use arises.

Two Voices.—Mr. R. Cunliffe-Smith having been to Rome, and returned, wrote to ask the editor of the *Morning Post* why we do not have electric trams in London. He had better have asked the London County Council. Rome, Mr. Cunliffe-Smith says, may afford us Londoners an admirable example of what can be done in the way of electric tramways. "The trams there are universally used, and the carriages are apparently brand new and spotlessly clean, make no noise, and can be stopped at a moment's notice with the greatest ease, going up and down the steepest inclines, while they are cheapness itself." Whereupon "An Old Resident in Italy" writes flatly contradicting all Mr. Cunliffe-Smith says, except that there are tramcars in Rome. So do different people see as black or white what is really only grey. But either the readers of the *Morning Post* were not anxious to liberate their minds on the subject of the Roman streets or the editor was not propitious, for there seems to have been no more of it.

Guttapercha.—It is well known that much guttapercha collection is carried on with little regard to the permanent preservation of the source of supply. Mr. A. Geyer, in the *Deutsche Colonial Zeitung*, has suggested that in the German colonies State aid and initiative should be given to the cultivation of guttapercha. (It really would be just as well if the Germans did something with their colonies now that they have got them.) According to our author, several orders for submarine cables have come to England simply because a first-class guttapercha was not obtainable elsewhere. Assuredly we do not grow it in this country in a hot-house, and as presumably the good German article when produced will be purchasable in the open market, we could look on with the utmost complacency at State-endowed guttapercha growing in German Papua or elsewhere. The more guttapercha there is, good or bad, the cheaper it will be, and the supply of the raw material we need is a form of unfair competition that we can put up with with equanimity.

The Nobel Millions.—Mr. Alfred Nobel, of dynamite fame, has left most of his two millions for the purpose of advancing science, though whether he has chosen quite the best way of doing it may be questioned. Although, as it is stated in the *Svenska Dagbladet*, of Stockholm, the full text of the will cannot be published at once, as some codicils are in Paris, the general effect of it is known. Almost the entire fortune of the deceased is to be converted into a fund, the yearly interest from which is to be divided into five equal portions. The first of these is to be allotted as a prize for the most important discovery in physics. The second is for the principal chemical discovery. The third is for the chief discovery in physiology or medicine. The fourth is for the most distinguished literary contribution in the same field, while the fifth is to be allotted to whomsoever may have achieved the most or done the best to promote the cause of peace in any one year. All these premiums are open to Scandinavians and foreigners alike.

Electric Sighting.—One of the questions in naval warfare which still await an answer is how often the big gun carrying a mile or more will hit the other ship. In fact, as it involves the question of "long bowls" or close action, the whole of naval tactics depends upon it. A good deal of the sighting of turret guns is done with the top of the turrets. This may be passable for "direction," but it is obviously very unsatisfactory for "elevation," especially in a heavy sea. Evidently what is required is some interconnection between a sighting telescope and the gun (adjusted for range), so that their positions may be always the same, or, what is practically more convenient, may be the same when everything is ready for firing. A comparatively simple arrangement, in which both this correspondence of position and the actual firing is effected by the use of electric circuits, is the subject of an article in the New York *Electrical Engineer* by Lieutenant B. A. Fiske, of the United States Navy. Trials at the target have, it is stated, shown the apparatus to work exceedingly well, but of course nothing but actual experience can show precisely what will happen when the target shoots back.

Cable Interruptions.—The official list of interruptions for last month published in the Berne *Journal Télégraphique* gives the following as unrestored up to December 25: the Puerto-Plata and Martinique cable (failure December 19, 1895), the Transcontinental African line beyond Mazoe (March 11, 1896), the Amazon Company's cable beyond Parantins (from May 4), the same company's cable between Obidos and Parantins (from December 7), the Columbian land lines (from July 4), the Salisbury and Umtali line (from July 11), the Pará and Maranham cable (from October 8), the Santa Cruz and Trinidad cable (from November 29), the Ceara and Maran-

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ham cable (from December 2), and the Suakim and Jedda cable (from December 5). It will be seen, therefore, that South America and the West Indies make anything but a good show. The Katherina and Larissa line in Greece is returned as "defective" from December 5. The only other long suspension is that of the St. Lucia and St. Vincent cable, which took place on November 29, and was repaired on December 10. It is useless reproducing quite short ones, as it seems probable some of the lines differ in their ideas of what should be reported.

Stamboul and Stupidity.—People that are fond of putting things together may collate with what appeared in our "Notes" on the subject of Turkish patents the following, which is given by the *Daily News* on the authority of Mr. Bérard. "The Sultan's cowardice," that gentleman remarks, "borders on folly. As he paid his last annual visit to the Mantle of the Prophet an earthquake shook the mosque. The word 'dynamite' was uttered, and put the Sultan to flight. Since then he has never returned to Stamboul, for Stamboul and dynamite are associated in his mind. He has even forbidden electric light in the city because it is generated by dynamos." Unfortunately for the inference, it seems not only necessary to presume idiotic cowardice but also an ignorance of (modern) Greek. Mr. Bérard seems to have forgotten that the Khalifa ul Islam besides being head of the Ottoman Turks, is also the Sultan of Roum. Emperors that live shut up in a palace and a park—it has been done before many times, and will be done again—always have strange tales told of them. Allowance must be made for longitude, and Turkish officials are not by any means the only people who have at one time or another had an unreasoning dread of the results of the introduction of electricity.

Repairing Wires.—General A. W. Greely, chief signal officer of the American War Department, in his annual report on the Government telegraph wires (not, of course, the wires of the private companies) says that interruption to telegraph communication has been so infrequent during the year as to be practically nil. The most frequent cause of interruption (the frequency of nothing has an indeterminate look) has been maliciousness, through a tendency of lawless individuals to pull down poles, cut wires, or shoot off insulators. (In this country the most destructive embodiment of lawlessness is the small boy with a pocketful of stones, but the American Government lines are many of them in out-of-the-way regions, where the policeman is practically unknown.) The speedy resumption of communication after such occurrences has been due to a great extent to the adoption of the bicycle as a means of transportation for repair men in place of the more expensive horse and wagon. The bicycle affords the more rapid as well as more economical method of travel. Frequently breaks in a line have been repaired by the use of the bicycle in less time than would have been consumed in obtaining a horse and vehicle. At some stations in a single year the original value of the bicycle has been saved to the Government.

Central Stations in America.—Mere arguments from statistics are only too often fallacious. Mr. Max Osterberg's article in the New York *Electrical Engineer*, in which it was contended that the doom of the central station was sealed, and it would be superseded by isolated plants, has called forth a vigorous reply, in which it is stated, with a shocking example to back it, that where central stations have failed it has been not from defect in the electrical or mechanical department, but because the financial management has wanted to make too many profits. In other words, the stock has been watered beyond all reason and conscience. The conclusion is not that central stations are doomed in America, "but the prevailing methods of stock manipulation are, and the sooner laws are enacted to prevent over-capitalisation of the municipal lighting companies the sooner will the public be relieved from the impositions arising from the attempts of the companies to take from them four or five times a legitimate profit, and the stock-holders will then feel secure that public opinion will not force legislation that will render their stock valueless, although they may be innocent holders, the victims of the adroit schemes of others." The article is anonymous, but it is said editorially of its author that he is "an engineer of the first eminence, and he has told his story with a frankness which is simply startling. He certainly places it beyond cavil that central stations in good localities, if properly carried on, are enterprises of an excellent kind, and that there are sure to be more of them before there are fewer."

The New Year Honours.—Sir Joseph Lister, the president of the Royal Society, is to be made a baron. Sir Joseph is one of those Englishmen the true magnitude of whose work is more appreciated on the Continent than in this country. Those whose paths in science are quite apart from the department of applied science which Sir Joseph Lister adorns will remember him from his address as president at the past year's British Association meeting. The other baron is Lord Kinnear, a Scotch judge Among the other honours it is announced that Mr. Birt, of the Great Eastern Railway, is to be made a knight. The Prime Minister should know what the Great Eastern used to be and the work the men had before them who have made it what it is. The misunderstanding as to which Mr. Laird was to be the Sir William has perhaps caused some good people at Birkenhead to look somewhat ridiculous, but the two persons most interested can hardly have been in doubt on the subject. It is the wise as well as the polite and usual course to ascertain whether a man will accept an honour before it is given him. In some quarters surprise has been expressed that the name of Mr. Herbert Spencer does not appear in the list to mark the completion of his great work. But what dignity could be conferred on Mr. Spencer which would be appropriate? Imagine him taking the privy councillor's oath in the usual manner! Or still more, imagine him nominated to the Council and neglecting to take it! It has been trouble enough to get him to have his portrait painted.

Telephone Troubles.—Apparently in Chicago it is part of the business of a druggist not only to sell things which are not drugs but cannot as conveniently be obtained elsewhere, but also to provide cheap telephonic communication. According to the *Electrical Journal*, "Under the old arrangements telephones were furnished to drug stores at an annual rental of 200dol., the understanding being that their use was to be confined to the legitimate needs of the business, and that for every call outside of these a fee of 10 cents was to be collected. While honest in their intention to deal squarely with the telephone company the druggists quickly became the slaves of conditions. Their telephones were kept busy all day by people who spent but little money with them, and yet it was dangerous to make complaint lest that little should be driven away. On the top of this came the imposition of having to furnish a boy to run errands in answer to telephone calls, an item for which nobody ever thought of paying a cent, and yet it increased expenses by fully 300dol. a year. Besides all this there was the mortification of having a good customer, who rarely used the instrument, rush in some morning in a great hurry to call up somebody, only to find some gibbering idiot of a girl talking nonsense through it for 20 minutes at a stretch."

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Consequently the telephone company have insisted on installing "dime-in-the-slot" instruments. The result is that the druggists who have got contracts unexpired for the old machines (usable free) get all the custom to their stores. The telephone seems to have an unrivalled faculty for producing dissensions in one way or another.

Foreign Manufactures.—If in England, or for the matter of that Germany, America, or anywhere else, there is started a new and successful industry, at first that country will supply all the world, but ultimately, and probably not long after the patents have run out, nothing in the world can prevent all other countries of any pretension wishing to supply themselves. The process can easily be watched in the electrical trades. Spain is not a rich country, but there has been a fair amount of electric lighting done there, the material of course being obtained from abroad. But last week we noted that *Electron* was rejoicing at the establishment of a manufactory of accumulators at Manzanares, and now we have *El Telegrafista Español* congratulating Madrid on the starting of an incandescent lamp factory in the Barrio del Pacifico by the Compañia National de Electricidad. Moreover, the new manufactory often enjoys advantages over the pioneers. Not only does it profit by their costly-won experience, but there is the question of cheaper labour and rents, not to mention other matters. The following from *El Telegrafista* is significant: "All the materials employed in the manufacture of these lamps are Spanish, with the result that, being free from the expense of customs duties and exchange, the cheapness of the lamps, as well as their excellent quality, are circumstances which can hardly be improved for competing successfully with foreign lamps." That is so, and quality being equal, there is no getting over it. It is probably a loss to German rather than to English trade; but all the same, the teaching a portion of our young men to speak the purest Castilian at the ratepayers' or taxpayers' expense would not materially mend the matter.

The Amazon Cable.—The submarine cable and the land line are known and all their incidents, but what happens to a river cable, especially when the river is the Amazon, is still to be learnt. Information of a sort may have been gathered from the monthly returns of cable interruptions, but that sort of information is satisfactory to no one. At first sight a soft mud bottom, not extremely shallow and not very deep, with the drift guaranteed to be always in one direction, and that parallel to the line, would seem an ideal resting place for a cable. But when it is remembered that new channels keep scouring out so that parts of the cable get buried and parts do not, and unsuspected rocks are laid bare where six months before the sounding line gave nothing but mud, it does not want the addition of the climate of a tropical river valley to make maintenance work seem less roseate than at first sight. Then there is the drift wood, and this, as was anticipated, has proved very troublesome in the upper parts of the river. And even where the floating wood is not dangerous, there is always the possibility of a harmless-seeming patch of mud being only the covering of a perfect skeleton of sunken tree trunks. It is evident, however, that Mr. Siemens is confident that by deviating one way or the other where the bad patches are found, he can get the whole of his cable buried in the mud of the bottom. As soon as that is accomplished, so far as external injury is concerned, the cable will be safe until the Amazon changes its course and the geologist of a future age finds a new kind of fossil. One of the most satisfactory things about the enterprise is to find that the inhabitants of the district have even a greater readiness than was expected to use the telegraphic communication which has been brought to them in the only way in which it could have been.

Christmas Lectures.—At the Royal Institution on Saturday, Prof. Silvanus Thompson arrived at that part of his course of lectures which deals with polarisation. He said it was really a very simple thing, only it had been given a very bad name. So it is at the start, only when you get into circular polarisation—sugar solutions, for example—or the plane polarisation produced by very small particles, the ideas are by no means so easy to grasp. Having regard to the capacities of an audience some of whom at least were juveniles, the lecturer did not pursue the subject further than interference colours. Incidentally, Prof. Thompson professed a complete unacquaintance with para-nitro-phenol, though the exigencies of the situation compelled him to introduce it to his distinguished audience, and he also protested against the way people have of calling mica talc. (On the other side of the Atlantic it has been called isinglass, which is even worse.) On Tuesday, the ultra-violet spectrum was dealt with, and fluorescence and photography, and the chemical action of light generally. The only Lippmann coloured photograph in England (a spectrum) was exhibited, and also Mr. Ives's method by the use of three coloured screens and the combination of three negatives. On Thursday the infra-red had its turn, and so on downward to the Hertzian electric waves. The Röntgen radiations are to come to-morrow (Saturday).—At the London Institution Prof. Fleming's course was much shorter, so that he soon ran ahead of Prof. Thompson, and has already finished off Röntgen radiations and all.—The juvenile lectures at the Society of Arts are by Mr. C. T. Dent, of the Alpine Club, and deal with the growth and demolition of mountains. All three of the courses have had crowded audiences.

The Underground Trolley Conduit.—During a snowstorm on Wednesday, December 16, the underground electric trolley line in Lenox-avenue, New York, was disabled for several hours. This is the first time that this line has succumbed to the weather, and as the system may be said to be yet on its trial the facts concerning the breakdown will be of interest. It seems that when the storm came on only about one-half of the usual amount of power was available, for the reason that half of the generators at the power station are being rebuilt. According to the chief engineer's statement, this would have been sufficient to keep the cars running under ordinary circumstances, but the mechanical resistance of the snow and the slippery condition of the rails, preventing adhesion, proved too much for the motors. Moreover, after the snow-ploughs and sweepers had opened up the line, a sudden fall in the temperature caused a coating of ice to form on the conductors, and thus prevent full contact. The conductors consist of two wrought-iron pipes, one on each side of the slot, which are carried on insulators attached to the top of the conduit. The *Scientific American* says the difficulty of ice forming on the wires is not unusual with the over head trolley, "but one would have thought that the protection of the closed conduit would have prevented such an accident. The difficulty was overcome by equipping the car with knifelike scrapers which cleared the conductors of ice just ahead of the contact shoes. By the time the cars were ready to run again after the scrapers had been attached, the conduit had filled up with snow and slush, and the tracks were so covered that it took several hours to get started. It is the intention of the company to equip every car with removable ploughs, specially designed for keeping the conductors clear of ice. In some of the northern cities, and in Canada, it has been a common thing during a storm of sleet to put a man on the top of the cars

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of an overhead trolley line, who carries a forked spear with which to scrape the ice off the wires." Our contemporary adds that the stoppage is not looked upon by the company as serious enough to have any effect upon their determination to equip the Fourth and Sixth Avenue lines on the same system.

In Praise of the Accumulater. — Mr. William Baxter begins an article in the *Scientific American* on the subject of modern applications of the storage battery with the remark that the storage battery came into the world with such a flourish of trumpets, and failed so completely to accomplish all that was expected of it, that for a long time it rested under a heavy cloud. "The sensational Press, ever ready to exaggerate the possibilities of new inventions, made claims for it that were far beyond the limits attainable, even by theoretical perfection, and those engaged in promoting its interests, either through ill-advice or an over-sanguine estimate of its capabilities, subjected it to the most trying tests, believing, no doubt, that if it succeeded in these its future would at once be established on a firm foundation. The results of these tests, as everyone knows, were disastrous, and during the following years those who spent their time and money in endeavours to improve upon the work of the past were looked upon as impracticable dreamers." Meanwhile, very decided improvements have been made, and "the batteries of to-day are thoroughly practical and reliable for a certain line of work, although they have not reached that point of perfection where they can be used with success for the purposes to which they were first applied—that is, for the propulsion of railway cars." Mr. Baxter then points out the way in which properly-designed accumulators will help the engines over the peak of the evening load and undertake the dead waste and middle of the night, or, to be accurate, the small hours of the morning on their own account. (The typical American load is not distributed over the 24 hours in quite the same way as the English). A diagram is given in which a two-peaked mountain of a load curve is rectified into a most beautiful oblong. There is just a reference to the loss of energy in working through the battery, and Mr. Baxter goes on: "From the foregoing it will be seen that the use of storage batteries in connection with lighting and power stations is beneficial in the highest degree. Not only is the cost of operation greatly reduced, but the reliability of the service is materially increased, for if at any time it becomes necessary to stop the machinery, the batteries can keep up the supply until it is started up again—that is, if the time of the shutdown does not exceed two or three hours, and it is very seldom that anything happens that requires a stoppage of more than a few minutes. In addition to the advantages mentioned in the foregoing, if a station becomes too small to meet the demands upon it, its capacity can be nearly doubled by the installation of a battery plant, and the increase can be made still greater if the engines are shut down only two or three hours every night, instead of five, as between the hours of 1 and 5 a.m. nearly all the power could be stored." Nothing is said as to the steadiness of voltage, which in this country is found to be a characteristic of those supply companies that work with accumulators, and the article concludes with the remark that "in Europe the storage battery is used in stations to a far greater extent than here (America), where, until within the past year or so, it has made but little headway. Now, however, it is gaining very fast, and before long will, no doubt, be considered an indispensable adjunct in all stations." If the path of virtue is the golden mean, in the matter of accumulators this country, occupying a position between Germany and America, should not be very far from it.

Victoria Falls.—The Africa Trust is a company which may be presumed to deal in mortgages and mining debentures, town "stands," and Rhodesian development generally. With such we have no concern, but the fact of Mr. Rider Haggard being chairman would make the general meeting interesting, even if it had not resulted in some further details being made public as to the proposal to serve the Victoria Falls as Niagara has been served. The Africa Trust, Limited, is not going to do it, but it has an interest in the African Concessions Syndicate, which is. In Mr. Haggard's words: "The object of this syndicate is to carry out a scheme to use the water power of the Victoria Falls on the Zambesi River with the object of utilising that power to generate electricity, and supply it to the various centres of population throughout Rhodesia, either in the form of power to work stamps and mills, or of motive power for other purposes. This great scheme, the greatest electrical scheme perhaps of this century, has been modelled upon that already achieved at the falls of Niagara in America, which, vast as they are, I believe, are surpassed in size by the Victoria Falls of the Zambesi. The undertaking has the advantage of being reported upon by Prof. Forbes, F.R.S., who was the engineer of the Niagara Falls works. Indeed, Prof. Forbes proceeded to Africa for the syndicate during the year 1895. Subsequently also it has been favourably reported upon by no less an authority than Prof. Hopkinson, F.R.S., C.E." Dr. Hopkinson has presumably not been to South Africa and seen the place. When the Victoria Falls were first discovered (and the men are alive who remember it), and the supremacy of Niagara as the "biggest thing" in that way was imperilled, the Americans simply said that there was nothing to prevent you making a waterfall as tall as you like if you put it in the middle of Africa. There is no doubt whatever about the falls and the water: they are good enough, but even yet communications are difficult, and the number of people that have braved the discomforts of the African climate and ox wagon in order to visit the falls is not enormous. In fact, a little more will have to be done in the way of railway construction or improvement of the Lower Zambesi before it will be easy to take heavy machinery there, so that it is altogether probable that our engineers will have had the opportunity of benefiting by a good deal of experience gained from the working of the Niagara plant before they seriously set to work to duplicate it only on a larger scale on the boundary of Barotseland. Mr. Haggard says: "The success of the enterprise is measurable by the success of Rhodesia. If Rhodesia proves a failure, it will fail; if, as most of us are convinced, Rhodesia proves one of the greatest colonising achievements of our colonising race, this scheme will prove a success. Meanwhile, I may add that both the eminent electricians of whom I have spoken assure us that there is no insurmountable scientific difficulty in the way of the transmission of electrical energy to a distance sufficient to bring an enormous area within range of the enterprise, which should prove an important factor in the rapid development of Rhodesia." It would be exceedingly interesting if Northern Rhodesia skipped the intermediate stages in the evolution of power development—the horse and the steam-engine—and went at one leap from oxen to electricity. Things march rapidly in that country when there is not a rebellion going on. One might strongly recommend a share in the waterfalls as a novel present from a godfather now that fairies are no longer obtainable in that capacity. By the time the young man had attained to years of discretion, he would know whether it was the foundation of a fortune or the modern equivalent of a withered leaf—a piece of waste paper.

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THE PRINCIPLES OF ALTERNATE-CURRENT WORKING.*

BY ALFRED HAY, B.Sc.(EDIN.), A.I.E.E.

(Continued from page 15.)

121. In the next few articles we shall briefly consider the behaviour of ordinary alternators when used as motors, and the parallel running of alternators.

Let A B C D (Fig. 84*a*) represent one of the coils of an alternator armature, in the position of maximum E.M.F., the direction of motion and that of the induced E.M.F. being indicated by the arrows. Suppose, for the sake of simplicity, that the current is in phase with the E.M.F. Then the coil in the position *a* experiences the maximum pull, the pull being opposed to the direction in which the coil is being driven by the engine. The pull gradually diminishes as the current dies down to nothing, and disappears entirely when the coil reaches the position *b*. As the coil passes from this latter position to the position *c*, the current induced in it is in the opposite direction, but since the coil is approaching a pole of opposite polarity, there will be an opposing pull which gradually increases, reaching a maximum value for the position *c*. The pull will then once more diminish, and so on.

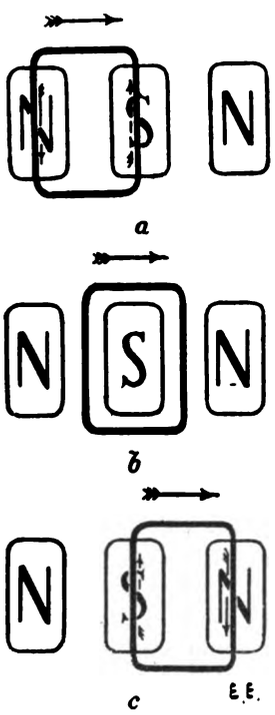

FIG. 84.

We thus see that when the current is in phase with the E.M.F. the alternator armature experiences a retarding torque, which varies periodically with the current, rising from nothing to a certain maximum value, and then dying down to nothing again. The direction of this torque, however, is always such as to oppose the driving torque. The resistance offered by a loaded alternator (always supposing the current to be in phase with the E.M.F.) to the engine driving it is therefore not a constant, but a rapidly fluctuating one, resembling in this respect the resistance offered by a circular saw cutting through a thin sheet of metal.

122. While the alternator is running, suppose the belt driving it to be suddenly thrown off, and an alternating current to be sent through the armature coils which has the same periodicity and amplitude as that developed by the alternator whilst it was being driven by the engine, but which is at every instant in opposite phase. Also, suppose that at the same time a brake is applied to the alternator pulley, so that the total resisting torque is the same as that which was formerly offered by the current circulating in the armature coils. The direction of the current for the positions *a* and *c* in Fig. 84 will now be the reverse of that indicated by the arrows, so that what was formerly an opposing torque will now become a driving torque. The driving torque will undergo precisely the same rapid fluctuations as those which characterised the resisting torque when the machine was being driven. The resisting and driving torques being equal, it is obvious that the alternator will go on running at the same speed as before, thus acting as a *motor*.

123. Such a motor possesses the peculiarity that it will run at only one definite speed, depending on the periodicity of the alternating current which drives it. For this reason, it is termed a *synchronous* motor. If we suppose that by a very sudden and great increase of load the speed of the motor is reduced, then it is obvious that what was formerly a regular succession of driving impulses will now become a perfectly irregular series of pulls on the alternator coils, now acting in one direction, now in the opposite, and with their algebraical sum over any considerable time interval equal to practically nothing; for now the direction of the current bears no definite relation to the position of the armature coils with respect to the poles. The motor will therefore abruptly come to a standstill.

124. In order to start such a motor, it becomes necessary to run it up to its *speed of synchronism** by some independent means, such as a small auxiliary motor. Further, the *phase* of the E.M.F. of the motor must be adjusted so as to be in opposition to the phase of the generator driving it before the switch is closed.† These operations are performed by using an arrangement known as a *synchroniser*.

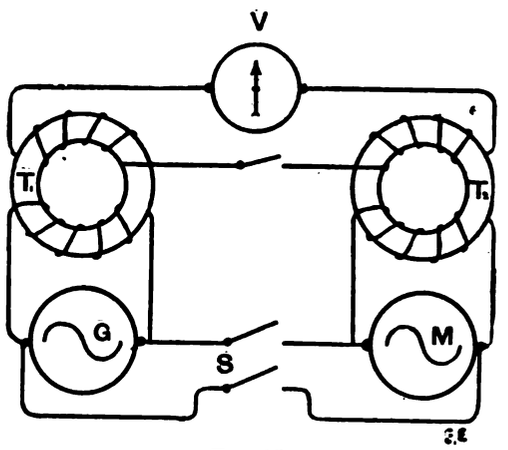

FIG. 85.

The form of synchroniser commonly used (Fig. 85) consists of two transformers, T_1 and T_2, with their primaries connected across the terminals of the generator G and motor M respectively, while their secondaries may be closed through a voltmeter V (or incandescent lamp), the connections being so arranged that when the two machines are in opposition as regards phase, the E.M.F.'s in the secondaries of the synchronising transformers are added together, and the voltmeter shows the highest reading. If the speeds of the two machines are different, the voltmeter reading will show fluctuations; the switch S must be closed at the instant when the voltmeter gives the maximum reading, and when that reading is steady.

125. We have hitherto supposed that the current through the motor armature is exactly opposed in phase to the E.M.F. Under these circumstances the current passes through its zero value at the instant when the coil is facing a pole, and therefore in the best position for exerting an effect on the field. With the current exactly opposed in phase to the E.M.F. we thus see that there will be no tendency on the part of the armature to either weaken or strengthen the field. It has already been shown (Art. 78) that in the case of a generator the armature current tends to *weaken* the field if the zero value of the E.M.F. occurs *before* the zero value of the current, and to *strengthen* it if

* Based on a series of evening lectures delivered at the University College, Liverpool.

* The speed of synchronism of a motor depends, for a given periodicity, on the number of poles in the motor field.

† Otherwise there would be an enormous current through the motor at the instant of switching on, due to the fact that the motor E.M.F. is *added* to that of the generator. This current would tend to stop the motion of the motor, and the shock might be sufficient to rip out the coils.

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it occurs *after* the zero value of the current. The opposite effect takes place in a motor, as will be readily seen by an inspection of Fig. 86. In Fig. 86*a*, the E.M.F. passes through its zero value *before* the current, and the armature tends to *strengthen* the field; in Fig. 86*b* it passes through its zero value *after* the current, and the field is weakened.

It must be borne in mind that, owing to the rapid pulsations of the current in the armature coils, the magnetising force due to the armature is not a steady one, but consists of a series of impulses following each other in rapid succession. The effect produced by the armature current might be imitated by winding a number of turns of wire on the field magnet, and supplying these with current impulses corresponding to those due to the armature. These current impulses would not, however, produce variations of corresponding amplitude in the magnetic flux through the field magnets. A mass of iron, as we have seen (Art. 120),

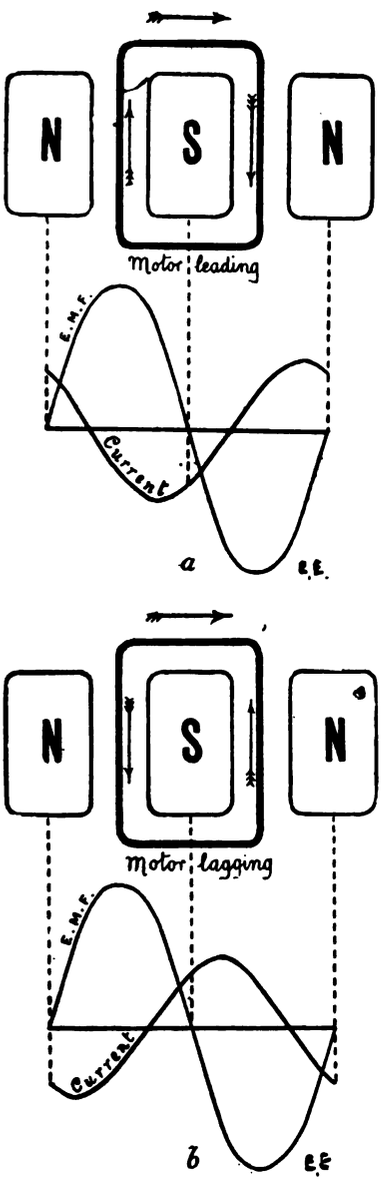

FIG. 86.

does not immediately respond to a magnetic force (unless very finely laminated). [This, in fact, renders possible the excitation of the field magnets of an alternator by a rectified alternating current.] The result is that the magnetic flux through the field does not follow the very rapid variations of current, but assumes a certain intermediate state which is practically steady. We are thus led to the conclusion that if the E.M.F. in a synchronous motor passes through its zero value *before* the current the field is permanently *strengthened*, while if it does so *after* the current, the field is permanently *weakened*. In other words, the E.M.F. in the first instance is increased, and in the second diminished, by the *armature reaction*.

126. Besides the weakening or strengthening of the field by the armature current when the latter is not exactly opposite in phase to the E.M.F., there are other actions which we have to consider. Referring to Fig. 86*a*, we notice that when the coil moves past the position there indicated, the force acting on it will be a *retarding* one, tending to arrest the motion of the armature until the current becomes reversed. Similarly, in Fig. 86*b*, the coil will, from the instant of reversal of current until it reaches the position shown, be acted on by a retarding force. In each case, therefore, the impulsive torques driving the motor will be alternately positive and negative, and the useful driving torque will be the difference between a positive and a negative one. The motor will in this case act as a motor only during the intervals when the driving torque has a positive value, and it will act as a *generator* during the intervals for which the torque is a negative or retarding one. The power curve for the motor would consist of positive and negative half-waves, resembling the full-line curve of Fig. 51.

127. Let us suppose that in the case of a loaded synchronous motor the exciting current is so adjusted that the armature current is in step with (*i.e.*, opposite in phase to) the E.M.F. Let the exciting current now be weakened. The immediate effect of this on the motor is to diminish its E.M.F., allowing a much stronger current to flow through its armature. The motor will thus be momentarily *accelerated*, its E.M.F. getting slightly out of step with the current, so that when an armature coil is in the position shown in Fig. 86*a* there is a current flowing through it, as indicated by the arrows. This current will, as already explained, tend to strengthen the field, thus counteracting to some extent the effect produced by weakening the exciting current. The motor will *lead*—*i.e.*, its E.M.F. will pass through its zero value before the current. That the latter must now be greater than it was when in step with the E.M.F. is also evident from the following consideration: the current not being in step with the E.M.F., the driving torque will now, during a certain fraction of each half-period, be negative; hence, in order to obtain the same driving torque, the positive torque must have a larger value than before—*i.e.*, the armature current must be greater.

The more the field excitation is reduced, the greater must the armature current become for a given torque, and the more will it be out of step with the E.M.F. A stage is finally reached when the field is so weak as to be unable, in spite of the very large armature current, to furnish the torque required. The motor then drops out of synchronism, and comes to a dead stop.

Instead of reducing the exciting current which makes the E.M.F. exactly opposite in phase to the current, let us next *increase* it. The immediate effect is to increase the E.M.F. of the motor, thus reducing the current and driving torque. The motor will therefore be momentarily *retarded*. The reversal of current in the armature coils will thus take place before the position of zero E.M.F. is reached, so that in this latter position (as shown in Fig. 86*b*) there will be a current tending to *weaken* the field, and thus counteract the effect produced by increasing the exciting current. The slight retardation of the motor armature will go on until sufficient current passes through it to provide the requisite torque; the motor will then go on running synchronously. The current taken by the motor must, as before, be greater than that corresponding to exactly opposite phases of current and E.M.F.; for now we have alternately positive and negative torques exerted by the motor, so that the positive impulses must be greater than before, necessitating a larger armature current.

From the above considerations it is evident that for a given load the armature current will depend on the field excitation. With a very weak field, the armature current is large, and the motor current and E.M.F. are considerably out of step. As the field is strengthened, the armature current diminishes, and at the same time comes more nearly into exact opposition of phase with regard to the E.M.F. For a certain value of the exciting current, the current in the motor armature is exactly opposed in phase to the E.M.F. This corresponds to the *minimum* R.M.S. value of the armature current, for the driving impulses received by the motor are now all positive. Any further increase of the exciting current produces an *increase* of the armature current. The relation between the exciting current and

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that through the motor armature is shown by the curves in Fig. 87. Corresponding to each load we have one such curve. As the load increases, the curves become more rounded.

128. When the current is in exact opposition to the motor E.M.F.—*i.e.*, when it has its minimum value—it is obvious that the efficiency of working is at its maximum. For the loss due to heating of the line and generator and motor armatures is then reduced to a minimum. In

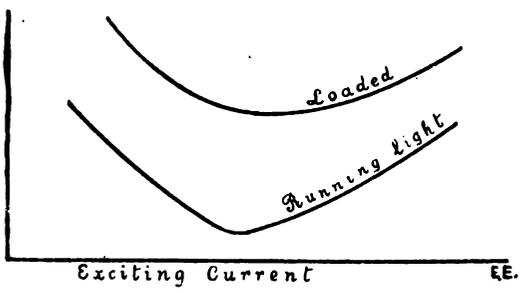

FIG. 87.

practice it is usual to excite the motor a little *above* the point corresponding to exact opposition of phase. This renders it more stable than when it is excited a little below this point, as will be evident from the following considerations.

Suppose, for the sake of simplicity, that E.M.F. and current obey the simple sine law, and that E and I stand for the maxima values of these quantities. Let γ denote the phase angle of displacement between the zero values of E.M.F. and current. Then the power spent in actually driving the motor is, by Art. 61, $\frac{1}{2}$ E I cos γ. Let now the load be suddenly increased. This will, of course, produce a momentary retardation of the motor armature. A reference to Fig. 85 will easily convince the student that the effect of such a retardation is to weaken the motor field, whether the exciting current be strong or weak, thus allowing a larger current to pass into the motor armature, and increasing the torque. But with a strong field, the value of E in the product $\frac{1}{2}$ E I cos γ is greater than with a weak field. Hence a *smaller* change in γ will produce the necessary increase of torque, and the motor will not fall out of synchronism so easily as when the field is weak. Where the motor is subject to sudden changes of load, a slight over-excitation* is thus useful in imparting greater stability to the motor, and providing a larger margin of power.

(To be continued.)

THE MECHANICAL CONSTRUCTION OF ELECTRICAL MACHINERY.

BY F. M. WEYMOUTH.

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THE DYNAMO.

(Continued from page 10.)

Bed-plates (*continued*).—Another point that might have been touched on in regard to Figs. 1 to 4 has reference to

FIG. 6. FIG. 7. FIG. 8.

the principal corners, though the remark has also a general bearing on our subject. This point is, that when designing a bed-plate, or indeed any casting, it requires to be borne in mind that the pattern is made of wood, and thus the most economical use of this material is a factor not to be overlooked. Now, obviously, a wooden box made of boards nailed together at the corners is the basis of an inexpensive pattern. Hence to this end corners need to be made as shown (Fig. 6), which in the pattern will appear as shown (Fig. 7). It will be observed that the inner and outer corners are both struck to the same radius—not from the same centre—and in the pattern the inner radius is obtained by the "cleating" *a*. By this arrangement the sides can easily be nailed or screwed together, and a strong corner to the pattern is permitted, which at the same time is also inexpensive. A good rule for the radius is to make it about two-thirds or three-quarters the thickness of the side.

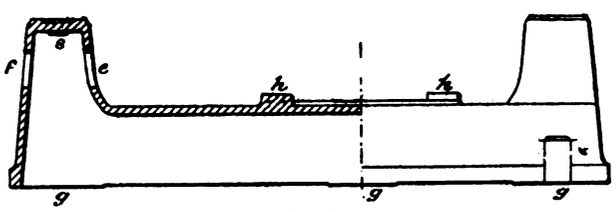

FIG. 9.

The comparative weakness in the pattern of a corner, as in Fig. 8, will be apparent.

We now come to another form of bed-plate, commencing with Fig. 9. This is a departure from the last in various respects, though in common therewith it is also for an "undertype" machine—that is, having the armature under the yoke. The pedestal rises at each end for the bearings, and the sides in plan (Fig. 10) are set in right and left, as shown by the solid lines. Viewing this as a loaded girder supported at the ends, which it would be if on two rails, the tension on the lower edges of the sides would tend to draw them straight, and the bed-plate would deflect. A third

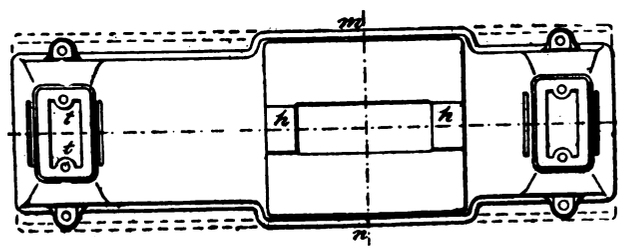

FIG. 10.

rail under the middle thus becomes necessary, and a facing on the lower edges both there and at the ends, lettered *g g*, will be observed in the illustrations for that purpose.

We may now give some more special attention to the pedestals. It is to be noted that these have not to support a mere steady dead-weight. With a shaft and heavy armature quickly rotating there will be much sideways strain also, and especially in the case of the bearing next the pulley. The correct or safest view of such a pedestal, therefore, is to regard it as a vertical cantilever, with

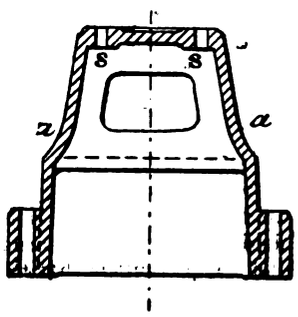

FIG. 11.

horizontal strains across its upper end as well as the direct load downwards. To resist these combined strains a hollow section is obviously the most suited when the pedestal is regarded as a whole member. It is to be noted, however, that lightening holes, as at *f* and *e*, have the effect of dividing the pedestal into two members, as at *a* or *b* (Figs. 11 and 12). In this latter case, therefore, where each such member must be in direct tension or compression, it

* By an "over-excited" motor is here meant a motor whose exciting current is greater than that corresponding to exact opposition of phase between armature E.M.F. and current.

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is plain that for these strains they should be perfectly straight. With small pedestals this reasoning may, of course, seem of little account. There will be some transverse strains as well, including shear, but these do not affect the argument. A case in point, however, not so small, is illustrated in Prof. S. P. Thompson's "Dynamo-Electric Machinery" (Plate XXIII., fourth edition), where a large lightening hole leaves both side members of a pedestal in a curved form; their rigidity, therefore, being dependent on a more massive section than would be required were they straight.

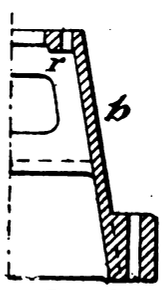

FIG. 12.

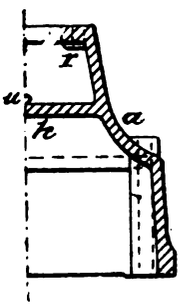

FIG. 13.

Now, in Figs. 11, 12, and 13, we have end views showing three designs of pedestal. The first two are alternative arrangements, such as might go on the narrow ends, shown in solid lines (Fig. 10). But Fig. 13 shows a method to suit the same bed-plate if its maximum width were maintained throughout its length, as shown dotted (Fig. 10). Of these it will thus be observed that while Figs. 11 and 13 may look best, Fig 12 is the simplest, and is also quite sufficiently strong. The section at *b*, though cast iron only, is obviously of great strength as compared, for instance, with the holding-down bolt below, or the torsional rigidity of the bed-plate. In Fig. 13, there is a great superfluity of strength and consequent waste of metal. The narrow base, therefore, if only on account of its economy of metal, is to be preferred.

Another point, however, as regards *a a* refers to the patternmaking once more. It is thus to be noted that while to put a curved edge on a board is a comparatively simple matter, it is not so in the case of a curved surface, for this latter must either be cut out of the solid, as shown in Fig. 14, involving great waste of both wood and labour, or else it must be built up of short boards put across, as shown in Fig. 15, also involving waste of labour, as compared with merely fitting one straight piece. A curved edge to a board also involves more waste than a straight edge. It is thus the cheapest for these reasons to design a casting in straight lines, especially as regards surfaces. An exception is when a large number of castings are required from one pattern. The expense of the pattern becomes

FIG. 14.

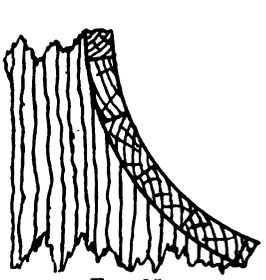

FIG. 15.

relatively of less importance, and is shared among all the castings. It is more important, then, to make the shape of the casting as economical in metal as possible, and a few shillings spent on the pattern to this end may save some pounds sterling in a numerosity of castings by reducing their weight.

In some cases we find the pedestal is used as a well to catch the waste oil from the bearing above. A horizontal diaphragm is cast across it, as shown at *k* (Fig. 13); and a hole is needed at the top if there are none at the sides, so that the core may be removed after casting. To drain off the oil a small brass tap is fitted, as at *u*; and this tap, it may be noted, can with advantage be straight, as then should it get choked it is easy to clear it by pushing a wire through. The inside of such of an oil-chamber may also be painted or coated with some composition, so as to leave a surface free from grit.

Before leaving the subject of these pedestals, we must note means for fixing the bearings. Thus the tops of the pedestals must have facings, which, for good stability, should consist of a peripheral strip only, as shown at *t t* (Fig. 10). This should encircle the boltholes, not only for reasons that have already been dwelt on in connection with Figs. 1 and 2, but also because it would be awkward commencing to drill a hole whose centre was on the edge of a facing. Small bosses or facings are wanted, as at *s s*, for the boltheads to bear against. Openings, or windows, as at *f* and *e*, are necessary if bolts are used, to enable them to be got at, and put through from below. If, as at *r* (Figs. 12 and 13), there is no room for bolt heads, then tap-bolts put in from above must be used. The bosses, *r r*, must then be deep enough to let the total thickness of metal become from $1\frac{1}{4}$ to $1\frac{1}{2}$ times the diameter of the bolt, so as to make allowance for the weakness of the thread in the cast iron. These holes in any case should not be cored. They must be accurate, and it is easier to drill a hole accurately in place through solid metal, than to correct the centre of a hole partly made by coring. Nor is it feasible to tap a cored hole; for, assuming it to be correctly in place, the hard skin of the casting and the grit and sand liable to be in or on it would damage the "taps," as the screwing tools are called. An incidental advantage attending these bosses *r r* is that the holes go through them. This makes it easier for tapping. The scrapings from the iron, as the tool revolves, fall through the bottom; and the taps can pass right through, making it an easier and consequently less expensive operation than tapping a "blind" hole.

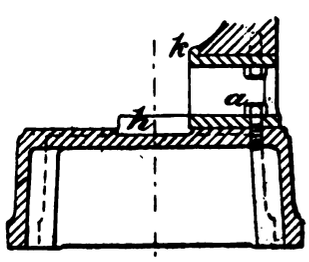

FIG. 16.

Fig. 16 is a section on *m n* in Fig. 10. Blocks *h h* are shown for the shoes to butt against. The attraction between the pole-pieces tends to make them spring together and grip the armature. Blocks cast thus, two on the bed-plate, and a ledge, *k*, on each shoe against the opposing lower horns of the pole-pieces, prevent this: otherwise this duty falls entirely on the bolts. But the stop blocks form the more mechanical arrangement in the respect that it steps one part on the other, so that the main strain (here the mutual attraction of the pole-pieces) comes directly on the shoe itself and the bed-plates, and not on the bolts; and these latter have only to keep the parts in their places, which is their most appropriate function. A disadvantage, however, is that such blocks will to some extent draw magnetic lines from the horns, and so slightly diminish the effective clearance between magnets and bed-plate.

For holding down the gunmetal shoe or bracket, bolts *a*, usually tap-bolts, are screwed or tapped into the bed-plate, so that by their removal the magnet and shoe may be withdrawn sideways. Bosses must then be cast underneath to allow sufficient depth of thread. Studs would require the magnet and shoe to be lifted, which would not be possible with the armature in this way. Bolts would be out of the question unless the hand can be got under the bed-plate. With a bed-plate not on rails, on removing the nut the bolt would fall through, which would be a calamity. But even if on rails, the tap-bolts would still probably be the more handy. If a bed-plate is deep, and bolts are desired, then hand holes are cast in the side so as to permit access to them from beneath. For the same reason that the shoe is of non-magnetic metal, so also should these bolts, and those fastening the shoe to the pole-

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piece, be of Muntz metal or phosphor bronze or other non-magnetic alloy. Otherwise, if of iron or steel, they would assist the passage of waste magnetism from the pole-pieces into the bed-plate.

(To be continued.)

THE STUDY OF HISTORY IN ELECTRICAL ENGINEERING.

BY CHARLES BRIGHT, F.R.S.E.

The importance of a familiar acquaintance with the step-by-step progress in all branches of engineering does not seem to be properly appreciated in these go-ahead times. Perhaps the present generation is, by temperament, less patient than its predecessors.

There is probably no science, or application of science, in which a knowledge of past history is of greater value than in that of electricity, magnetism, and their adaptations, particularly if regarded from the engineer's and inventor's point of view.

Let us take, by way of illustration, the oldest branch of electrical engineering—namely, telegraphy—premising only that this is not selected because it necessarily presents a more striking instance to the point than any of the other main departments. In the preparation of a work on this subject the writer has recently had occasion to examine all patents in any way connected with telegraphy, land or submarine, both from the engineer's and from the electrician's aspect. The result of this investigation—and that of an epitome of the whole—was to reveal the fact that a very large proportion of patents applied for and granted consisted of repetitions, in part or in whole, of inventions either previously patented or that had actually been adopted, and thus belonged to the "domain public." Again, still more remarkable was the large number of patents which have never been used in practice, and are never likely to be.

This condition of things may be eminently satisfactory to the State, but is certainly suggestive of a sad waste of money in patent fees on the part of the reinventor. Moreover, it is very much open to question whether, in many instances, the outlay is warranted by the advantage gained, or even whether the device would not be best left unpublished and unprotected. It may be presumed that if these reinventors had known of the similarity—nay, often the identity—of their "creations" with those of their predecessors, they would not have troubled the Patent Office.

The obvious moral to be drawn from this is that a would-be patentee should either take the trouble to institute enquiries for himself more thoroughly than appears to have been the general custom, or else that he should engage a qualified patent agent to do so for him. It may here be remarked that such investigations prove an extremely useful training in the study of any branch of engineering by giving a *reliable* insight into the tendencies of the age at different periods under certain conditions. The Patent Office publish every 10 years that which does not seem to have been sufficiently studied by many—viz., a volume of abridgements of all the patents in any particular subject of the previous 10 years. These volumes will be found invaluable as a first step in the way of investigation after settling that there is a genuine demand for the device, combination, or process in question. Even in this latter respect the current applications for patents form a very fair indication for our would-be patentee.

In this connection an amusing incident is told *a propos* of pioneer submarine telegraphy. The senior partner in a well-known contracting firm had been expatiating to some brother engineers and electricians upon certain improvements he was about to adopt in the construction of an Atlantic cable. A few days later, when visiting the Patent Office, he discovered that his audience had each and severally, on their own account, made applications for the legal protection of these very improvements! In this instance the above knowledge appears to have been turned to exactly the opposite account to what is suggested in this article; but then there are some people who are never happy unless they are—well, let us stick to our present subject, and say taking out patents for something which they have no business to monopolise.

Finally, had a more close intimacy with history been general, it is conceivable that we should not be troubled with the same number of misrepresentations with regard to pioneer work in the various branches of engineering that is now becoming as common in this country as in the States. The unconscious pilfering of reputations, whether of the living or of the dead, and the distortions of some of the most elementary facts connected with the past achievements in our great scientific and engineering industries, is one of the most ugly results of the prevailing historical ignorance. Let us hope this is but a transitory phase in the evolution of "the scientific spirit of the age."

ON THE MAGNETIC FIELDS OF COILS.*

BY W. H. EVERETT, B.A., B.E.

This subject is one of considerable interest, owing chiefly to the fact that a coil of some form or other is an indispensable part of every electromagnet, and yet it has till recently received but little attention. The principal formulæ of the present paper were briefly communicated to the British Association in September, 1895, and apply to a cylindrical coil of any shape of cross-section. The only case previously examined is that of a coil of circular section†, and even in this case the results arrived at are by no means simple. After the proof of the necessary formulæ, some examples will be given of their use.

The methods of treatment hitherto adopted have been founded on considerations derived from magnetic shells. In the present paper the work is based on Ampère's rule for the force due to an element of current. The results apply to a solenoid of any cross-section, provided the depth of winding (measured normal to the cylindrical surface) is inappreciable. The fields of solenoids in which the latter condition does not hold can be treated by adding the forces due to different layers; and this course has been recommended, in the case of circular coils, by Prof. Gray,‡ although he also gives a formula applicable to a coil of any depth. Four or five layers chosen from different depths in the coil will usually be enough for determining the field due to the whole coil, and in many cases a smaller number will suffice.

It is assumed that the solenoid can be regarded as made up of plane turns, normal to the axis, the number of which is constant for every equal cross-sectional slice. If there is an appreciable helical slope in the winding, so that the turns cannot be considered as plane, the current can be resolved into two components. The component round the coil comes under the present treatment; the axial component forms a hollow cylindrical current-sheet, flowing parallel to the axis, and therefore giving rise to a force everywhere perpendicular to the axis; this requires separate calculation, and the results do not appear to be reducible to any convenient form.

We will commence by finding the components of magnetic force at any point P due to a current i flowing in any plane circuit. Draw P Q perpendicular to the plane of the circuit, meeting this plane at Q (Fig. 1). Take X, any point of the circuit; join Q X, and draw Q T perpendicular to the tangent at X, meeting it in T. Let ds be an element of the circuit at X, and $d\theta$ the angle subtended at Q by ds. Let $PX = \rho$, $QX = r$, $QP = h$, $QT = p$, and $TX = x$. The force at P due to ds is, by Ampère's rule, vectorially equal to the current, multiplied by twice the area subtended by ds at P, and divided by ρ^3. This force is perpendicular to the plane P ds.

For convenience of description, suppose the circuit to be horizontal, and therefore Q P vertical. Then the horizontal projection of twice the area P ds is $r^2\,d\theta$, and the vertical

* Paper read before the Physical Society on November 8, 1895, with additions.

† J. Stuart, *Phil. Trans.*, 1872, and *Phil. Mag.*, 1873. Prof. Gray, "Absolute Measurements in Electricity and Magnetism," vol. ii., pp. 260-264. Prof. Minchin, *Proc.* Phys. Soc. and *Phil. Mag.*, 1894.

‡ *Op. cit.*, p. 261.

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projection taken perpendicular to ds is $h\,ds$. Hence the vertical component of the force at P, due to ds, is

$$dZ' = i\frac{r^2\,d\theta}{\rho^3} = i\frac{r^2\,d\theta}{(r^2+h^2)^{\frac{3}{2}}}. \quad . \quad . \quad . \quad (1)$$

The vertical force at P due to any length of the plane circuit is therefore

$$Z' = i\int\frac{r^2\,d\theta}{(r^2+h^2)^{\frac{3}{2}}}. \quad . \quad . \quad . \quad . \quad . \quad (2)$$

In this expression r is, of course, a function of θ, and h is independent of θ. The limits of integration depend on the position of the vertical projection of P on the plane of the circuit. When the projection of P falls anywhere within the circuit the limits are 0 and 2π, if the circuit consists of one complete turn.

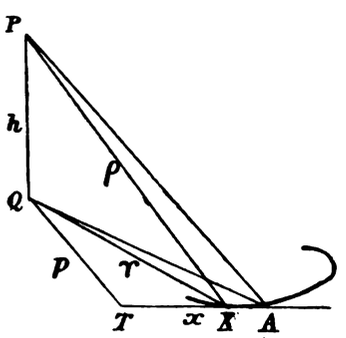

Fig. 1.

To find the force (which is entirely vertical for this case) in the plane of the circuit, put $h=0$ in (2), and we have

$$F = i\int\frac{d\theta}{r}. \quad . \quad . \quad . \quad . \quad . \quad (3)$$

This expression can also be found directly from Ampère's rule.

Now imagine a large number of such circuits, all exactly alike, piled uniformly in a vertical column one above the other to a total height h. Take z as the variable co-ordinate along h, and let there be n circuits per unit length of z, and therefore $n\,dz$ in a length dz. The whole vertical force at any point P in either of the end planes of the solenoid thus formed is

$$Z = i\,n\int_0^h\int\frac{r^2\,d\theta\,.\,dz}{(r^2+z^2)^{\frac{3}{2}}} \quad . \quad . \quad . \quad . \quad (4)$$

In integrating with respect to θ, z is to be taken as constant; and in integrating with respect to z, r and θ are to be considered as constant. Integrate first with respect to z, and we have

$$Z = i\,n\,h\int\frac{d\theta}{\sqrt{r^2+h^2}} \quad . \quad . \quad . \quad . \quad (5)$$

or, if we write N for the total number of turns,

$$Z = i\,N\int\frac{d\theta}{\sqrt{r^2+h^2}} \quad . \quad . \quad . \quad . \quad (6)$$

The limits are 0 and 2π for a point within the section of the solenoid.

Equations (4), (5), (6) apply only to points in either of the end planes. For a point not in one of the end planes the longitudinal force is the algebraic sum of the end forces due to the two parts into which the solenoid is divided by the cross-section through the point considered.

The simplest way to practically evaluate the integral in (5) is perhaps as follows. Put $r = k\,h$, and plot a curve of reference connecting k and $1/\sqrt{1+k^2}$. The latter number can then be read off for any value of r/h. In any given case we have only to draw a number of radii vectors, hence find the values of r/h, and from the curve of reference find the corresponding values of $1/\sqrt{1+k^2}$. Having plotted a curve with θ and $1/\sqrt{1+k^2}$ as Cartesian co-ordinates, we obtain the final result by graphical integration. The result can be expressed as

(Total angle subtended) × (mean value of $1/\sqrt{1+k^2}$),

the total angle being subdivided equally. If this condition cannot conveniently be complied with, proportionate weights must be assigned to the values of $1/\sqrt{1+k^2}$ in taking the mean.

The same curve of reference can be used in connection with equation (11), and a similar method can be applied to formula (2).

When h is very large compared with r, equation (5) reduces to

$$Z = i\,n\int d\theta \quad . \quad . \quad . \quad . \quad . \quad (7)$$

showing that in the case of a very long solenoid the longitudinal force, and therefore the induction-density, is uniform and equal to $2\pi\,n\,i$ for all points within the end sections, and vanishes for outside points in either of the end planes. And, in general, we see that the value of Z as given in equation (5) depends less on r as h increases, which proves that for a solenoid of given cross-section the longitudinal force in an end plane becomes more nearly uniform as the length is increased.

Suppose two equal solenoids, A, to be placed end to end, forming a single solenoid, B, of double the length of either. The force in the central section of B is equal to double the longitudinal force in an end plane of A for each corresponding point, and therefore there is the same percentage of variation over the section; but the variation over an end plane of B is less than over an end plane of A, hence the longitudinal force over an end section of any solenoid is more uniform than over the central section. The greatest variability, however, occurs over sections near the ends.

In any solenoid the surface-integral of the induction leaking out through the curved surface between the centre plane and an end plane is equal to the difference between the surface-integrals taken over these two planes. For a very long solenoid this difference is half the integral of the induction through the centre plane (or any plane far from the ends and between them)—in other words, half the total induction leaks out between the centre and end planes. The shorter the solenoid the less is the proportion of leakage. In the case of a circular solenoid with diameter and length equal, it is reduced to about 38 per cent.

Formula (3) can be used to find an expression for the force due to a circular current at any point P in the plane bounded by the circle. Draw any chord through P and call its segments r, r'. Write c for the distance of P from the centre, b for half the minimum chord through P, and a for the radius. Then for the force at P the formula reduces to

$$F = i\int_0^{2\pi}\frac{d\theta}{r},$$

$$= i\int_0^{\pi}\left(\frac{1}{r}+\frac{1}{r'}\right)d\theta,$$

$$= \frac{2\,i}{b^2}\int_0^{\pi}\sqrt{a^2-c^2\sin^2\theta}\,.\,d\theta.$$

This can be written $F = i\,\frac{s}{b^2}$,

s being the perimeter of the ellipse with a and b as semi-axes, and having some value between $2\pi\,a$ and $4\,a$, according to the position of the point considered.

Thus far only vertical forces have been considered; we may now turn to horizontal forces.

By the reasoning preceding equation (1) we see that the horizontal component of the magnetic force at any point P due to the current in any small arc ds is perpendicular to ds, and equal to

$$dR' = i\frac{h\,ds}{\rho^3} = i\frac{h\,ds}{(r^2+h^2)^{\frac{3}{2}}} \quad . \quad . \quad . \quad . \quad (8)$$

The resultant of all such forces for successive values of r will be the horizontal force at P due to a plane circuit. This can be found approximately by supposing the circuit divided into a number of convenient parts, finding the force due to each part, and compounding these forces graphically. Or the forces may all be resolved along two perpendicular directions, x and y. Writing ϕ for the angle that any element makes with the axis of x, the whole force in one direction due to the circuit will be

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$$R'_x = i h \int \frac{\sin\phi \, . \, ds}{(r^2+h^2)^{\frac{3}{2}}} \quad . \quad . \quad . \quad . \quad (9)$$

and, in the other direction,

$$R'_y = i h \int \frac{\cos\phi \, . \, ds}{(r^2+h^2)^{\frac{3}{2}}} \quad . \quad . \quad . \quad . \quad (10)$$

In some cases the direction of the resultant horizontal force can be seen at once, and then we have to resolve along this direction only.

Next consider a vertical column of elements forming a longitudinal strip of a solenoid with n elements per unit length of z, the whole length being h. The horizontal force at any point, due to this elementary column, is perpendicular to the column, and equal to

$$dR = i n ds \int_{h_1}^{h_2} \frac{z \, dz}{(r^2+z^2)^{\frac{3}{2}}}$$

$$= i n ds \left\{ \frac{1}{\sqrt{r^2+h_1^2}} - \frac{1}{\sqrt{r^2+h_2^2}} \right\} \quad . \quad (11)$$

It is evident from this expression that for a point in an end plane ($h_1 = 0$), the value of dR increases as h_2 increases, and for a strip of a very long solenoid

$$dR = i n \frac{ds}{r}.$$

The transverse force at a point due to a solenoid is the resultant of all the forces given by inserting successive values for r in equation (11). This resultant can readily be found by approximate vectorial construction. Or the elementary forces can be resolved along two perpendicular directions; the work is simplified by choosing the values of ds in such a way that $\sin\phi \, ds$ has the same value for each element, and then similarly for $\cos\phi \, ds$.

The following theorem is obviously true: the transverse force due to any solenoid of length a, at a point at a distance b beyond the end, is equal to the transverse force due to a solenoid of the same cross-section but of length $a + 2b$ at a similarly situated point in a cross-section dividing this solenoid into lengths b and $a+b$. Writing R_b for the transverse force at a point in an end plane of a solenoid of length b, each side of the equality in the above theorem is the vector difference of R_{a+b} and R_b.

Hence, the solution for the transverse force in any particular case also furnishes the solution for a second case.

The formulæ (5) and (11) can be readily applied for approximate calculation to a cylindrical coil of any cross-section, including coils of circular and rectangular sections. In the case of rectangular coils the formulæ are integrable, though they lose much of their simplicity by the operation. The results, which may be briefly indicated, apply to a coil of any rectilinear section, but this will be here taken as rectangular. Imagine four planes to be drawn through P, the point considered, parallel to the sides of the coil, and another plane perpendicular to the coil. Let p be the perpendicular distance of P from one of the faces of the coil and a one of the two parts into which the corresponding side of a cross-section is divided by the perpendicular from P. Then the longitudinal force at P is found to be given by the algebraic sum of 16 terms, each of the form—

$$Z = i n h p \int_0^a \frac{dx}{(x^2+p^2)\sqrt{x^2+p^2+h^2}},$$

$$= i n \sin^{-1} \frac{a h}{\sqrt{(a^2+p^2)(h^2+p^2)}} \quad . \quad . \quad (12)$$

And the transverse force at P is the resultant of eight terms, each of the form—

$$R = i n \int_0^a \left(\frac{1}{\sqrt{x^2+p^2+h_1^2}} - \frac{1}{\sqrt{x^2+p^2+h^2}} \right) dx,$$

$$= \frac{i n}{2} \log \left(\frac{p^2+h_2^2}{p^2+h_1^2} \cdot \frac{a+\sqrt{a^2+p^2+h_1^2}}{a+\sqrt{a^2+p^2+h_2^2}} \right). \quad . \quad (13)$$

For any point in either of the two longitudinal planes of symmetry of a rectangular solenoid the number of terms required to express the longitudinal and transverse forces is in each case reduced by half.

To save labour in applying the results—(12) and (13), for example—sets of curves can be used. Thus, in (12), take a as the unit of reference; then, keeping h constant and equal to some multiple of a, give p a number of convenient values in terms of a. A curve can then be plotted having p as abscissa and the corresponding force divided by n as ordinate. In this way, by taking different values for h, a set of, say, a dozen curves can be constructed, with the aid of which the longitudinal force at any point due to any rectangular solenoid can be very approximately found without much trouble.

In Table I. are given a sufficient number of values of the *longitudinal force coefficient* — *i.e.*, the coefficient which, when multiplied by the number of turns per centimetre length and the current in C.G.S. units, gives the longitudinal force in an end plane—for constructing a set of these curves.

Some results obtained with the aid of such curves are shown in Tables II. and III. These results are all calculated for rectangular solenoids with a cross-section 20 × 10 (in terms of any unit of length). This section is chosen as being fairly representative of the dimensions of the field-magnet coils of many dynamos, which, though never exactly rectangular, are usually approximately so. It should be remembered that the force coefficient is the same at similarly situated points for all geometrically similar solenoids.

In Table II. are given the longitudinal force coefficients at various points in an end plane for solenoids whose length varies from 2 to 25, the cross-section in every case being 20 × 10. From these results the data in Table III. have been found by addition or subtraction. To get an idea of what these coefficients mean, they can be compared with the value of the coefficient for any point in an end plane of any very

TABLE I.—Values of the Longitudinal Force Coefficient in Terms of h/a and p/a.

$\frac{p}{a}$	Value of $\frac{h}{a}$.												
	∞	8	4	3	2	1·5	1	·7	·5	·4	·3	·2	·1
0	1·571	1·571	1·571	1·571	1·571	1·571	1·571	1·571	1·571	1·571	1·571	1·571	1·571
·1	—	—	—	1·466	—	—	—	—	1·347	—	—	—	·780
·2	—	—	—	1·363	—	—	—	—	1 138	—	—	—	—
·25	—	—	—	1 326	1·295	1·276	1·228	1 150	1·049	0·967	0·838	0·651	0·369
·4	—	—	—	1·169	—	—	—	—	0·811	—	—	—	—
·5	1·109	1·102	1·089	1·080	1 049	1·012	0 927	0·816	0·684	0·592	0·478	0·340	0·177
·75	—	—	—	0·891	0·845	—	0 696	—	0·459	—	—	—	—
1	0 785	0·778	0·756	0·734	0 684	0·629	0 524	0 417	0·321	0·266	0·204	0·139	0 070
1·5	—	—	—	—	0·460	—	0·313	—	—	—	—	—	—
2	0·464	0 449	0·412	0 381	0 322	0·271	0·201	0·148	0·108	—	0·066	0·044	0·022
3	0·322	0·300	—	—	0·176	—	0·100	—	—	—	—	—	—
4	—	0·219	0·172	0 146	0·109	—	0·059	—	—	—	—	—	—
6	0·165	0·132	—	0 073	—	—	0·027	—	—	—	—	—	—
10	0·100	0·062	—	—	—	—	—	—	—	—	—	—	—

TABLE II.—Longitudinal Force Coefficients in End Planes of Rectangular Solenoids of Cross-Section 20 × 10 and of Various Lengths (see Fig. 2).

Length.	Position of point.			
—	O	C	D	A
25	5 97	—	—	6 03
20	5·83	5·85	5 89	5·94
18	5 75	5·77	5 82	5·90
15	5·57	—	—	5·83
10	5 01	5·18	5·34	5·46
5	3·54	3·78	4·28	4·80
2·5	2 09	—	—	4·10
2	1·71	1·85	2·46	3·93
·	O	E	F	B
20	5 83	5 84	5·87	5·89
18	5·75	—	—	5·84
10	5·01	5 08	5·17	5·23
2	1·71	—	—	3 70

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long solenoid, which is 2 π, or 6·28, the coefficient at any point within the solenoid and far from the end being 4 π, or about 12·57.

Table IV. gives a few values of the coefficient for circular solenoids. These have been calculated directly by an application of the general formula. Deductions therefrom are shown in Table V.

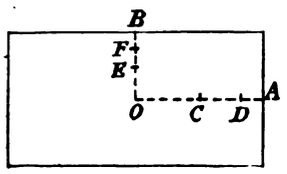

FIG. 2.—For Tables II and III.

O C = 5 O D = 8 O A = 10 O E = 2·5 O F = 4 O B = 5

TABLE III.—Longitudinal Force Coefficients for Rectangular Coils of Cross-Section 20 × 10 and Lengths 20, 10, 5 respectively (see Fig. 2).

Length.	Distance along axis from centre.	Position of points.			
		O.	C.	D	A.
20	0	10·02	10·36	10·68	10·92
20	5	9·11	—	—	10·63
20	8	7·46	7·61	8·28	9·83
20	10 (end)	5·83	5·85	5·89	5·94
20	15	2·43	—	—	1·23
10	0	7·08	7·56	8·56	9·60
10	5 (end)	5·01	5·18	5·34	5·46
10	10	2·03	—	—	1·03
5	0	4·18	—	—	8·20
5	2·5 (end)	3·54	3·78	4·28	4·80
5	7·5	1·47	1·40	1·06	0·66
		O.	E.	F.	B.
20	0	10·02	10·16	10·34	10·46
20	8	7·46	—	—	9·54
20	10 (end)	5·83	5·84	5·87	5·89

TABLE IV.—Longitudinal Force Coefficients in End Planes of Solenoids of Circular Cross-Section (Diameter = 20).

Length.	At centre of end section.	Close to coils.
20	5·62	5·76
17·5	5·45	5·66
15	5·23	5·54
10	4·43	5·16
5	2·81	4·51
2·5	1·48	3·97

TABLE V.—Longitudinal Force Coefficients in a Solenoid of Circular Cross Section having Length = Diameter = 20.

Distance along axis from centre.	At centre of section.	Close to coil.
0	8·86	10·32
5	8·04	10·05
7·5	6·93	9·63
10 (end)	5·62	5·76

It will be noticed from the results that in any internal cross-section of a coil the longitudinal force increases from the axis up to the coil. In the end planes it is approximately uniform, being exactly uniform for a very long coil, while beyond the ends the longitudinal force becomes greatest along the axis. Fig. 3 illustrates these points. That the longitudinal force is less along the axis of a coil than close to the coil can be easily seen, if we may assume that the lines of (total) force due to a coil diverge in passing from the centre plane to the ends. Let Fig. 5 represent an axial section of a coil, A and B being in the centre plane. Imagine a unit pole moved from A to B, then along the axis to C, and from C towards the coil to D, this latter path being chosen so as to be perpendicular to the lines of force at every point. Since the lines of force diverge in passing towards the end, it follows that the path C D must curve away from the end, and hence A D must be shorter than B C. Therefore the average force along A D is greater than along B C; for the work done in A B and C D is zero, and hence if the unit pole is moved back to A along D A the work along D A is equal and opposite to the work along B C, since the whole work done is zero.

Several papers have been written in recent years on the distribution of magnetisation in cylindrical electromagnets*;

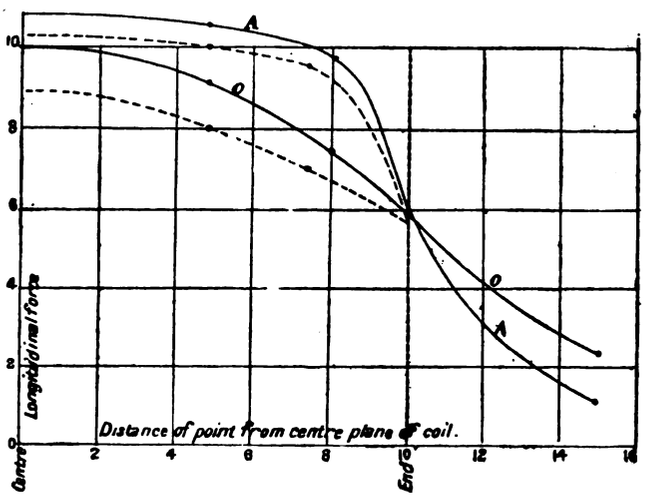

FIG. 3.—The full curves give the longitudinal force in a rectangular coil, section 20 × 10, length 20; curve O for points along the axis, curve A for points along the centre line of one of the narrower sides. The dotted curves are for a circular coil with length = diameter = 20; the lower curve is for points along the axis, the upper curve for points close to the coil. Force = ordinate × $n\,i$.

but the field due to the coil itself, on which the magnetisation of the iron must obviously to some extent depend, seems to have received very little attention from the authors. In one paper†, indeed, the results of experiments on the coil alone are given, but they are entirely misleading, for they would indicate that the force is greater near the axis than near the coil, and this is the conclusion arrived at by the author of the paper. The results were probably influenced by a gap which was made in the coil for experimental purposes.

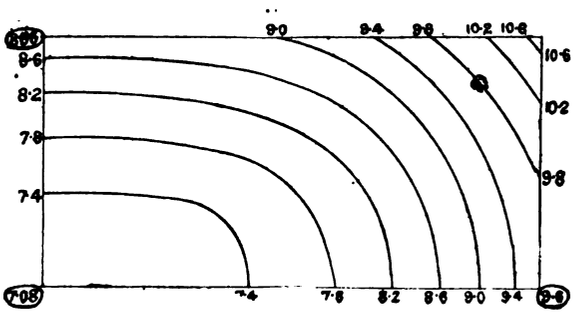

FIG. 4.—Lines of equal magnetic force for the central cross-section of a rectangular solenoid; section 20 × 10, length 10. The figure shows one-quarter of the section. Force = coefficient × $n\,i$.

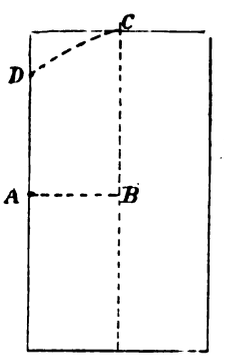

FIG. 5.

The general result of experiments seems to be that the (longitudinal) force in cylindrical electromagnets is less near the axis than near the coil, and that the difference becomes more marked as the length of the magnet is decreased; thus agreeing in character with the fields of coils without iron.

* Grotrian, *Wied. Ann.*, 50 (1893), p. 709; 52 (1894), p. 735; 54 (1895), p. 452. Ascoli, *Wied. Ann.*, 54 (1895), p. 381; 55 (1895), p. 187. *N. Cim.*, 41 (1895), p. 5 and p. 106; 43 (1896), p. 5. Du Bois, *Wied. Ann*, 51 (1894) p. 529.

† *Wied. Ann.*, 52 (1894), p. 735.

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CALCULATION OF ELECTRIC MOTORS.*

BY ALFRED E. WIENER.

(Concluded from page 26.)

Numerical Example Showing Application of Formulæ (8) to (11).—A shunt dynamo generates an output E.M.F. of E = 250 volts when driven at a speed of N_1 = 1,500 revolutions per minute; the drop in its armature at full load is $I' \times r_a = 15$ volts; to find the speed it will run at as a motor under full load (1) when supplied with 250 volts, (2) when supplied with any other potential, say, 200 volts.

The first part of this problem is directly solved by means of formula (8), from which

$$N_2 = \frac{250 - 15}{250 + 15} \times 1{,}500 = 1{,}330 \text{ revolutions per minute.}$$

The speed of the motor for the second voltage, since the behaviour of the machine as a generator is known, can be similarly obtained thus:

$$N_2 = \frac{200 - 15}{250 + 15} \times 1{,}500 = 1{,}045 \text{ revolutions per minute.}$$

If, however, the speed as a generator is not known, the second part of the problem is solved by the use of formulæ (9) to (13), as follows: Assuming that in figuring this motor we have found Φ = 4,000,000 webers, N_c = 264 conductors, n_p = one pair of parallel armature circuits, and r_a = ·08 ohm, its specific generating power is obtained, by (9):

$$e = 4{,}000{,}000 \times 264 \times 10^{-8} = 10{\cdot}6 \text{ volts at one revolution per second,}$$

its current capacity, by (10):

$$I' = \frac{15}{\cdot 08} = 187{\cdot}5 \text{ amperes.}$$

and its torque, by (11):

$$\tau = \frac{11{\cdot}74}{10^{10}} \times 187{\cdot}5 \times 264 \times 4{,}000{,}000 = 233 \text{ foot-pounds.}$$

Hence, by (12), its speed for a supply of 200 volts:

$$N_2 = 60 \times \left(\frac{200}{10{\cdot}6} - 8{\cdot}52 \times \frac{\cdot 08 \times 233}{10{\cdot}6^2} \right) = 1{,}045 \text{ revolutions per minute.}$$

Supposing the energy required at no load is $P_o'' = 4{,}000$ watts, the current intensity for 200 volts is

$$I_o' = \frac{P_o''}{E} = \frac{4{,}000}{200} = 20 \text{ amperes,}$$

and therefore the torque

$$\tau_o = \frac{11{\cdot}74}{10^{10}} \times 20 \times 264 \times 4{,}000{,}000 = 25 \text{ foot-pounds.}$$

This into (12) furnishes the speed at no load:

$$N_2 = 60 \times \left(\frac{200}{10{\cdot}6} - 8{\cdot}52 \times \frac{\cdot 08 \times 25}{10{\cdot}6^2} \right) = 1{,}121 \text{ revolutions per minute,}$$

while by the approximate formula (13) we obtain:

$$N_2 = 60 \times \frac{200}{10{\cdot}6} = 1{,}130 \text{ revolutions per minute,}$$

which is less than 1 per cent. greater than the accurate value.

Constant Speed.—The important requirement of constant speed under variable load may be almost perfectly met by the compound-wound motor, is nearly met by the shunt-wound motor, and is not met without the aid of special mechanism by the series-wound motor. A compound-wound motor will maintain its speed perfectly constant under all loads if the series winding is so adjusted that the increase of current strength through the series coils and armature shall diminish the M.M.F. of the field magnets to the degree necessary to compensate for the drop of pressure in the armature winding.

If constant speed is required, such as is the case in operating silk mills and textile machinery, the compound motor will therefore be found to give the best satisfaction, since in shunt motors, although running with "practically constant" speed, the variation may be too great to be without influence upon the product of manufacture.

When started without load the speed of a shunt motor gradually increases and reaches a maximum from which it falls down again as soon as the load is put on. The rise at no load is due to the fact that since the potential at the field terminals is constant, the field current decreases as the resistance of the field coils increases, owing to their heating, thereby decreasing the magnetising power, and in consequence the counter E.M.F. of the motor. The subsequent decrease of the speed is caused by the increase of the armature current with increasing load, and by the heating of the armature due to the passing current, the counter E.M.F. decreasing with increasing drop of voltage in the armature. Tests made by Thomas J. Fay with shunt motors of various sizes gave the results compiled in the following Table III.:

TABLE III.—Tests on Speed Variation of Shunt Motors.

Capacity of motor.	Normal speed at no load, cold.	Increase of speed from no load cold to no load hot, due to heating of field coils.	Decrease of speed from no load hot to full load hot, due to heating of armature.	Final change in speed. + = increase. − = decrease.
h.p.	revs. p. m.	of normal speed.	of normal speed.	of normal speed.
3	1,400	20 per cent.	12 per cent.	+8 per cent.
5	1,200	8⅓ ,, ,,	5 ,, ,,	+3⅓ ,, ,,
7½	1,360	5¼ ,, ,,	4 ,, ,,	+1¼ ,, ,,
10	1,200	2 ,, ,,	8⅔ ,, ,,	−6⅔ ,, ,,
15	1 180	2½ ,, ,,	3½ ,, ,,	−1 ,, ,,
20	860	½ ,, ,,	4 ,, ,,	−3½ ,, ,,

From this table it will be seen that the resistance of the field and of the armature can be so proportioned with relation to each other that the final speed at full load hot is equal to the normal speed at no load cold. But in order to reduce to a minimum the variation of the speed during the period of heating up of the motor it is necessary that both the increase due to the heating of the magnet coils and the decrease due to the heating of the armature should be reduced as much as possible. For this purpose the field winding should be so proportioned as not to heat very much above the temperature of the surrounding air, and the armature resistance should be as low as possible.

III. CALCULATION OF CURRENT FOR ELECTRIC MOTORS.

A. Current for Any Given Amount.—The current in the armature of a motor for any load P_x' watts = 746 × hp_x horse-power, at the pulley, since at any instant the entire energy supplied to the motor must be equal to the sum of the expenditures can be found from the equation:

$$E \times (I_x' + I_{sh}) = P_x'' + I_x' \times (r_a + r_{se}) + E \times I_{sh} + P_o''$$

which gives: $$I_x' = \frac{E - \sqrt{E^2 - 4(r_a + r_{se}) \times (P_x'' + P_o'')}}{2(r_a + r_{se})}, \quad (14)$$

where E = line potential supplied to motor terminals, in volts;
I_x' = current in armature of motor, in amperes, for any given load;
I_{sh} = current in shunt field of motor, in amperes;
P_x'' = useful load of motor, in watts;
P_o'' = energy required for no load, in watts;
r_a = armature resistance, in ohms;
r_{se} = series field resistance, in ohms.

Formula (14) directly applies to series and compound wound motors. In case of shunt-wound motors, r_{se} being = 0, it reduces it to

$$I_x' = \frac{E - \sqrt{E^2 - 4 r_a \times (P_x'' + P_o'')}}{2 r_a} \quad . \quad (15)$$

By means of this formula the current required for a load of P_x = 20,000 watts imposed upon the motor, given in the example above, is found

$$I_x' = \frac{200 - \sqrt{200^2 - 4 \times \cdot 08 \times (20{,}000 + 4{,}000)}}{2 \times \cdot 08} = 125 \text{ amps.}$$

* From the *Electrical Engineer* (New York).

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*B. Current for Maximum Commercial and Electrical Efficiency.**—As the energy commercially utilised in a motor is:

$$P_2'' = E \times I' - I^2 \times (r_a + r_{se}) - P_o'',$$

and the entire energy supplied is:

$$P_2 = E \times I' + P_{sh}';$$

the commercial efficiency can be expressed by

$$\eta_c \frac{E \times I' - I'^2 \times (r_a \times r_{se}) - P_o''}{E \times I' + P_{sh}},$$

and similarly, the electrical efficiency, by:

$$\eta_e = \frac{E \times I' - I'^2 (r_a + r_{se})}{E\, I' + P_{sh}},$$

P_{sh} being the energy absorbed in the shunt.

These efficiencies are maxima for:

$$I = \sqrt{\frac{P_{sh} + P_o''}{r_a + r_{se}} + \left(\frac{P_{sh}}{E}\right)^2} - \left(\frac{P_{sh}}{E}\right). \quad . \quad (16)$$

and

$$I = \sqrt{\frac{P_{sh}}{r_a + r_{se}} + \left(\frac{P_{sh}}{E}\right)^2} - \left(\frac{P_{sh}}{E}\right). \quad . \quad (17)$$

respectively. Formula (16) therefore gives the current that must be supplied to the armature of a motor in order to have maximum commercial efficiency, and formula (17) the current for maximum electrical efficiency.

Assuming that the shunt field resistance of the above motor is $r_{sh} = 65$ ohms, the energy consumed in the shunt, at a pressure of $E = 200$ volts, is

$$P_{sh} = \frac{E^2}{r_{sh}} = \frac{200^2}{65} = 615 \text{ watts},$$

by (16), consequently, the current for maximum commercial efficiency:

$$I' = \sqrt{\frac{615 + 4{,}000}{\cdot 08} + \left(\frac{615}{200}\right)^2} - \left(\frac{615}{200}\right) = 237 \text{ amperes},$$

and, by (17), that for maximum electrical efficiency:

$$I' = \sqrt{\frac{615}{\cdot 08} + \left(\frac{615}{200}\right)^2} - \left(\frac{615}{200}\right) = 85 \text{ amperes}.$$

IV. Designing of Motors for Different Purposes.—According to the purpose a motor has to serve, its efficiency is desired to either be high and nearly constant over a wide range of its load, or to increase in proportion with the output and be highest at the maximal load the motor can carry.

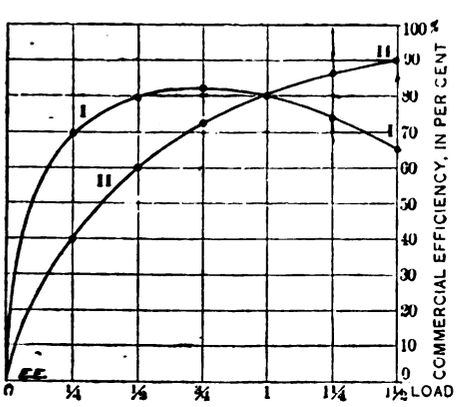

FIG. 1.

The shape of the efficiency curve of a motor depends upon the proportioning of its various losses. The losses in a motor are of two kinds—fixed and variable. The fixed losses are those due to the shunt field current, hysteresis and eddy currents, brush friction, bearing friction, and air resistance. The variable losses are those due to armature and series resistance, and to commutation, and increase with the load. If the fixed losses are small compared with the variable ones, the efficiency at light loads will be high and will rapidly drop as the load, and with it the variable loss, increases. If, on the other hand, the fixed losses are very large, and the variable losses small, the efficiency with small loads will be low, but will increase as the load becomes greater, for the reason that the total energy increases proportional to the load while the losses in this case remain nearly constant, increasing but very little with the load.

In order to have the fixed losses in a motor small and the variable losses great, it is necessary to employ a massive magnetic circuit with few shunt ampere-turns, and ample cross-section of iron in the armature core, and a large number of turns on armature and series field; hence the energy lost in shunt field excitation in hysteresis and eddy currents is small, but that lost by armature and series field resistance and by commutation is great. The reverse of these conditions ensures an increase in the fixed or a decrease in the variable losses.

Curves I. and II. (Fig. 1) show the variation of the commercial efficiency with the load in two motors of different design, both having the same efficiency, $\eta_c = 80$ per cent. at normal load, but I. having very high efficiencies at light loads, while II. has very low efficiencies at small loads, but even greater than normal efficiency with overloads:

—	Efficiency at various loads.					
	Quarter load.	Half load.	Three-quarter load.	Normal load.	25 per cent. overload.	50 per cent. overload.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
I.	70	80	83	80	73	65
II.	40	60	72	80	86	90

An efficiency curve similar to I. is desired in constant power work where the greatest load is put on the motor but once in starting and where, after the friction of rest has been overcome, the motor is called upon to work on half to three-fourths its normal output continually; motors, consequently, which are to be employed for running printing presses, machine shop tools, power pumps, etc., must be designed with a heavy frame of low magnetic density, a weak field, small excitation, and a powerful armature. In order to obtain an efficiency curve similar to II., which is preferable in all cases where the motor is not doing steady work, but is called upon to give more than its normal power at frequent intervals, as, for instance, in operating electric railways, elevators, cranes, hoists, etc., the motor must be provided with a light frame of high magnetic density, a strong field, powerful excitation, and a weak armature.

FORTHCOMING EVENTS.

The following are some of the announcements for the next week.

TO DAY (FRIDAY).—Electrical Section of the London Chamber of Commerce (Botolph House, Eastcheap, at noon).—Ediswan Company's entertainment (People's Palace, 5 p.m.).

TO-MORROW (SATURDAY).—Prof. Silvanus Thompson's lecture at the Royal Institution, 3 p.m.

MONDAY, JANUARY 11.—Northern Society of Electrical Engineers, at Manchester (Mr. Dorman's presidential address), 8 p.m.

TUESDAY, JANUARY 12.—Institution of Civil Engineers, Great George-street ("Superheated Steam," Prof. Ripper's paper).

WEDNESDAY, JANUARY 13.—Society of Arts Juvenile Lecture (Mr. Clinton Dent on "Mountains"), John-street, 7 p.m.—The North-East Coast Engineers' Meeting, at Newcastle.

THURSDAY, JANUARY 14.—Meeting of the Institution of Electrical Engineers (at the Civil Engineers, Great George-street, at 8 p.m., Sir H. Mance's presidential address).—Prize-giving at the Birkbeck Institution (the Lord Chief Justice and the Lord Mayor).

FRIDAY, JANUARY 15.—Students' meeting of the Institution of Civil Engineers, Great George-street.—Meeting of the French Society of Civil Engineers at Paris.

Presentation.—Mr. Wm. J. Rawlinson Thomas, A.I.E.E., who has recently been appointed as electric inspector by the Birmingham Corporation, was presented on his leaving St. Pancras Vestry with a handsome marble timepiece by the staff of the Stanhope-street station. The clock bore the following inscription: "Presented to Mr. J. Rawlinson Thomas by the staff of the Stanhope-street, Regent's Park, Central Station Electricity Department as a token of regard and esteem on his leaving the service of the Vestry. December, 1896." The presentation was made by Mr. Baron, and a few words were added by Mr. Cooper. Mr. Thomas was appointed inspector of works to the Electricity Department, St. Pancras Vestry, on September 3, 1891. He carried out the whole of the outside work, including the public lighting, under Mr. Baron previous to Mr. Baynes being appointed chief electrical engineer.

* "Shunt Motors," by W. D. Weaver, the *Electrical World*, February 25, 1893, vol. xxi., p. 137.

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TO CORRESPONDENTS.

All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notice of Meetings, Issue of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

All communications intended for the Editor should be addressed C. H. W. Biggs, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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BETWEEN THE DEVIL AND THE DEEP SEA.

The young consulting engineer, like the young barrister, very often has to live upon "hopes" and parental allowances, unless, indeed, he, like the barrister, turns his attention to matrimony in the right direction. The barrister marries the solicitor's daughter, and makes his fortune. The young electrical consultant may also try to marry influence, and, perhaps, succeed. But, after all, 'tis not given to every man thus to rise in his profession; and how about the residuum? Theirs is a hard lot, and how to obtain the "first step" is a problem hard to solve. At the present moment one phase of the problem may be discussed. It has been often considered before, but with little resulting good. The fact is, human nature is too enamoured of the cheap and easy to trouble whether the momentary saving of time and labour will be beneficial in the end. With regard to authorities undertaking electric light and power distribution, we have always contended there was but one course to follow—namely, to employ a trustworthy consulting engineer to prepare plans and superintend the erection and equipment of the station. Unfortunately, from one point of view, authorities differ in opinion as to this suggestion, and many of them ask for competitive plans. Many, and especially the younger consulting engineers, think competition their opportunity, and hope by success to obtain a footing in the ranks of those who "have some work to do." Singular to say, that although we deprecate the asking for competitive designs, we must admit that if human nature was superhuman nature there would be many advantages in the system. While, however, men are what they are, the disadvantages outweigh the advantages. In the first place, the men who have made a name in the profession will not compete. This at once entails a loss to the authority of the benefit of the experience such a man as Prof. Kennedy, for example, has obtained. Perhaps, however, some people would incline to put as the greatest difficulty that of obtaining a competent, unbiassed judge to examine and report upon the designs sent to the authority. It is well known that one of the first questions a young engineer asks is about the "judge." There is no lack of feeling in the matter, and in several instances there has been a widespread feeling that the designs have not been honestly examined, and, in addition, that details of the designs have been subsequently used by the judge. Young engineers who feel they have ability, who have studied their subject as far as they can as assistants, and who may possibly present schemes of value, are exceedingly chary in giving away the result of their brainwork. Indeed, we are calling attention to this subject in response to a communication from a correspondent, one who declines to send designs unless he knows the award will be altogether fair. A third point much criticised by some of the younger men is the plan of contractors by a side wind becoming competitors. An assistant or employé has the staff of the contractor's drawing-office placed at his disposal, the experience of that drawing-office, and perhaps of other professional men whose designs have been carried out. This

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assistant sends in a design in his own name, but in reality he is not competing with fellow engineers. His is a collective scheme, and sent in so that in the long run the contracting firm may benefit. We need not pursue these objectionable features much further; the three we have named are sufficient to show that the system is far from perfect. Let us summarise them: (1) the best and most experienced talent refuses to compete; (2) there is in the electrical industry, at any rate, a very great difficulty in getting an independent authority to make the award; and (3) it is sometimes made to play into the hands of contractors.

The objections we have mentioned, with the exception of the first, will more or less vanish with time. When some of the acting engineers grow older, and, having made enough money to supply their wants, place themselves upon the retired list, they can amuse themselves by examining designs and awarding premiums. The only criticism then will be from men who lose the competition and hint that the judge is antediluvian and knows nothing of progress and progressive tendencies. As regards the third objection, opinions, we know, even now differ; but on the whole we are inclined to side with those who hold contractors have a direct incentive to follow somewhat stereotyped plans, because having patterns in stock and having carried out similar work, a continuation of one type of machine and of work will be less costly than when alterations are made. We end, then, as we began, deploring the difficulty young consulting engineers have in making the first step, but unable to point out any solution of the difficulty. No doubt in years to come the ranks of consulting engineers will be largely recruited from those of municipal electrical engineers, so that men will enter the profession of consultant with a large experience gained often under the greatest difficulties.

SPEED CONTROL OF MOTORS.

We referred to this subject in a leader some weeks ago, pointing out the objections to the arrangement advocated by Mr. H. Ward Leonard. Although a full account of the discussion of his paper before the American Institution is not yet to hand, the notes in electrical journals indicate that the matter was well ventilated. Prof. W. A. Anthony's short article on the same subject, which we give elsewhere in this issue, is interesting in this connection. Although we disagree with the conclusions of the author, we have seldom seen a better statement of the conditions required for sparkless regulation. Echoing Prof. Anthony, "The control of sparking at the commutator depends largely upon the density and stability of the magnetic 'fringe' at the pole corners"; "this fringe disappears very rapidly as the field is weakened"; and "to maintain this fringe intact the field magneto-motive force must be kept well in excess of the armature reaction." These are the main principles of design for sparkless machines. It is a well-established fact that if the induction under the polar edges nearest the brushes is reduced by the cross-induction below a certain minimum, sparkless collection becomes impossible. This minimum, determined by the armature reaction, limits the possible increase of spread by reducing the field strength. Prof. Anthony recognises this fact, and proposes to get over it in multipolar dynamos in the following way. The multipolar dynamo must have a series-wound armature, and a certain number only of the poles are to be weakened or reversed. Thus, in a six-pole machine running at, say, 1,000 revolutions per minute, the demagnetising of two poles would increase the speed to about 1,500 revolutions, and the reversal of their polarity would raise it to 3,000 revolutions. The remaining four poles would be kept at the full induction, and would, with the full-load current, have the usual distribution of fringes. The professor claims that this device would give a much greater range than the usual method of weakening the whole field. It seems to us that he has not taken account of the fact that the two poles idle when the machine is running at 1,500 revolutions would still be the seat of the usual cross-induction. This cross-induction would be directly opposed to the reserval of current in the short-circuited sections. These conditions are directly opposed to fundamental requirements for non-sparking in the third statement above. In fact, if a numerical example is worked out, it will be found that in any case no benefit can accrue from the unsymmetrical variations of the field over the usual symmetrical methods. We fancy that the erroneous belief that there could be such an advantage arose from overlooking the fact that the cross magneto-motive force of the loaded armature wound as above would be equally effective on the idle and acting pole-pieces.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

FREE WIRING, ETC.

SIR,—With reference to my letter in your last issue on this subject, I have noticed that a mistake was inadvertently made with regard to the example given; the number of lights should read: Eight lights; estimated cost of installation, £7. I should feel obliged if you would rectify this in your next issue, in order to avoid any misunderstanding that might occur with reference to the cost of wiring. The example given was applicable to a small shop, and the mistake is not one of importance, as it was only to show the way in which the wiring arrangements would operate.

Yours, etc., F. J. WARDEN-STEVENS.

SIR,—In the letter which you published in your last issue from Mr. F. J. Warden-Stevens, I see he refers to the system of free lamp supply, stating the method he recommends for Fermoy. Possibly such a system would answer there and might not be found to introduce dissatisfaction or too many complications, but it would be quite impossible in Bradford or where the consumers were numerous. The door to fraud would at once be opened, to say nothing of the impossibility of accurately ascertaining the number of lamps installed. I think that Mr. Warden-Stevens will also find that the never too considerate consumer will not hesitate to avail himself of the open offer to investigate defective (!) lamps. However, it is possible that criticism of the question may at the present be too previous, and it will be interesting at least to know how Mr. Warden-Stevens finds his method answer in, say, 12 months.

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I enclose a copy of the conditions of our free supply of lamps.—Yours, etc., ALF. H. GIBBINGS.

Town Hall, Bradford, January 5, 1897.

FREE SUPPLY OF INCANDESCENT LAMPS.

Basis of Supply.

Every incandescent lamp, if properly made, consumes a definite amount of electricity, a 16-c.p. lamp requiring 60 watts, a 32-c.p. lamp requiring 120 watts, and so on in proportion. The Board of Trade unit being 1,000 watts for one hour, or its equivalent, it follows that a 16-c.p. lamp must be in use for 16⅔ hours before a unit of electricity is consumed. If, therefore, we know how many units have been used by any given consumer, we can ascertain at once how many hours a 16-c.p. lamp would be burning in order to consume that number of units. This, of course, would be equivalent to adding up the total number of hours of each single lamp which had been in use. The number of hours which represents the average life of a lamp is 1,000. A good lamp will frequently last 2,000 or 3,000 hours before it actually breaks down, but it is not advisable to use them longer than 1,000 hours, as after that time they rapidly get coated on the inside of the glass with a sooty deposit, and the candle-power rapidly diminishes. The basis of supply, or, in other words, the correct time for the renewal of a lamp is therefore once in every 1,000 hours of consumption. If, therefore, a 16-c.p. lamp consumes one unit in 16⅔ hours it will consume 60 units in 1,000 hours. Hence we obtain the following basis for the renewal of lamps :

16 c.p.	lamp	burning	1,000	hours	consumes	60	units.
25	,,	,,	,,	,,	,,	94	,,
32	,,	,,	,,	,,	,,	120	,,
50	,,	,,	,,	,,	,,	188	,,
100	,,	,,	,,	,,	,,	376	,,
200	,,	,,	,,	,,	,,	752	,,
300	,,	,,	,,	,,	,,	1,128	,,

And so on.

Conditions of Supply—On Foregoing Basis.

1. Every consumer of electricity from the Corporation mains will be entitled on and after January 1, 1897, to one 8-c.p. or 16-c.p. incandescent lamp, supplied free of charge by the Bradford Corporation, for every 60 units of electricity consumed since July 1, 1896, by the use of incandescent lamps only. If other and higher candle-power lamps are desired instead of 16 c.p., the number of lamps to which the consumer is entitled will be in the inverse ratio to such candle-power. Thus :

60 units entitles to 1—8 or 16 c.p. lamp.
120 ,, 2—8 or 16 c.p., or 1—32 c.p.
240 ,, 4—8 or 16 c.p., or 2—32 c.p.
480 ,, 8—8 or 16 c.p., or 4—32 c.p., or 2—50 c.p.

(the balance of units consumed in excess—viz., 105 in this last instance—being held over until the following six months' supply or made up by lamps of a lesser candle-power, as may be desired by the consumer.)

2. The consumer may choose the class of lamp terminal he prefers—*i.e.*, either screw or brass collar—up to 50 c.p., and may also have the lamps entirely frosted, half-frosted, or plain ; but after the lamps have once been delivered to him no exchange will be made under any circumstances.

3. The lamps will be delivered to the consumer only at the Corporation stores, electricity works, Bolton-road, Bradford, where he must send for them, and provide the necessary convenience for removal.

4. At the time of delivery of the lamps the consumer must sign an official receipt, which will be provided at the stores.

5. Upon making application for lamps the consumer must produce his receipted account for electricity from the borough collector's office, and if the account is not paid on or before the last day of the second month from the expiration of the half-year in which the electricity is consumed, the consumer will forfeit his right to any lamps he would have been entitled to under that account.

6. No lamps will be given under any circumstances whatever unless the receipted account is produced.

7. The lamps will only be obtainable at the end of every six months ending June and December respectively, notwithstanding any arrangement for the payment of accounts quarterly.

8. After the lamps have been handed to the consumer or his representative, the Corporation will not recognise any breakage, defects, or accident to the lamps.

9. Lamps must be removed, carried, and handled with the greatest possible care and delicacy, in order to prevent straining or fracturing the filament.

10. All lamps will be marked with their respective voltage, candle-power, and maker's name.

11. Each lamp will have been carefully tested and examined before delivery to the consumer, with a view of eliminating all defects and of providing a lamp perfectly satisfactory as regards standard candle-power, probable life, class of filament, mechanical construction, and efficiency.

12. In the event of the consumer cancelling his application or giving up the electric light, or leaving the premises for which he has required the supply of electricity, he shall not be entitled to any lamps for his consumption of electricity for the then current half-year, except and unless he removes to other premises adjacent to existing electricity mains, and continues to be a consumer.

13. The lamps supplied may be safely used in any position—*i.e.*, vertically downwards, vertically upwards, horizontally, or at any angle. It must be pointed out, however, that a lamp is likely to last longer when hanging in a perfectly vertical position than in any other position.

PERSONAL.

SIR,—As the announcement of Mr. Ravenshaw's retirement from the position of consulting engineer to Messrs. P. R. Jackson and Co., Limited, Manchester, seems to have caused some misunderstanding, may we state that the feeling existing between the two firms has always been, and still is, of a most friendly character.—Yours, etc.,

BOOTH AND RAVENSHAW.

THE LOCAL DISTRIBUTION OF ELECTRIC POWER IN WORKSHOPS, ETC.

BY ERNEST KILBURN SCOTT.

PART I.

(*Continued from page 18.*)

A point on which there is also considerable difference of opinion is the question what proportion of the total power of an engine is used up in overcoming the frictional and other losses of the shafting and belting. There is a distinct tendency on the part of some engineers to underrate the amount, and Prof. A. B. Kennedy, for example, has stated that it averages only 25 per cent. ; the writer, however, proposes to present a few well-authenticated figures which go to show that this figure is much too low. Fortunately, the point is one which can be easily settled by simply indicating the engines before and after all the tools are thrown on. The following table, No. II., taken from Mr. J. J. Flather's article in the *Engineering Magazine*, vol. viii., p. 670, gives an average of over 40 per cent. as the power required to drive the shafting alone in nine typical American factories.

TABLE II.—List of Powers.

Name of firm.	Nature of work.	Total.	To drive shafting.	Per cent. to drive shafting.
J. A. Fay and Co.	Wood-working machinery	100	15	0·15
Union Ironworks	Engines, mining machinery	400	95	0·23
Frontier Iron and Brass Works	Marine engines, etc.	25	8	0·32
Baldwin Locomotive Works	Locomotives	2,500	2,000	0·80
W. Sellers & Co. (one dpt.)	Heavy machinery	102·45	40·89	0·40
Pond Machine Tool Co.	Machine tools	180	75	0·41
Yale and Towne Company	Cranes and locks	135·05	66·81	0·49
Ferracute Machine Co.	Presses and dies	35	11	0·31
Bridgeport Forge Company	Heavy forgings	150	75	0·50

Table III., compiled by Mr. Thomas Richardson, the well-known marine engineer, shows that for eight different engines in his own works the power lost in driving shafting, belts, pulleys, etc., varied from 25 to 70 per cent., and averaged over 43 per cent.

TABLE III.

Engine.	Length of shafting, in feet.	No. of pulleys.	Length of belt, in feet.	I.H.P. Loaded.	I.H.P. Light.	Loss per cent.
No. 1	370	153	4,292	48	17·2	35·8
,, 2	782	113	2,263	93·9	23·4	25
,, 3	515	283	3,582	44	20·2	46·2
,, 4	571	335	4,831	28·9	15	52
,, 5	691	79	1,401	56·2	20	35·6
,, 6	381	22	464	75·7	22·8	30
,, 7	117	49	1,210	9·3	6·5	69·9
,, 8	242	70	1,429	15·6	7·8	50

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Mr. Westgarth has also stated before the Cleveland Institute of Engineers that in an engine and boiler works he experimented upon, fully 59 per cent. of the total power developed by the steam-engine was absorbed by the shafting and gearing. In one of the workshops, where two long lines of shafting were used for driving a comparatively small number of machines, the power absorbed was 75·6 per cent. of the total; whilst in another workshop, where the shafting was well laid and rope gearing used for the main drives, the percentage loss was 42.

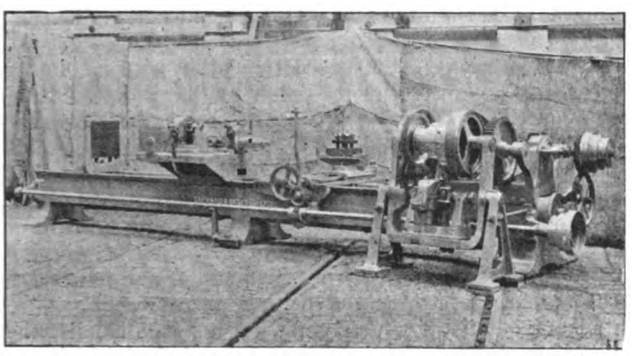

FIG. 1.—Lathe with two Electric Motors.

A most complete enquiry made by the French Steam-Engine Owners' Association in 1893 shows conclusively that in 319 factories and workshops in France employed on all kinds of work, the average amount of power required for turning the shafting and belting was well over 40 per cent. of the whole. These results, which are most complete, were made by Engineers Compère, Schmidt, Desjuzeur, Clivier, Maire, and Walther-Meunier. The engines tested varied from 5 to over 700 h.p., and the percentage of power required for the shafting, etc., varied from 10 to nearly 78 per cent. As the average of all the above figures is over 40 per cent., we shall therefore be within the mark in taking that figure as the mean.

If we examine in detail the efficiency that may be obtained on an average electrical system, we find that the total efficiency is principally determined by the sizes of the motors employed; thus, a 50-h p. motor would probably have an efficiency of 92 per cent., a 26-h.p. motor 89 per cent., a 12-h p. 87 per cent., and a 6-h p. only about 82 per cent.

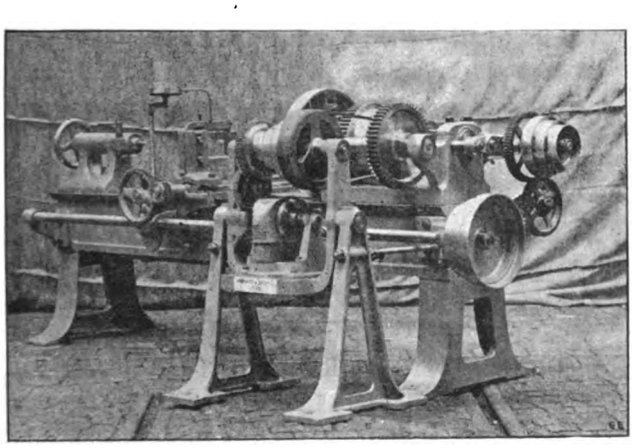

FIG. 2.—Lathe Driven by Motor and Short Belt.

In an electrical installation of, say, 100 b.h p., with 10 motors of 10 h.p. each, driving tools by gear wheels, the total losses on full load might be expected to come within 27 per cent., made up as follows:

Dynamo	6%	of which $1\frac{1}{2}$%	is for friction.
Leads	3%	—	
Motors.....	13%	,, $3\frac{1}{2}$%	,,
Proportion of gearing ...	5%	,, 1 %	,,
Total.....	27%	Total...	6%

Only 6 per cent. is wasted in friction, the rest being made up of heat losses in the windings, etc., which do not cause any deterioration, being rather an advantage than otherwise, by keeping the insulation dry. On the other hand, with mechanical transmission, the whole 40 per cent. loss is spent in continuously wearing out the shafting, belts, and bearing brasses, besides consuming a large amount of oil, which an attendant must keep replenishing in order that the frictional losses may not rise above the 40 per cent. limit.

Another point to note is that machine tools are, as a rule, only run loaded for three or four hours out of the eight or nine which make up the working day. For the rest of the time, if driven by motors, they may be switched off, and we thus see that the 6 per cent. is a maximum figure.

To anyone not having seen electric driving in actual, every-day operation, it is difficult to realise the immense saving in power effected by the fact that each large tool or section of shafting can be switched on and off with the same ease that incandescent lamps are turned on and off, and the whole power necessary for running an empty line of shafting or tool instantly saved. Where small steam-engines are coupled direct to the tools, it often happens that they are kept

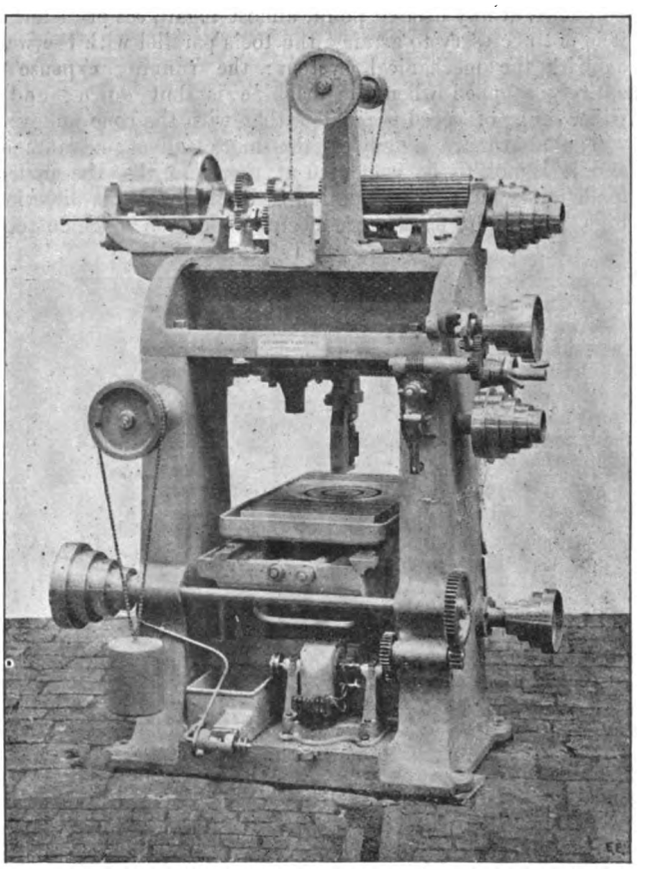

FIG 3.—Milling Machine with Electric Motor.

running when actually doing no work, to save trouble in starting up again, open and shutting pet cocks, and seeing that the cranks are not on the dead centres.

In applying electric motors to machinery two systems may be employed. We may either provide each machine with its own particular motor, or we may group a number of machines together on to one countershaft and drive this by a motor. The ideal arrangement is that each machine shall have its own separate motor, but for the present, at any rate, it would be difficult to persuade proprietors to adopt such a sweeping innovation. (Of course, this argument would not apply to new factories, where all the machines are brand new). For the present, therefore, the best we can do is a compromise—namely, to supply separate motors to each of the large tools and to divide up the smaller ones and the existing shafting into groups, each containing a certain number of tools which are likely to be used simultaneously, and which require about 6 h.p. to 12 h.p. when running together.

When transmitting power by mechanical means, it sometimes happens that the construction of a building is such that it is not possible to drive the shafting furthest from the motive power by belting from the main line, and the only way is by transmitting the power through couplings from one shaft to another, and so on to the last. With such an

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arrangement, overtime on a special breakdown job is a very costly matter, as the bulk of the shafting must be kept going for the sake of perhaps one or two tools. Electric driving changes the aspect of the question at once; and if a set of accumulators are laid down (as they generally are for lighting the offices, etc.), then the matter becomes still more simple, the cells supplying the overtime current.

Where the tools or machines are large and require each an appreciable amount of power, directly applied motors are now being extensively employed; but in the future it is probable that motors of as small a size as ½ h.p. to ⅔ h.p. will be attached direct to such machines as are only used intermittently.

The special advantages of having each motor and machine combined are almost self-evident: The ease of moving the machines from place to place; the entire absence of overhead shafting and bearings, and the drip of oil from same; clear and unobstructed passages and headroom, the latter facilitating the use of travelling cranes, and of lighting the shop by large lights placed above the work. The machines may be placed at any desired point, almost regardless of distance; it is not necessary to arrange the tools parallel with the wall, as with the mechanical system; the running expense is entirely stopped when the machine is shut down; and a wider range of speed is possible than with the cone pulleys.

The above are a few of the more salient advantages, and it is not to be wondered at, therefore, that the modern tendency in machine-tool design is distinctly in this direction. Figs. 1, 2, and 3 show some electrically-driven machine tools made by Messrs. Greenwood and Batley, of Leeds. It will be noticed that the lathes still retain the ordinary speed cones and back gear. The motor is fixed in a cradle, so arranged that the weight of motor and cradle is always tending to keep the belt taut. In this way a good drive is secured, with plenty of headroom and a short cheap belt, which, running horizontally, is subject to less wear and tear than if it ran vertically. The gearing has straight teeth throughout; and as there is a double reduction in speed between the motor spindle and the driving cones, the speed may be as high as 600 to 1,000 revolutions per minute, and the motor is therefore small and cheap.

Fig. 4 is taken from a photo of one of Messrs. Hulse and Co.'s 19in. centre duplex lathes, arranged for electrical driving; several of these lathes having been supplied for the new works of Messrs. Ferranti and Co., at Manchester.

The chief difficulty in designing direct-geared lathes lies in the fact that it must be possible for the turner to easily obtain a considerable variety of speeds whilst still running the motor at its full velocity. In this type of machine a bracket at the fast headstock end supports the motor, and it is so placed that its spindle is at right angles with the bed and nearly central with the headstock. On the motor spindle is a worm, which gears into the worm-wheel shown in the figure. The worm-wheel has a spur-wheel, cast in one piece with it, and on the same spindle there is a swing frame having two radial arms. A shaft carried in the bearings at the outer ends of these arms has keyed to it two spur-wheels. One of the wheels receives motion from the spur-wheel attached to the worm-wheel, and the other, shown between the arms, can slide along the shaft on a feather key. By swivelling the swing frame on its axis, therefore, this wheel can be put into gear with any one of the four different-sized wheels, which take the place of the usual cone pulley. Four distinct driving speeds are thus obtained on the wheel cone, and these speeds may each in turn be transmitted through either single, quick treble, or slow treble gear, thus giving a total of 12 changes of speed. In this way the main spindle of the lathe may be run at speeds varying from 2 to 44 revolutions per minute. The lathe has two tool rests, the back one of which is provided with an inverted vee to resist the upward thrust on the tool. Objects up to 28in. diameter by 10ft. long may be operated upon. Messrs. Hulse and Co. have just completed a 30in. centre lathe with a similar electric driving arrangement, and they have also in hand several powerful gun-boring machines to be similarly fitted.

So far very few lathes have been made with the motors coupled direct on to the lathe spindle, because of the slow speeds at which such spindles revolve, and on account of the great range of speed required. Such an arrangement, if it could be arranged, would be well worth the time of working out; for besides the great saving in first cost and power due to the absence of gearing and belting, there would also be the advantage that, by merely moving a switch handle, the operator could get instant change of speed, from maximum to minimum, or to any intermediate speed; also instant reversal. With the ordinary lathe, a change of speed means either a shifting of the belt or a change of gearing, either of which consumes time. Of course the speed of a motor may be regulated in the ordinary way with a rheostat, as is done with elevators and tramcars in starting and stopping, etc., but such an arrangement would hardly be suitable for a lathe, owing to the great waste of power which would be continually going on at low speeds, and also because of the capital cost of switch and resistance.

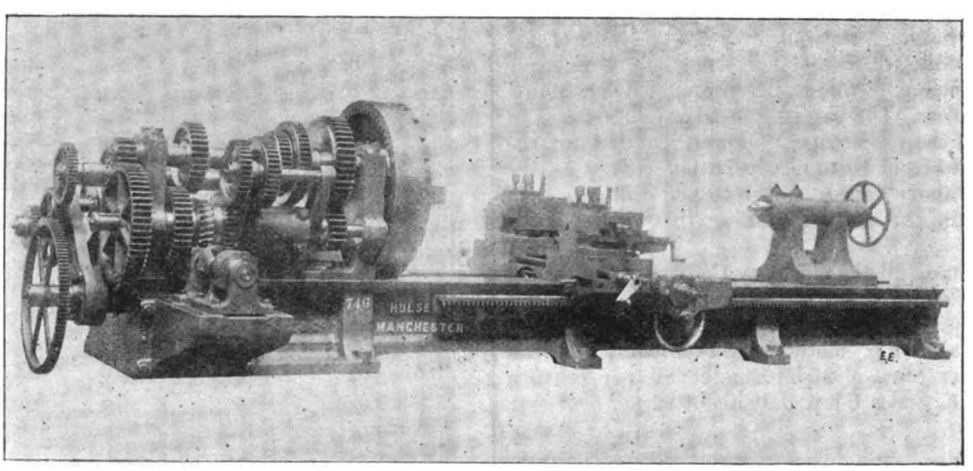

FIG. 4.—Duplex Lathe, with Gearing Arranged for Electric Driving.

(To be continued.)

ON THE MAGNETIC PERMEABILITY OF LIQUID OXYGEN AND LIQUID AIR.*

BY J. A. FLEMING, M.A., D.SC., F.R.S., AND JAMES DEWAR, LL.D., F.R.S.

The remarkable magnetic properties of liquid oxygen were pointed out by one of us in a communication to the Royal Society in 1891, and were subsequently described to the Royal Institution in a lecture delivered in 1892. We have for some time past directed our attention to the question of determining the numerical values of the magnetic permeability and magnetic susceptibility of liquid oxygen, with the object of determining not only the magnitude of these physical constants, but also whether they vary with the magnetic force under which they are determined.

Although a large number of determinations have been made by many observers of the magnetic susceptibility of different liquids taken at various temperatures, difficulties of a particular kind occur in dealing with liquid oxygen. One method adopted for determining the magnetic susceptibility of a liquid is to observe the increase of mutual induction of two conduct-

* Paper read before the Royal Society.

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ing circuits suitably placed, first in air, and then when the air is replaced by the liquid in question, the susceptibility of which is to be determined. A second method consists in determining the mechanical force acting on a known mass of the liquid when placed in a non-uniform magnetic field. Owing to the difficulty of preserving any quantity of liquid oxygen from evaporation for any length of time, even in a good vacuum vessel, and the impossibility of sealing it up in a bulb or tube, and having regard to the effect of the low temperature of the liquid in deforming by contraction and altering the conducting power of coils of wire placed in it, it was necessary to devise some method which should be independent of the exact constancy in mass of the liquid gas operated upon, and independent also of slight changes in the form of any coils of wire which might be used in it. After many unsuccessful preliminary experiments the method which was finally adopted as best complying with the conditions introduced by the peculiar nature of the substance operated upon is as follows: A small closed-circuit transformer was constructed, the core of which could be made to consist either of liquid oxygen or else immediately changed to gaseous oxygen, having practically the same temperature. This transformer consisted of two coils. The primary coil was made of 47 turns of No. 12 S.W.G. wire. This wire was wound into a spiral, having a rectangular shape, the rectangular turns having a length of 8cm. and a width of 1·8cm. This rectangular-sectioned spiral, consisting of one layer of wire of 47 turns, was bent round a thin brass tube 8cm. long and

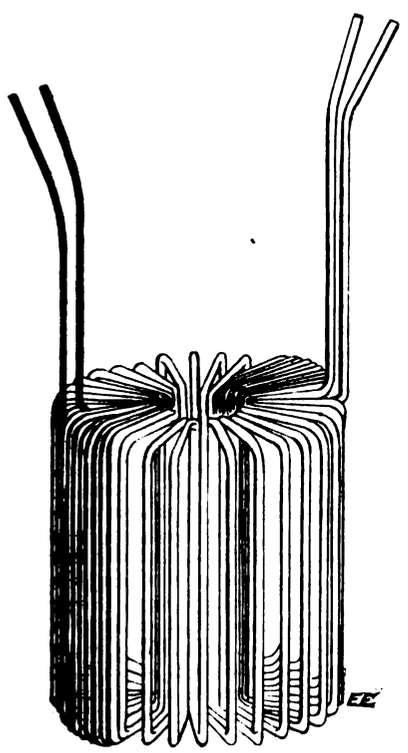

FIG. 1.—Diagram of the Closed Circuit Transformer used in the Experiments.

2½cm. in diameter, so that it formed a closed circular solenoid of one layer of wire. The wire was formed of high-conductivity copper, doubly insulated with cotton, and each single turn or winding having a rectangular form. The turns of covered wire closely touched each other on the inner circumference of the toroid, but on the external circumference were a little separated, thus forming apertures by which liquid could enter or leave the annular inner core. The nature of this primary coil is show in Fig. 1. The mean perimeter of this rectangular-sectioned endless solenoid was 13½cm., and the solenoid had therefore very nearly 3·5 turns per centimetre of mean perimeter. When immersed in liquid oxygen a coil of this kind will carry a current of 50 amperes. When a current of A amperes is sent through this coil the mean magnetising force in the axis of this solenoid is therefore represented by 4·375 times the current through the wire; hence it is clear that it is possible to produce in the interior of this solenoid a mean magnetising force of over 200 C.G.S. units. This primary coil had then wound over it in two sections about 400 or 500 turns of No. 26 silk-covered copper wire to form a secondary coil. The primary and secondary coils were separated by layers of silk ribbon. The exact number of turns was not counted, and, as will be seen from what follows, it was not necessary to know the number. The coil so constructed constituted a small induction coil or transformer, with a closed air-core circuit, but which when immersed in a liquid, by the penetration of the liquid into the interior of the primary coil, became changed into a closed-circuit transformer, with a liquid core. The transformer so designed was capable of being placed underneath liquid oxygen contained in a large vacuum vessel, and when so placed formed a transformer of the closed-circuit type, with a core of liquid oxygen. The coefficient of mutual induction of these two circuits, primary and secondary, is therefore not affected by immersing the transformer in liquid oxygen, because the whole of the induction produced in the interior of the primary coil is always linked with the whole of the turns of the secondary coil, and the only change that can be made is a small change in the mean perimeter of the primary turns due to the contraction of the coil as a whole. In experiments with this transformer the transformer was always lifted out of the liquid oxygen into the cold gaseous oxygen lying on the surface of the liquid oxygen and which is at the same temperature. On lifting out the transformer the liquid oxygen drains away from the interior of the primary coil and is replaced by gaseous oxygen of very nearly the same temperature. The vacuum vessel used had a depth of 60cm. outside and 53cm. inside and an internal diameter of 7cm. It held two litres of liquid oxygen when full, but, as a matter of fact, four or five litres of liquid oxygen were poured into it in the course of the experiment.

Another induction coil was then constructed, consisting of a long cylindrical coil wound over the four layers of wire, and a secondary circuit was constructed to this coil, consisting of a certain number of turns wound round the outside of the primary coil, and a small adjusting secondary coil, consisting of a thin rod of wood wound over with very open spirals of wire. The secondary turns on the outside of the primary coil were placed in series with the turns of the thin adjusting coil, and the whole formed a secondary circuit, partly outside and partly inside the long primary cylindrical coil, the coefficient of mutual induction of this primary and secondary coil being capable of being altered by very small amounts by sliding into or out of the primary coil the small secondary coil. This last induction coil, which will be spoken of as the balancing coil, was connected up to the small transformer, as just described, as follows: The primary coil of the small transformer was connected in series with the primary coil of the balancing induction coil, and the two terminals of the series were connected through a reversing switch and ammeter with an electric supply circuit, so that a current of known strength could be reversed through the circuit, consisting of the two primary coils in series. The two secondary coils, the one on the transformer and the one on the balancing induction coil, were connected in opposition to one another through a sensitive ballistic galvanometer in such

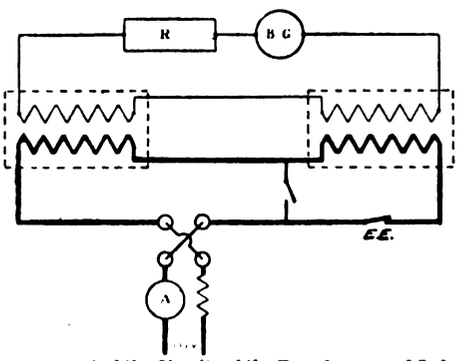

FIG. 2.—Arrangement of the Circuits of the Transformer and Induction Coil.

manner that on reversing the primary current the galvanometer was affected by the difference between the E.M.F.'s set up in the two secondary coils, and a very fine adjustment could be made by moving in or out the adjusting coil of the balancing induction coil. The arrangement of circuits is shown in Fig. 2.

For the purpose of standardising the ballistic galvanometer employed, the primary coil of the balancing induction coil could be cut out of circuit, so that the inductive effect in the ballistic galvanometer circuit was due to the primary current of the closed-circuit transformer alone. A resistance box was also included in the circuit of the ballistic galvanometer. The resistance of the ballistic galvanometer was about 18 ohms, and the resistance of the whole secondary circuit 30·36 ohms. The experiment then consisted in first balancing the secondary E.M.F.'s in the two coils exactly against one another, then immersing the transformer in liquid oxygen, the result of which was to disturb the inductive balance, and in consequence of the magnetic permeability of the liquid oxygen coil being greater than unity, a deflection of the ballistic galvonometer was observed on reversing the same primary current. The induction through the primary circuit of the small transformer is increased in the same proportion that the permeability of the transformer core is increased by the substitution of liquid oxygen for gaseous oxygen, and hence the ballistic deflection measures at once the amount by which the magnetic permeability of the liquid oxygen is in excess over that of the air or gaseous oxygen forming the core of the transformer when the transformer is lifted out of the liquid. As a matter of fact it was never necessary to obtain the inductive balance precisely.

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All that was necessary was to observe the throw of the ballistic galvanometer, first when the transformer was wholly immersed under the surface of liquid oxygen, and, secondly, when it was lifted out into the gaseous oxygen lying on the surface of the liquid, the strength of the primary current reversed being in each case the same. In order to standardise the galvanometer and to interpret the meaning of the ballistic throw, it was necessary to cut out of circuit the primary coil of the balancing induction coil, and to reverse through the primary circuit of the small transformer a known small primary current, noting at the same time the ballistic throw produced on the ballistic galvanometer, this being done when the transformer was underneath the surface of liquid oxygen. It will be seen, therefore, that this method requires no calculation of any coefficient or mutual induction, neither does it involve any knowledge of the number of secondary turns on the transformer, nor of the resistance of the secondary circuit; all that is necessary for a successful determination of the magnetic permeability of the liquid oxygen is that the secondary circuit of the transformer should remain practically of the same temperature during the time when the throw of the ballistic galvanometer is being observed, both with the transformer underneath the liquid oxygen and out of the liquid oxygen. If, then, the result of reversing a current of A amperes through the two primary coils in series when the secondary coils are opposed is to give a ballistic throw, D, and if the result of reversing a small current a amperes through the primary coil of the transformer alone is to produce a ballistic throw, d, then if μ is the magnetic permeability of liquid oxygen, that of the gaseous oxygen lying above the liquid and at the same temperature being taken as unity, we have the following relation:

$$\frac{D}{\frac{A}{a}d} = \mu - 1,$$

which determines the value of μ.

Deferring for a moment the correction to be applied to determine the value of the magnetic permeability of liquid oxygen in terms of that of a vacuum, the following are the results of observation:

OBSERVATIONS ON MAGNETIC PERMEABILITY OF LIQUID OXYGEN.

Throws of Ballistic Galvanometer. Induction Coils Balanced

Exp. I.	4·0 mm. to left 4·2 ,, ,, 4·3 ,, ,,	The transformer in liquid oxygen. Primary current = 37 8 amperes reversed through primary coils.
Exp. II.	17·0 mm. to right 17·5 ,, ,, 18·5 ,, ,,	The transformer lifted out of liquid oxygen into cold gaseous oxygen at the same temperature. Primary current = 37·8 amperes reversed through primary coils.
Exp. III.	3·2 mm. to left 2·5 ,, ,, 2·8 ,, ,,	The transformer in liquid oxygen. Primary current = 37 2 amperes reversed through primary coils.
Exp. IV.	20·0 mm. to right 21·0 ,, ,, 21·3 ,, ,,	The transformer lifted out of liquid oxygen into cold gaseous oxygen at the same temperature. Primary current = 36 8 amperes reversed through primary coils.

Throws of Ballistic Galvanometer in Standardising Observations. Primary Coil of Balancing Coil Disconnected.

Exp. V.	24·0mm. to right 25 0 ,, ,, 25 0 ,, ,, 24·5 ,, ,, 25·0 ,, ,,	Corresponding to 0·1145 ampere reversed through primary coil of the transformer, the transformer being in liquid oxygen. The mean of these ballistic throws is the quantity denoted by d, and the current 0·1145 ampere is the a in the formula above.

Standardising Observations repeated with another Current.

Exp. VI.	58·0mm. to right 58 0 ,, ,,	Corresponding to 0·2639 ampere reversed through primary coil of transformer, the transformer being in liquid oxygen.

Throws of Ballistic Galvanometer. Induction Coils Balanced.

Exp. VII.	4·0mm. to right 4·0 ,, ,,	The transformer lifted out of liquid oxygen into cold gaseous oxygen at same temperature. Primary current = 8 037 amperes reversed through primary coils.
Exp. VIII.	0·4mm. to left 0 4 ,, ,, 0·2 ,, ,,	The transformer in liquid oxygen. Current = 8 095 amperes reversed through primary coils.
Exp. IX.	4·5mm to left 4 8 ,, ,, 4·2 ,, ,,	The transformer in liquid oxygen. Current = 28·8 amperes through primary coils.
Exp. X.	12 0mm. to right 12·0 ,, ,, 12 2 ,, ,,	The transformer lifted out of liquid oxygen into cold gaseous oxygen at the same temperature. Current = 28·1 amperes reversed through primary coils.
Exp. XI.	1·2mm. to left 1·3 ,, ,,	The transformer in liquid oxygen. Current = 28·1 amperes reversed through primary coils.

EXP. XII.

The transformer in liquid oxygen.		The transformer lifted out of liquid oxygen into cold gaseous oxygen at same temperature.	
Current reversed in primary coils, in amperes.	Ballistic throw in millimetres. Deflection to the right.	Current reversed in primary coils, in amperes.	Ballistic throw, in millimetres. Deflection to the right.
58·8	10·5	—	—
—	—	50·2	47·0
50·2	15·0	—	—
—	—	50·8	48·5
50·2	17·0	—	—
—	—	50·0	49·0

The above table shows the results of the observations made with the small transformer alternately placed underneath the surface of liquid oxygen, and then lifted up into the cold gaseous oxygen lying above the surface of the liquid oxygen. It will be noticed that the ballistic throws in each set of observations are not constant, but that there is a tendency usually for the throw to increase if repeated, whilst the transformer is still maintained in the same condition. This is in all probability due to the fact that the continued passage of the primary current heats the primary circuit of the balancing induction coil, and hence heats, also, by radiation, the secondary coil of the balancing induction coil, and, therefore, by enlarging the area of the adjusting coil, continually breaks down the inductive balance. It was found necessary, therefore, to take the observations in groups at equal intervals of time. First, a group of three observations was taken, the transformer being in liquid oxygen, the balance being, as nearly as possible, obtained. Then the transformer was lifted out of the liquid oxygen, and the ballistic throws again taken, reversing the same primary current; then again immersed in liquid oxygen, and finally once more taken out of the liquid oxygen. Taking the sets of observations marked I., II., III., IV., the mean of the means of the three observations in Sets I. and III, corrected for the variation in the primary current, were taken as the result of the measurement in liquid oxygen, and this result was then compared with the ballistic throws in Set II.

Again, the mean of the means of sets of observations II. and IV., properly corrected for variation of primary current, were compared with the mean of the observations in Set III., and the result is to give the data for calculating the permeability of the liquid oxygen for a primary current through the primary coil of the transformer of about 37 amperes, corresponding very nearly to a mean magnetising force of 166 C.G.S. units. The sum or difference of these means of the throws, taken in the liquid oxygen and out of the liquid oxygen, depending on whether they are on the opposite or the same side of the zero of the scale, gives us the value of the quantity denoted by D in the Table I. below, and in the formula for the value of μ.

The above sets of observations, I., II., III., and IV., refer to a primary current of about 37 amperes; but similar sets of observations were taken with a primary current of about 8 amperes, 28 amperes, and 50 amperes respectively, and the results of all these observations, which are included in the sets of observations, I. to XII., above given, have been reduced in Table I. below to show the magnetic permeability of the liquid oxygen corresponding to different magnetising currents. The set of observations marked Experiment V. and Experiment VI. in the above table of results, gives the observations for standardising the ballistic galvanometer. In the first case the primary coil of the balancing induction coil was cut out, and a primary current, having a value of 0·1145 ampere, was reversed through the primary coil of the transformer alone, and gave ballistic deflections as stated in the observations in Set V. These observations serve to standardise the galvanometer and interpret the meaning of the throw obtained when the large current is reversed through the primaries of the two induction coils, the

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secondaries of which are opposed. It will be noticed that one important advantage of the above-described method is that the quantity which we desired to know—viz., the amount by which the presence of the liquid oxygen increases the magnetic permeability of the core of the transformer—is the quantity which is measured directly, and that any error in the measurement of this quantity does not affect the permeability to anything like the same proportional extent. An error of about 10 per cent. in the measurement of the ballistic throw would only affect the fourth place of decimals in the number representing the permeability of the liquid oxygen.

The results of all the above observations, when reduced, are comprised in the following table :

TABLE I.—Table of Results of Observations on the Magnetic Permeability of Liquid Oxygen.

1.—A = primary current in amperes passing through primaries of the transformer and balancing coil.

2.—Corresponding mean magnetising force in C.G.S. units in primary circuit of transformer.

3. Total ballistic throw which would be produced if primary current of A amperes were reversed through primary of transformer alone $= \frac{A}{a} d$.

4. Ballistic throw of galvanometer resulting from immersion of the transformer in liquid oxygen. Transformer and balancing induction coil being opposed = D.

5. μ = permeability calculated from $\mu - 1 = \frac{D}{\frac{A}{a} d}$.

1.	2.	3.	4.	5.
8·037	32·3	1,734	4·33	1·00250
28·13	123·0	6,068	14 9	1·00246
37·8	165·4	8,153	21·18	1 00260
36·8	161·0	7,938	23·57	1 00297
50·5	220·9	10,894	32 98	1·00304

The values of the permeability given in the foregoing table are not all of equal weight.

The calculated value of $\mu - 1$ depends upon the observed ballistic throw, and this cannot be read to a higher degree of accuracy when the throw is as small as four millimetres. We consider that the best result is obtained by taking the mean of the values for the primary currents, 37·8, 36·8, and 50·5 amperes, and these values give $\mu = 1{\cdot}00287$, with a probable accuracy of $\pm$ 0·0002. This value of the permeability of the liquid oxygen corresponds to a magnetising force lying between 166 and 220 C.G.S. units. It will be seen that this method is best applicable to the determination of the permeability under large magnetising forces ; and that these observations do not, in themselves, allow us to state whether the permeability is a constant for all forces, or is a function of the value of the force.

In the next place the value is a relative one. The number 1·00287 is the ratio of the magnetic permeability of liquid oxygen to that of the gaseous oxygen nearly at the same temperature resting upon the surface of the liquid. We were not able by this method to detect the difference between the permeability of the cold gaseous oxygen lying on the surface of the liquid oxygen when in quiet ebullition, and which has a temperature of about − 182deg. C., but a density of at least three times that of oxygen at 0deg. when compared with that of gaseous oxygen at ordinary temperature, and under the normal pressure. In a very valuable memoir on the determination of magnetic susceptibilities M. P. Curie* has examined the susceptibility of gaseous oxygen at different temperatures, and shown that between the limits of 0deg. C. and 452deg. C. the magnetic susceptibility of oxygen (K) per unit of mass is a function of the absolute temperature, T, such that

$$10^6 \, K = 33{,}700/T.$$

and that the value of K (per gramme) at 0deg. C. is, therefore, $123/10^6$. The mass of 1 c.c. of oxygen gas at 0deg. C. and 760mm. is 0·0014107 gramme, and, reciprocally, the value of one gramme is 708·9 c.c. at 0deg. C. and 760mm.

Hence the magnetic susceptibility of gaseous oxygen at 0deg. C. and 760mm. per unit of volume (1 c.c.) would be $123 \times 0{\cdot}00141 \times 10^{-6} = 0{\cdot}173 \times 10^{-6}$, which agrees very fairly with that of other observers.†

If then it could be supposed that gaseous oxygen followed the same law down to − 182deg. C., and taking the gas in a condition when the density is nearly 0·00423, the volume susceptibility (k) at − 182deg. C. would be $1{\cdot}6 \times 10^{-6}$, and hence the permeability (μ), where $\mu = 1 + 4\pi k$, should be 1·00002.

It is, however, certain that the susceptibility per unit of mass will not continue to increase in accordance with the hyperbolic law, because this would imply that at the absolute zero of temperature the susceptibility would be infinitely great, and hence the above number, 1·00002, in all probability gives a superior limit for the permeability of the gaseous oxygen at − 182deg. C. lying on the surface of the liquid oxygen.*

The conclusion is that the correction to be applied to the above observed value of μ for the liquid oxygen—viz., 1·00287—to refer it to a vacuum taken as unity is altogether masked by the unavoidable errors of experiment, and hence, pending further more exact measurements, this may be taken as the value of the constant. We have, however, at the present time, arranged a method which will enable us, we hope, to determine directly the magnetic susceptibility of liquid oxygen with far greater accuracy. This method consists in observing the mechanical force which acts upon a vacuum bulb or mass of matter of known and very low susceptibility when it is suspended free from gravity in a vessel of liquid oxygen, and in a variable magnetic field. Under these conditions a vacuum bulb of very thin glass would behave like a strongly diamagnetic body, and if the magnetic susceptibility of the vacuum bulb or test mass is k_1, and that of liquid oxygen if k_2 for equal volumes, then the apparent diamagnetic susceptibility of the mass will be $-(k_2 - k_1)$, and the actual paramagnetic susceptibility of liquid oxygen may be deduced from a knowledge of k_1 and $-(k_2 - k_1)$. By this method we hope to be able to determine whether the permeability of liquid oxygen is a function of the magnetising force. The latest experimental results and measurements made with solutions of iron salts, such as those made recently by Mr. J. S. Townsend,† appear to show that the magnetic permeability of solutions of these iron salts is a constant quantity at least for a range of magnetic forces varying from one to nine C.G.S. units.

The value—viz., 1·00287—as determined by us for the magnetic permeability of liquid oxygen, shows that the magnetic susceptibility (k) per unit of volume is $228/10^6$. It is interesting to compare this value with the value obtained by Mr. Townsend for an aqueous solution of ferric chloride, and which he states can be calculated by the equation

$$10^6 \, k = 91{\cdot}6 \, w - 0{\cdot}77,$$

where w is the weight of salt in grammes per cubic centimetre, and k the magnetic susceptibility. Even in a saturated solution, w cannot exceed 0·6 ; hence, from the above equation, we find the value of the magnetic susceptibility of a saturated solution of one of the most paramagnetic iron salts — viz., ferric chloride is $54/10^6$ for magnetic forces between one and nine. This agrees fairly well with other determinations of the same constant. On the other hand, the magnetic susceptibility of liquid oxygen for the same volume is $228/10^6$, or more than *four times as great*. The unique position of liquid oxygen in respect of its magnetic susceptibility is thus strikingly shown. It is, however, interesting to note that its permeability lies far below that of certain solid iron alloys generally called non-magnetic.

The 12 per cent. manganese steel of Mr. R. A. Hadfield is usually spoken of as non-magnetic, yet the magnetic permeability of this last substance has been shown to be 1·3 or 1·4.

We have applied the foregoing method also to the determination of the magnetic permeability of liquid air. Since liquid air which has been standing in a vacuum vessel for any length of time has a composition which varies with the time and which may contain as much as 75 or 80 per cent. of oxygen, it was not to be expected that very closely consistent results could be obtained in the case of air. The following figures show, however, the observational results :

PERMEABILITY OF LIQUID AIR.

Throws of Ballistic Galvanometer. Induction Coils Balanced.

Exp. I.	1·5mm. to right 1·2 ,, ,, 1·1 ,, ,,	The transformer in liquid air. Current = 38·0 amperes reversed through primary coils.
Exp. II.	17·0mm. to left. 17 5 ,, ,,	The transformer lifted out of liquid air into cold gaseous air at the same temperature as before. 37·5 amperes reversed.
Exp. III.	0·3mm. to right 0·3 ,, ,,	The transformer in liquid air. Current = 37 amperes reversed through primary coils.

* "Thèses présentés à la Faculté des Sciences de Paris pour obtenir le grade de Docteur ès Sciences Physiques," par M. P. Curie, Paris, 1895. This memoir is of remarkable interest in many ways.

† Faraday, "Experimental Researches," vol. iii., p. 502, gives a value for the susceptibility of gaseous oxygen at 60deg. F., referred to an equal volume of water as unity, which when reduced to absolute values by taking the magnetic susceptibility of water as $0{\cdot}77 \times 10^{-6}$, gives the value of the susceptibility as $0{\cdot}18 \times 10^{-6}$. Becquerel found a value not very different.

* The critical pressure of oxygen is − 118deg. C. The corresponding absolute temperature is 155deg. If we then put T = 155, in Curie's formula, 10^6 K = 33,700/T, we get 10^6 K = 217·4 as his deduced extrapolated value for the susceptibility per unit of mass. Since the density of liquid oxygen, as determined by one of us (J. Dewar), is 1·1375, our value for the susceptibility per unit of mass of the liquid oxygen is 228/1·375 = 200·7. These figures show that the hyperbola does not represent the value of the susceptibility per unit of mass below the critical temperature.

† See *Phil. Trans.*, A, vol. 187, 1896, "Magnetisation of Liquids," J. S. Townsend, M.A.

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Exp. IV.	17·0mm. to left 17·0 ,, ,, 17·3 ,, ,,	The transformer lifted out of liquid air into cold gaseous air, and at the same temperature as before. Current = 37 amperes reversed through primary coils.
Later. Exp. V.	2·8mm. to left 2·8 ,, ,,	The transformer in liquid air. Current = 36·7 amperes reversed through primary coils.
Exp. VI.	18·8mm. to left 19·2 ,, ,, 19·4 ,, ,, 19·8 ,, ,,	The transformer lifted out of liquid air into cold gaseous air, at the same temperature as before. Current = 37 amperes reversed through primary coils.
Exp. VII.	3·5mm. to left 3·4 ,, ,,	The transformer in liquid air. Current = 36·7 amperes reversed through primary coils.
Exp. VIII.	22·0mm. to left 22·0 ,, ,, 22·0 ,, ,,	The transformer in liquid air. Primary circuit of balancing coil cut out of circuit and 0·1118 ampere reversed through primary of transformer to standardise the ballistic galvanometer.

The results of these observations, when reduced, show that corresponding to a primary current of 37·5 amperes, or a mean magnetising force of 164 C.G.S. units, the apparent magnetic permeability of liquid air in terms of gaseous air of the same temperature is 1·00240.

At the time of these observations the liquid air used had probably become almost entirely liquid oxygen by the evaporation of the nitrogen. The figure, however, serves to check approximately that of the liquid oxygen.

In conclusion, we desire to express our thanks to Mr. J. E. Petavel for the assistance he has given to us in the above work. We hope shortly to be able to make a further contribution to this portion of the investigations on which we are engaged on the electrical and magnetic constants of liquid oxygen, and which will include a determination of the dielectric constant of liquid oxygen, made with the object of determining the extent to which this substance obeys Maxwell's law connecting magnetic permeability, dielectric constant, and optical refractivity.

ELECTRICAL WELDING.*

BY SYDNEY F. WALKER.

The subject I have to bring before you this evening is that of welding by electricity. Strictly speaking, however, as I shall explain to you in the course of my remarks, the processes that I shall describe to you are not welding at all, though they effect the junction of two pieces of metal very much in the same manner that welding does. Welding, as many of you will be aware, or the ability to be welded, is a property enjoyed only by some classes of iron and steel. In the process of mechanical welding, two pieces of the same metal whose surfaces have been prepared to unite are heated to a particular temperature, at which the metal becomes of a pasty character, and when in that state the junction is completed by hammering or by pressure. If the temperature of the two surfaces that are to unite is either too high or too low, the operation of welding cannot be performed. Mechanical welding also cannot be accomplished in cast iron, in copper, or in any other than the metals named above. With the electrical processes, on the other hand, junctions similar to those produced by mechanical welding can be made between any two pieces of the same metal, and by proper arrangement even between pieces of different metals. In the electrical processes the metals are raised to a temperature at which they can be worked with the hammer or other suitable means by the aid of electric currents, either passed directly through the metals to be welded, through the surfaces to be joined, or by directing the heat of the electric arc upon the bodies to be operated upon. In all electrical operations some heat waves are generated by the passage of the electric waves through any substance however little resistance it may offer, but the art of the electrical engineer is directed to reducing all such transformations in every part of his apparatus, except where the production of heat or light waves will tend to the result he has in view. In the electric welding apparatus, where the one object is the production of heat waves at the junction of the metals he wishes to unite and their immediate neighbourhood, all his calculations and arrangements are directed to deliver the whole of the electrical energy at his disposal at that spot, and to there convert it into heat energy in such a manner as to produce the result he wants—the heating of his specimens to the temperature at which they can be made to unite. He never succeeds in accomplishing this wholly. In fact, there are immense losses in the whole series of transformations—not real losses; you cannot have a loss of energy—you can only have a conversion into another form, but losses so far as the ends in view are concerned. In order to provide electric currents for the apparatus I have to show you to-night, a long series of these transformations have to be gone through, each one entailing a loss so far as the end in view is concerned. Prof. Elliott has a boiler outside the laboratory, and Mr. Applebee has a series of boilers at the Corporation electricity supply works in Eldon-road. Both are being used for the purpose of the experiments to-night. The Willans engine you see before you is driving the armature of the dynamo to which it is attached, and Mr. Applebee's engines at Eldon-road are driving armatures to which they are attached, though not quite of the same form. The revolution of the armature in each case transforms a portion of the energy imparted to it from the crankshaft into electric waves, at the same time setting free some of the energy previously locked up in the iron forming a large part of the machines, the result being that electric currents, or, as I understand them, a series of electric waves, are passed into the cables connected to the respective dynamos. From the dynamo before you the currents are led to the switchboard, from which a portion are taken to the lamps you see around you, and are there transformed into heat and light waves, and a portion will be led presently to the apparatus on the table, where they will be also converted into heat and light waves for the purpose of the lecture. The currents generated by Mr. Applebee's dynamos are taken to his switchboard, from whence they are brought up to an apparatus, also known as a transformer, the office of which I will explain presently, from which a portion of them are brought into this laboratory to the welding apparatus you see, where a portion of them will again be converted into heat waves for the purpose already described. You will notice I have stated that at each transformation a portion only of the waves of the particular form are converted. The conversion is never complete. Each apparatus takes toll for conversion. The boiler itself and the engine both absorb heat, and not only absorb it, but pass the heat waves on to surrounding objects, as you soon discover when you stand near either of them. The dynamo demands toll of the mechanical energy delivered to it, which it converts into heat in various ways before it produces any electrical waves; the cables and switches do the same. The transformer that I referred to in connection with Mr. Applebee's currents does the same. Its office is to convert the currents, which are generated at very high pressure, at which they are generated at Canton, so that they may be delivered by comparatively small cables into currents of such a pressure that we are able to use them here without danger. These currents, as you will see, are further transformed by suitable apparatus attached to the Thomson welders before you to currents of very low tension indeed, less than that of a single Leclanché cell such as you use for ringing your bells. The object of this is to enable us to have at command in the welding apparatus the enormous currents that are necessary in this process, without the necessity of using very large cables and other apparatus. This leads me on directly to the question involved—viz., what is necessary in order to weld or unite metals by electricity? Merely bring the necessary current to the specimen, in some form or other, that will generate the necessary heat. But this is not all the problem. As you know, the temperature that a body assumes under the influence of different sources of heat varies under different conditions. All bodies absorb heat themselves, and all pass it on to other bodies near them. Further, as the air in contact with any heated body becomes also heated, expands, and moves away from the place at which it received its heat, what are termed convection currents are set up in the surrounding atmosphere. That is to say, there is a continual stream of air passing over the heated body, carrying off heat waves, and so lowering the temperature. The temperature assumed, therefore, by the body to be heated depends upon—(1) its own capacity for absorbing heat, which again depends upon its mass and its substance; (2) on the heat passing away from the body by the various paths described; and (3) the heat delivered to the body. Where electricity is the agent, the heat delivered is easily measured. It depends upon the current strength, the resistance offered, and the time; or, with a given body, the heat generated in a given time depends directly on the square of the strength of the current. It also depends, with a given body for a given time, on the square of the pressure—the E.M.F. that is causing the current to pass through the body. It is also measured by the product of the current strength and the pressure the current is working under within the body to be heated. And the power required can be measured by taking either of these quantities, which are then in the form of an electrical unit called the watt, the unit of power, and dividing them by 746, the number of watts in 1 h.p. Thus, in the Thomson welder, if a certain specimen requires, say, 15,000 amperes, at a pressure of one volt, or 15,000 watts, this is equivalent to rather over 20 h.p. If in the Benardos process a certain specimen takes 300 amperes, with a pressure of 50 volts, making again 15,000 watts, this is also the equivalent of rather over

* Paper read before the Bristol Channel Centre of the Institute of Marine Engineers in the Engineering Laboratory of University College, Cardiff.

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20 h.p., though the currents are applied, as will be seen, under totally different conditions. These are not the indicated horse-power in the cylinders of the steam-engines. All the losses, the conversions into heat not used where it is required, have to be added, so that usually the indicated horse-power is at least double the electrical energy actually transformed into heat in the metals being welded. There are three processes at present in use in this country for uniting metals by the aid of electricity, and they divide themselves into two distinct classes, very much upon the lines of the arc and incandescent systems of electric lighting.

Thomson System.—The Thomson system, the invention of Prof. Elihu Thomson, one of the able band of electrical engineers that America has produced within the last 15 years, is on what may be termed the incandescent system. In this process the metals to be united are placed together in an apparatus specially designed for the purpose, which has been called an electric welder, and samples of which are before you. In this apparatus pairs of clamps are placed in convenient positions for holding the specimens, and on top of an iron box. Attached to and controlling the clamps are lever and screw arrangements for pressing the two metal surfaces against each other. Under the top of the box is a special form of electrical alternate-current transformer, arranged to convert the current which is usually delivered to it at a voltage or pressure of 200 volts, or thereabouts, down to about one volt, the result being the passage of a current of enormous strength, many thousands of amperes, through the secondary coil of the transformer, and the metals that are to be united. The strength of the current passing through the metals that are being operated upon varies, of course, according to their size. The welders are made in different sizes, to take different sized specimens, and provided with transformers that will take from the primary supply circuit the necessary current required, and deliver it to the specimens converted to the proper strength and pressure for the work. Within their own limits each welder on the Thomson process is approximately self-regulating—that is to say, the current taken by the primary coil of the converter, and the current delivered by the secondary coil to the metals, is regulated automatically within the limits of each welder, by the size of the metals it is called upon to weld, very much as the current taken from the primary circuit of an alternate-current electric lighting supply service is regulated by the current called for by the secondary circuits of the transformers, as lamps are turned in or out, but adjustable resistances or impedance coils are often added to give more complete control of the current. Welds have been made with the Thomson apparatus in specimens ranging from 1-10in. diameter up to 2½in. diameter, or the equivalent in sectional area, and I see no reason that much larger specimens should not be done. The energy absorbed in the operation of welding is strictly proportional to the size of the specimens that are united under the same conditions, and omitting losses in transmitting and transforming the current. The Thomson process appears to me to be best suited for built welds, but it is also used by means of special clamps for scarf and V welds. The actual process of welding consists, with this apparatus, as you will see, in bringing the two surfaces that are to be joined into contact by means of the clamps as shown, allowing the necessary current to pass through the junction till the metals in the neighbourhood of the joint are raised to the necessary heat, applying pressure by means of the levers and screws to the joint as the temperature rises, and finishing off, where necessary, by hammering, the whole process occupying from 20 seconds to 2½ minutes, according to the size of the specimens that are being worked. The Thomson patents are held in this country by the Electric Welding Company, of London, who have kindly lent the welders shown, and the specimens that will be tested after the reading of the paper. The power taken in the Thomson process for welding steel works out approximately at 22 h.p. for one minute; for one square inch sectional area welds in smaller pieces are made in less time, but with larger proportional expenditure of energy during that time; for larger pieces less power is absorbed proportionately, but for a longer time.

Dr. Zerener's System.—In the next process—that of Dr. Zerener, of Berlin—the electric arc is employed. An apparatus somewhat similar to that used for arc lamps holds two carbon pencils inclined to each other, and surmounted by an electromagnet. The arc which is found between the carbons is made very much longer than is usual in arc lamps, so that a long flame is obtained, and this flame is directed outwards from the carbons by the action of the electromagnet, till it assumes a form somewhat similar to a blowpipe flame. The flame in this form is directed on the metals to be welded simply by turning the apparatus in the necessary direction. Mr. T. Scott Anderson, of Sheffield, who owns the license in this country, tells me that he uses the apparatus for all sizes of work. In particular, he has used it for welding the seams of boiler tubes up to ½in. thick, and for softening portions of steel armour plates, chilled by the Harvey process, that are required to be drilled. Either the continuous current or an alternating current may be employed, as convenient, and no apparatus appears to be necessary beyond the arc lamp-looking blowpipe arrangement, and the usual cables to connect with the dynamo, or transformer, and the switches and resistances for controlling the current strength. The power used in the Zerener process varies from 85 to 110 volts, and from 25 to 40 amperes, or from 4 h.p. to 6 h.p., in addition to the charges for conversion before mentioned.

Benardos Process.—In the Benardos process the electric arc is also employed, but not in the same manner as in the Zerener process. In the Benardos process an arc is formed between the metal that is to be welded and a carbon held in the hand of a workman, and provided with a suitable holder and guard as shown. A continuous current is used, which may be taken from a dynamo driven by an engine having a very heavy flywheel, or from a dynamo in conjunction with accumulators. The dynamo is allowed to run continuously, its current passing into the accumulator. The welding carbons and the work to be welded are connected to the accumulator, and draw current from it, or, if its charge is low, from the dynamo. The patents of the Benardos process are owned in this country by Messrs. Lloyd and Lloyd, of Birmingham, who have very carefully worked out the details of the invention, and who have kindly sent specimens of their work and of their apparatus. At their works they have a compound condensing engine, indicating 120 h.p., running day and night, charging a battery of 1,440 Benardos accumulators by means of three dynamos working at 150 volts. The 1,440 cells are arranged in sets of 60, all taking their charge from what are termed the omnibus bars in the switch-room, to which also all the dynamos and all the welding apparatus are connected. From the switch-room, where switches are arranged to control each circuit, and instruments to show exactly what each dynamo and each welder is doing, leads are taken to the welding-room or smithy. The welding-room is in appearance exactly like a smithy, except that there are no fires. Each smith is provided with a mask, such as I have here, to protect his eyes and face from the glare of the arc, with a carbon-holder similar to that I have, which is attached to one of the leads from the omnibus bars with a sort of anvil, to which the other lead from the omnibus bar is attached, and an adjustable resistance to vary the strength of the current and the pressure. The metals to be welded are either connected directly to the lead, or are laid on the anvil. The smith, when he is ready, adjusts his mask, touches his carbon on the work to be welded, and draws it gradually away, forming an arc about 2½in. long, which creates an intense heat. As the positive pole of the accumulator or the dynamo is connected to the metal to be welded, the greatest portion of the heat is generated in the metal opposite to the carbon rod. In from a few seconds to two or three minutes the metals to be welded are at a sufficiently high temperature to be united, and are then hammered together in the usual way. Where a long weld is to be made, a short length, one or two inches, is done at each weld till the whole is complete, the time required for each heat in these cases being from 1½ to 2 minutes. Messrs. Lloyd and Lloyd are employing the Benardos process for very varied classes of work. In addition to welding pieces of metal together, they head up steel casks made for carrying petroleum, weld flanges on pipes made to withstand considerable pressure, and other things. Their plan for this class of work is to tack the two pieces of metal lightly together in any convenient manner, leaving a space that can be filled up in such a way as to unite the two. In this space are placed small billets of the same metal, the billets and the two pieces to be joined being heated to the required temperature and then hammered with a former. They also use the process for burning holes in tubes, or for burning pieces out of masses of iron, such as iron girders, the burning operation taking the place of the hammer and chisel; also for making good steel castings in which dirt has caused blow-holes, etc., the flaws being burnt clean away by means of the arc, and filled in with fresh metal, so that the whole forms one homogeneous mass. In the Benardos process the power employed is from 50 to 60 volts, and from 200 to 400 amperes, or in horse-power from 13 h.p. to 32 h.p., according to the work to be done, besides losses in conversion.

At the conclusion of the paper and the experiments,

The PRESIDENT said they would all agree with him that the lecture had been very interesting. The present century would go down in history as the one in which the work of the electrical engineer was made practicable. The electrical welder had passed beyond the experimental stage. It was a splendid tool in the hands of the engineer, and they might say they could produce welds that would compare more than favourably with the best of welds by hand, and six to ten times more expeditiously per man, as Mr. Walker had pointed out. Yet we were quite young at this business, and nobody knew where it would stop. After all, a riveted joint was not so good as a weld, which was relatively 80 per cent., whereas these electrical welds were up to a percentage of 90. He had been struck, like Mr. Walker, with the enormous power required for electrical welding. They wanted an engine of 200 h.p., while to attempt welding with currents of 50 or 60 amperes was utterly useless. They must have 300 amperes,

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and perhaps 800. He believed Messrs. Lloyd and Lloyd had laid down a plant giving off something like 1,700 amperes.

Mr. NEVILLE APPLEBEE stated that all engineers knew the difficulty of keeping joints of steam-pipes intact under high pressure—160lb. and upwards—but by electrical welding there were no joints to speak of, and all that trouble disappeared. They had seen how suitable alternating currents were for this class of work, because pressures might be increased or reduced just as they were required.

NEW CAPITAL.

The following is an abstracted statement of the new capital authorised and the capital issued during the six months ended December 31, 1896, based on the announcements of new companies, loans, or other issues made in the *Times*, with certain particulars relating to the creation or issue of the capital, and also of the purchase-moneys payable to vendors, so far as such particulars are stated in the prospectuses announcing the issues:

—	Security.		Capital.		Price of issue.	Taken by vendors			Date of allotment if announced.
	Amount.	To be paid up.	Authorised.	Issued.		Securities.	Cash.	Securities or cash.	
Aluminium Co.—4½ p.c. Debs. Red ...	Stk.	—	—	90,000	103	—	—	—	July 21
Anglo-French Motor Carriage	1	1	300,000	258,000	Par	86,000	33,000	64,000	—
British Arsenic Mines—									
10 p.c. Cum. Pref..... ...	1	1	30,000	30,000	Par	1,000	—	12,500	—
Ordinary	1	1	20,000	20,000	—	20,000	—	—	—
British Electric Traction									
6 p.c. Cum. Pref.	10	10	300 000	—	—	—	—	—	—
Ordinary	10	10	300 000	300,000	Par	—	25,000	—	Nov. 16
British Motor Syndicate.....	1	1	1,000,000	1,000,000	3	—	—	2,700,000	—
Brockie-Pell Arc Lamp	1	1	80,000	75,000	Par	25,000	30,000	5,000	Aug. 4
Callender's Cable and Construction—									
Ordinary	5	5	100,000	100,000	—	100,000	—	—	—
4½ p.c. Debs Red.....	Stk.	—	90,000	90,000	103	40,000	—	—	July 31
Charing Cross and Strand Electricity									
4½ p.c. Cum. Pref...	10	10	100,000	50,000	Par	—	—	—	July 27
City of Birmingham Tramways—									
5 p.c. Pref.	5	5	400,000	200,000	£5. 4s.	—	500,000	—	Oct. 22
Ordinary	5	5	600,000	300,000	—	—		—	—
4 p.c. Debs. Red.	Stk.	—	500,000	300,000	102	—		—	Oct. 22
Electrical Development and Finance	1	1	500 000	250,000	Par	—	—	—	—
London Electrical Cab.....	1	1	150,000	—	Par	—	—	50,000	—
Metropolitan Electric Supply—Ord...	10	10	500,000	125,000	12	—	—	—	July 17
River Plate Electric—5 p.c. Debs. Red.	Stk.	—	150,000	125,000	97½	—	—	—	July 15
Warrington Rubber Works—									
10 p.c. Cum. Pref.....	1	1	50,000	50,000	Par	5,000	25,000	—	Sept. 16
Ordinary	1	1	50,000	50,000	Par	5,000		—	Sept. 16

ELMORE'S AMERICAN AND CANADIAN COMPANY.

A meeting of the Elmore American and Canadian Paten

LEGAL INTELLIGENCE.

PUTTING UP TELEPHONE WIRES.

In the City of London Court on January 4, before Mr. Commissioner Kerr, the case of Loader *v.* the National Telephone Company, Limited, was heard. These proceedings were brought by Mr. Thomas Loader, Wellington road, Charlton, to recover from the defendants, Oxford-court, Cannon-street, the sum of £7. 2s. for expenses incurred in repairing premises which were damaged by the defendants' men in putting up some telephone wires and poles.

Mr. Compton Smith was counsel for the defendants.

From the evidence it appeared that the defendants wanted to put up a telephone pole close to the plaintiff's house, and that, without asking permission, they removed the gates of the plaintiff's house, and went on to the roof, causing the water to come through.

The defendants' case was that they had permission for what they did from someone who appeared to be the lady of the house. They denied having done any damage.

The learned **Judge** found for the plaintiff for the amount claimed.

COMPANIES' MEETINGS AND REPORTS.

AMAZON TELEGRAPH COMPANY, LIMITED.

The general meeting of this Company was held on December 31 at the Company's Offices, London-wall, E C.

In the absence through ill-health of Mr. W. S. Andrews, **Lord Richard Browne** presided, and moved the adoption of the report. This was seconded by **Mr. Earle**, and carried unanimously.

In the course of his speech **Lord Richard Browne** said he considered the revenue account from February 12 to June 30 to have been a satisfactory one. Of the total receipts in that period, some £5,000 was from messages and £6,000 in subsidy from the Brazilian Government. They would have a large subsidy from the Government for 20 years. They had had great difficulties in the upper waters where large tributaries came into the river. It had been intended to keep the "Inverness" up the river, but since the report was printed they had heard news of her having gone ashore. She would probably not be got off, but was insured. They would suffer nothing worse than delay until the "Inverness" could be replaced by a new ship. He regretted that their line had been much interrupted during the last half-year, but hoped they would be less open to interruptions in future. If a continuous service could be maintained there would be a great increase of messages.

Mr. Alexander Siemens subsequently spoke. The soundings they had taken in the preliminary expedition had not given them a correct idea of the upper part of the river. It seemed to be soft mud, but there were rocks in it in places covered with a thin coating of mud. These were only in patches, and could be avoided by deviating the cable to one side or the other. A great deal of revenue had been obtained from very small places from which they had not expected much traffic, and he believed the prospects of the Company were favourable.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Kattowitz.—Tenders will be received on January 11 by the Prussian State Railways (Königliche Eisenbahn Direktion) at Kattowitz for the supply of electric lighting carbons. Particulars are obtainable for 50 pfg. (6d.).

Santiago (Chile).—The City Authorities of Santiago de Chile have published conditions under which offers will be received for converting the existing tramways to electric traction, and for lighting the city by electricity.

Saint-Yvon (France).—Tenders will be wanted on January 31 for an electric lighting installation (to replace 1,500 gas lights) at the lunatic asylum at Saint-Yvon, in the Seine Inferieure. Application to the asylum authorities.

Breslau.—Tenders will be received on January 12 for the supply of porcelain insulators, telegraphic wire, etc., for the Prussian State Railways. Particulars are obtainable for 50pfg. (6d.). The address is Gartenstrasse 106, Breslau.

Paris.—Tenders will be received on January 21 by the French Post and Telegraphs Department (Paris, rue de Grenelle 103), for the supply of 103,745 wooden telegraph posts (treated). Application to tender must be made by January 11.

COPPER DEPOSITING COMPANY.

Copper Depositing Company was held on December 31 at the Great Northern Hotel, Leeds, Mr. J. J. Atkinson presiding. The report and balance-sheet for the year, an abstract of which appeared in our last issue, were adopted. Mr. J. T. Cooper was re-elected a director. Other formal business was transacted, and the **Chairman** intimated that during the year a scheme for amalgamating with the English Copper Company, whose works were at Leeds, would be laid before the shareholders, but before anything was done they would be furnished with full details.

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Erfurt.—The Prussian State Railway Authorities (Königliche Eisenbahn Direktion) will receive tenders on January 20 for the supply of wooden telegraph posts. Particulars are obtainable for 25pfg. (3d.); the address is Erfurt, Bahnhofs-strasse 23.

Visé (Belgium).—The authorities (l'administration communale) of the town of Visé desire propositions from companies and others for town electric lighting. The proposal is an open one, both as to method and date, and offers or enquiries should be made to the Collège echevinal, Visé.

Alexandria. — Tenders are required for the supply of miscellaneous stores connected with lighting and signalling by the Railway, Telegraph, and Harbour Board. Particulars at the Gabbary Stores. Tenders, on stamped paper, to the President of the Administrative Council, Cairo.

Paris.—The French Telegraphic Authorities will receive tenders at Paris, rue de Grenelle 103, on January 28, for 600 000 galvanised iron screws (two lots), about 25 tons of bronze wire, and for wood fibre packing, for the requirements of the telegraphic service during three years from February next. Application to tender must be made by January 16.

Hull.—The Corporation invite tenders for a lease of the tramways authorised to be constructed by the Tramways Orders Confirmation (No. 1) Act, 1896. Tenders to be delivered by February 1, endorsed "Tramway Tender," at the office of Mr. R. Hill Dawe, town clerk, Town Hall, Hull, from whom all particulars and conditions of tender may be obtained.

Milton (Portsmouth).—The Guardians of Portsea Island Union invite tenders for electric lighting and hot-water and engineering work at the new infirmary buildings at the union house. Persons desirous of tendering either for electric lighting or hot-water and engineering work may inspect the specification and obtain any other information on application at the offices of Mr. C. W. Bevis, F.R.I.B.A., architect, Elm-grove-chambers, Southsea. Tenders to be delivered at the Union House by 3 p.m. on 20th inst.

Edinburgh.—Tenders are required for the complete wiring of the Royal Infirmary. Specifications and drawings can be inspected at the office of Mr. William S. Caw, treasurer and clerk, or at that of the consulting engineer to the infirmary, Prof. Kennedy, 17, Victoria-street, Westminster, S.W. Firms desirous of tendering can have copies of the specification and drawings on making a deposit of £5. 5s., which will be returned on receipt of a proper tender. Tenders must be received by the Clerk, in sealed envelopes, marked "Tenders for Electric Lighting," by 10 a.m. on 28th inst.

Dover.—Tenders are required by the Town Council for the construction of about three miles of the Corporation tramways—single line with passing places—including a concrete road bed, the laying of rails, tie-bars, etc., and paving with granite setts, for the Town Council. Forms of tender, specifications, and bills of quantities may be obtained on payment of £3. 3s., returnable on receipt of a bona fide tender, and conditions and plans inspected at the Borough Engineer's Office, Town Hall. Tenders to be sent in to Mr. E. Wollaston Knocker, town clerk, Town Clerk's Office, Castle-hill House, Dover, by 2 p.m. on January 12.

Dover.—The Town Council also invite tenders for the supply and delivery of steel girder rails, fishplates, fishbolts, tie bars, points, crossings, and other accessories for about three miles of the Corporation tramways. Forms of tender, specifications, and bills of quantities may be obtained on payment of £3. 3s. (returnable on receipt of a bona fide tender), and conditions and plans inspected at the Borough Engineer's Office, Town Hall. Tenders to be sent in to Mr. E. Wollaston Knocker, town clerk, Town Clerk's Office, Castle-hill House, Dover, by 2 p.m. on January 12.

Bristol.—The Electrical Committee of the Corporation require tenders for the supply and erection at the Electric Lighting Station, Temple Back, Bristol, of five mild-steel Lancashire boilers, with fittings, etc. Plans and sections of the station may be seen at the office of the Engineer, Temple Back, and copies of the specification and form of tender seen and obtained at the office of Mr. Frank M. Prosser, secretary, Electricity Department, Temple Back, on payment of three guineas. Tenders, endorsed "Tender for Boilers," must be addressed to the Secretary, and delivered to him by 4 p.m. on 21st inst. Only boilermakers will be permitted to tender.

London, N.W.—The Vestry of St. Pancras invite tenders for supplying and laying earthenware conduits, lead covered armoured cables, and bare copper strip conductors in culverts, for the Vestry of St Pancras. Copies of specification, conditions of contract, quantities, and form of tender in duplicate to be obtained upon application to the Electricity Department Offices, 57, Pratt street, N.W., on payment of a deposit of £1, which will be returnable on receipt of a bona fide tender and specification. Tenders to be sent to Mr. C. H. F. Barrett, vestry clerk, Vestry Hall, Pancras-road, London, N.W., endorsed "Tender for Earthenware Conduits, Lead-Covered Armoured Cables, etc.," by 12 noon on 26th inst.

Blackburn.—Tenders are invited by the Board of Guardians for the laying of a service of electric fire-alarm communication between the various buildings of the workhouse. Plan and report showing the requirements of the Guardians may be seen and information with regard thereto obtained upon application to Inspector Simpson at the Borough Fire Station, Clayton-street, Blackburn, by appointment. Competitors are requested to inspect the workhouse premises, take measurements, and prepare their own plans and specifications, which, together with tenders, duly endorsed "Fire Alarm," must reach Mr. Robt. C. Radcliffe, clerk, Union Offices, Cardwell-place, Blackburn, by 10 a.m. on January 9.

Colwyn Bay.—The Urban District Council invite plans, particulars, and estimates, etc., for a scheme of electric lighting for their district, the powers for which they obtained last session. To the author of the scheme considered the best a premium of £30 will be paid, and in the event of the work being carried out such premium must be considered as part payment of the engineer's commission. To the author of the scheme considered second best a premium of £20 will be paid. Further information will be received on personal application to Mr. Wm. Jones, A.M.I C.E., the Council's surveyor. The schemes must be sent in not later than January 12, 1897. Further particulars are contained in an advertisement in another part of the paper.

Montevideo.—We have received information from the Foreign Office that the Uruguayan Government are calling for tenders for working the electric light system in the town of Montevideo, in accordance with Art. 25 of the law of liquidation of the Banco Nacional. The principal conditions are that the renting company shall take over the payment of all the private debts of the concern, which, on September 30, 1895, were as follows: Banco Hipotecario del Uruguay, mortgage in cedulas on the central station in Calle Yerbal, 63,865dol.; mortgage on the central station in Arroyo Seco, 71,411dol.; Ernesto Tornquist for machinery, 29,332dol. To carry out the public lighting at a price 5 per cent. below that actually paid for the first five years, and 10 per cent. discount for the second five years. The rental to be for 10 years. The renter to take over the debts of the concern. The renter to purchase 400 shares at present in private hands. Tenders to be presented on January 15, 1897, at 2 p m. A guarantee of 10,000dol. to be given. Tenders are to be sent in sealed envelopes to the Ministry of Finance, and will be opened in the presence of the interested parties.

RESULTS OF TENDERS.

Essen a. d. Ruhr.—The tenders for zincs for the Prussian State Railway service on December 17 were: Schulze, 47pfg.; Schmitz and Kuhnert, 58pfg.; and G. Hagen, 38pfg. each.

Leeds.—For building a tramway depôt and workshops in Kirkstall-road, the City Council have accepted the tender of Messrs. J. Schofield, Sons, and Co for the whole of the building excepting the ironfounders' work, at £13,394. 14s. 8d., and that of Messrs. Clayton, Son, and Co., Limited, for the ironfounders' work, at £6,691. The lowest tender was accepted in each case.

BUSINESS NOTES.

Leeds.—The City Council have resolved to extend the tramway in York-road.

Yarmouth.—A debate took place recently at the Liberal Club on the question of the tramways.

Direct Spanish Telegraph Company, Limited.—The traffic receipts for December were £3,609.

Cable Companies' Festival.—The fifth annual dinner and *réunion* of the cable companies was held last week at Liverpool.

Globe Telegraph and Trust Company, Limited.—The directors announce an interim dividend of 1s. 6d per share upon the ordinary shares.

Allgemeine Elektricitats-Gesellschaft of Frankfort.—This Company will shortly issue 4 per cent. obligations for 5,000,000 marks (£250,000).

Social.—The annual dance of the "Faraday" Electrical Company employés took place last week in the Mikado Tea Rooms, Jamaica-street, E.

Battersea.—The Vestry have selected a site in Lombard-road for a central station to cost £5,400, and it is also proposed to purchase two wharves adjoining for £8,500.

Paris.—A motor fire-engine is shortly to be given a trial in Paris, and in the event of being successful others will gradually be adopted throughout the whole of the brigade.

Oxford.—The electric lighting company have paid a dividend of 3½ per cent. on the third year's working. The number of customers increased last year from 154 to 225.

City of London Electric Lighting Company, Limited.—Warrants for payment of interest on the £400,000 debenture stock for the half-year ended December 31 have been posted.

Augusta Railway and Electric Company.—Coupons due on January 1 on the bonds will be paid on and after that date by the North American Trust Company, 95, Gresham-street, E.C.

Wrexham.—At the Town Council meeting the sealing of the memorial presented to the Board of Trade applying for a provisional order under the Electric Lighting Acts was confirmed.

Christmas Annual.—We have received from the Electrical Power Storage Company, Limited, their annual blotting-pad, which is now well known and looked for by electrical engineers.

Grantown.—A public meeting has been held to consider the reports of Mr. Burgess on the schemes for lighting the town with electricity, and a committee was formed to deal with the matter.

West India and Panama Telegraph Company.—For the half-month ended the 31st ult the traffic receipts amounted to £2,607, as compared with £2,652 for the corresponding period of last year.

Ely.—A discussion took place at the Urban District Council meeting as to the bad quality of the gas and its inefficient lighting power, and it was suggested that the Council should go in for electric lighting.

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Bermondsey.—The Vestry have called in Messrs. Kincaid, Waller, and Manville to report on lighting the parish by electricity, and on the advisability of working in conjunction with a destructor.

Poole.—The Board of Guardians have decided to appeal against the decision of the Branksome Bench in reference to the assessment of the property of the Bournemouth Electric Light Company.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended January 3 amounted to £1,374, as compared with £1,150 in the corresponding week of the previous year, being an increase of £224.

Millet's Patent Motor Wheel Company, Limited.—This Company has been registered, with a capital of £100,000 in £1 shares, to carry on business as manufacturers of and dealers in motors of every description, as electricians, etc.

Handsworth.—The Urban District Council have instructed the surveyor to institute enquiries with a view to electrically lighting such parts of the Council's district as are not at present supplied with gas by the Sheffield Gas Company.

Motor Wagons.—At the fourth ordinary meeting of the Liverpool Self-Propelled Traffic Association a lecture was delivered by Mr. G. F. Thompson, consulting engineer, the subject being "The Motor Wagon Scientifically Considered."

Bristol Tramways and Carriage Company, Limited.—The traffic returns for the week ended January 1 were £2,394. 2s. 3d., compared with £1,937. 4s. 5d. for the corresponding period of last year, being an increase of £456. 17s. 10d.

Garston.—At the meeting of the Urban District Council the law clerk, Mr. P. F. Garnett, stated that all the necessary steps had been taken on behalf of the Council to apply to the Board of Trade for an electric lighting provisional order.

West Bromwich.—To secure a *locus standi*, the Corporation are recommended by the Highway Committee to oppose the Bill which is being promoted by the tramway syndicate, and which proposes to introduce the overhead system of electric traction.

Llanelly.—Mr. J. C. Howell has successfully carried out his experiment of lighting New Dock-road by arc lamps, and it is possible now that the Town Council will look more favourably on Mr. Howell's proposal to light the whole town with electricity.

Wednesbury.—At the meeting of the Town Council a copy of the Birmingham and Wolverhampton General Tramways Company Bill was received and referred to the Highway Committee, the town clerk being empowered to call a special meeting if necessary.

Uruguay.—The electric light station in Salto will soon be finished. The machinery will arrive from Germany during the current month, and when this is at work, together with the plant already laid down, the station will have a capacity of 4,000 16-candle lamps.

Cycle Electric Lamp Company, Limited.—This Company has been registered, with a capital of £30,000 in £10 shares, to acquire various patents and to carry on the business of electricians, electrical engineers, mechanical engineers, suppliers of electricity, cycles, motorcars, and vehicles, etc.

Berlin (Conn.).—Contracts have been signed for the construction of an immense electric power station at Berlin, from which trains on the Berlin and Middletown branches of the New York, New Haven, and Hartford Railroad and on the New England tracks from New Britain to Hartford will be operated.

Birmingham.—At a meeting of the Birmingham and Midland Institute Scientific Society recently, a paper was read by Mr. A. E. Briscoe (head of the electrical engineering department of the Battersea Polytechnic) on "The Largest Magnet in the World." The paper dealt with the magnetism of the earth.

Lamp Filaments.—The most expensive product in the world is said to be charcoal thread, employed as filaments for incandescent electric lamps, which, in the shape of filaments for 30-c.p. lamps, is worth over £3,000 per pound. It requires 1,500,000 of these filaments to make a pound, and their total length would be 187 miles.

Notice of Removal.—Messrs. W. McGeoch and Co., electrical engineers, who ask us to state that they are not connected with any other firm in London, are removing their London showrooms from 10, Berners-street to 11, Charing Cross-road, W.C., and an advertisement announcing this and other facts of interest is to be found in another part of this issue.

Analysing with the Rontgen Rays.—Analysis of food is enlisting the services of Röntgen rays for the discovery of adulteration. In pictures so obtained of powdered materials thinly scattered on a sheet of glass, the presence of any of the mineral adulterants commonly used is plainly visible, on account of the rays not being able to penetrate them.

Glasgow.—The Tramway Committee of the Corporation, after considering the offer by Sir William Arrol and Mr. G. Johnston to equip free of expense a section of the local tramways with motorcars, have decided not to accept the offer. It is understood that a number of members of the committee favour a scheme of electric traction by means of overhead wires.

Algeria.—Telegraph lines are being steadily extended in Algeria. One has just been erected between Wargla and Ghardaia. The latter post had previously been connected by telegraph with Tugurt. The southern posts of El Golea, Ghardaia, Wargla, Tugurt, Biskra, and El Wad are now connected. Next year Southern Oran will be the scene of operations.

Railway Signalling.—It is stated that the electrical system of railway signalling invented by Mr. W. S. Boult is now being tested in daily working on the Manchester, Sheffield, and Lincolnshire Railway. Mr. Boult avoids one of the usual troubles with electric signalling apparatus by placing his contacts inside a closed box and working them with an electromagnet.

Improved Lighting Syndicate, Limited.—This syndicate has been registered, with a capital of £5,000 in £1 shares, to acquire any patents, inventions, etc., relating to improvements in apparatus for the generation and distribution of lighting or illuminating power of any nature and description whatsoever.

Ealing.—Mr. Rienzi Walton has held a Local Government Board enquiry concerning an application by the District Council for permission to borrow £24,000 for sewerage, electric lighting extensions, and other purposes. The item for electric lighting amounts to about £4,000. These extensions include additions to the installation works, new mains, and house connections, and a number of minor matters.

Canterbury.—The Town Council have resolved to apply to the Local Government Board for sanction to expend a sum of £23,000 in laying down municipal electrical works in the city. Mr. Robert Hammond, by whom the scheme was prepared, mentioned that out of 115 electric light undertakings in England 66 were in the hands of municipal authorities, the capital invested amounting to about £3,000,000.

An American Submarine Torpedo Boat.—The Holland submarine torpedo boat, for which the American Government some time ago appropriated the sum of 150,000dol., has been launched at Baltimore. This boat is cigar-shaped, constructed of steel, propelled and lighted by electricity, and is designed to fire torpedoes under water. The boat can dive and remain under water for hours together, being supplied with condensed air.

Salford.—At the meeting of the Borough Council a question was asked by Mr. Jackson as to the terms of supplying electricity to the Lancashire and Yorkshire Railway Company. It was stated that the Electric Light Sub-Committee had decided the price charged for the supply of electric current for lighting purposes should be reduced from 6d. to 4d. per unit, and the price of the current for motive power from 3d. to 2d. per unit.

Altrincham.—The notice and plan deposited by the Manchester Carriage and Tramways Company having been considered, the Council decided to oppose the application for a provisional order to establish a tramway on the ground that the scheme would seriously interfere with the usual traffic, on account of the width of the streets, and also that the overhead system of electricity and the use of steam power for traction would be objectionable.

Storage Cells.—The Electrical Power Storage Company, Limited, give notice that in consequence of the great increase in the cost of raw materials, it becomes necessary to advance the prices of E.P.S. storage cells. The prices are, therefore, increased as and from January 12, 1897, by about 5 per cent. All estimates based on the old prices, the acceptance of which does not reach the firm by the 12th inst., will be cancelled. A new catalogue will be issued shortly.

Yardley.—The Rural District Council have before them an application from the City of Birmingham Tramways Company for power to extend the tramway at Sparkhill from the present terminus at the top of the hill to a point on the Stratford-road, three quarters of a mile farther from the city, and to extend the Coventry-road tramway from the present terminus near the park to the Church-road, Hay Mills, a distance of 1½ miles. In both cases it is proposed to lay down double lines.

Belfast.—Councillor Jaffe stated at the Corporation meeting that last year there was a profit of £381 on the electric lighting undertaking after providing for interest. They had spent in building, in machinery, and in laying mains £35,053 up to December 29 last. They had received £25,000 from the gasworks and £10,000 from the bank. The total amount of electricity sent out was within £3 of £4,000, and the cost of generating this was £2,500. They hoped to have the steam-driven station ready for next winter.

A New Junction-Box.—We have received a circular giving full particulars, with plan, elevation, and section, of the Jeckell patent junction-box, which has already been illustrated and described in our columns. By the use of this box the advantages of laying cables on a draw-in system are combined with the advantages of direct-buried cables. Up to the present there has been no easy and satisfactory means of taking off house connections from cables if laid in cast-iron pipes. This joint-box is designed to supply this want.

Penarth.—A local daily paper is informed that the syndicate which is promoting the electric railway being desirous of being authoritatively advised as to whether there are engineering difficulties in connection with the scheme which would be in any way prejudicial to the Cardiff Municipality, has taken the opinion of Messrs. Kincaid, Waller, and Manville. The syndicate has been advised that with the arrangements as set forth by Mr. Atkinson all the objections raised by the borough engineer can be satisfactorily met.

Brierley Hill.—At the Urban District Council meeting the General Purposes Committee reported that they had received a copy of the Bill coming before the next session of Parliament to incorporate certain tramways, including the Dudley and Stourbridge tramways. A sub-committee was appointed to go through the Bill and report thereon. The Lighting Committee reported that they had had the question of electric lighting before them, and they proposed that a special meeting of the Council be held to fully consider the subject.

Catalogue.—We have received from Mr. A. W. Richardson, Patricroft, near Manchester, a copy of his latest "I. R." arc lamp catalogue. This lamp is a differential direct-acting one, having a simple yet positive and sensitive feeding arrangement which acts

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upon the carbon direct. This feeding arrangement is actuated by a pair of solenoids of a large area, the cores of which are attached to a rocking lever which works the centre tube to which the feeding gear is fixed. This gear is fitted in a box below the lamp bottom plate and so protected.

Cardiff.—The introduction of the motorcar into Wales was marked on Saturday by a slight accident. One of Thorneycroft's horseless carriages had been purchased for conveying ships' stores and similar material from Cardiff to Barry Dock, and had been brought by road from London. When near Cardiff Infirmary Mr. W. Duncan, the secretary to the purchasing company, in attempting to remount the car while in motion, slipped, and before the carriage could be stopped Mr. Duncan had one of his big toes crushed, and amputation was necessary.

Tunbridge Wells.—Enquiries as to penny-in-the-slot meters for household electric lighting, and also as to possible supply of electricity for motorcars in Tunbridge Wells and Southborough, are being considered by the Lighting Committee of the Town Council. The Trades Council having complained to the Corporation of the alleged long hours of labour of the employés in the electric light works, additional men have been engaged in the hope that this would remove further cause of complaint. The electric lighting is being extended in all parts of the borough.

The Telephone Workers' Dispute.—With regard to the dispute among the outdoor employés of the National Telephone Company in Leeds and other centres, it is expected to be amicably settled before long. As a result of the conference of representatives in Leeds, certain decisions were arrived at or suggestions put out by the company. A statement embodying these decisions was prepared and forwarded to the head offices of the Gasworkers and General Labourers' Union in London to receive the approval of the executive before being submitted to the company.

Clontarf.—With regard to the proposed extension of the tramway company's line in the Dollymount district, a letter was read at the meeting of the Township Commissioners from Mr. Anderson offering £1,000 for the widening of the high road. Mr. Bonass proposed a motion, of which he had given notice, binding the Board not to accept less than £150 a year per mile for wayleave to the company. However, Mr. Bonass's motion was not seconded, and consequently fell through. The whole question is already in the hands of a committee, and no action was taken.

Wood Casing.—Mr. J. Skegg, of 231, Oldfield-road, Salford, has forwarded us a specimen of his new wood casing. It takes the form of a moulding going round the top of the walls, and is made in two parts. The upper contains the wires, and rests on the lower, which is an ordinary bracket section moulding. The idea is to put the casing in a slot, where it will be free from possible injury, and yet leave it easily accessible. There might be a little trouble in fitting it to a room already provided with a cornice, but otherwise the idea is not a bad one. The casing has been passed by the Phœnix Company.

Plymouth.—A wreck enquiry has been held at Westminster concerning the damage caused by the explosion of a comparatively small quantity of Dicks's anti-fouling composition to the cableship "Scotia," belonging to the Telegraph Construction and Maintenance Company, on October 8 last, near the Eddystone Lighthouse. Mr. Francis R. Lucas, engineer-in-chief to the company, said he was in charge of the expedition, which was going out to lay the new German cable from Vigo to Borkum. His theory was that the full drum got adrift during the gale and became damaged, causing the paint to leak out.

Sale.—At the meeting of the District Council the proceedings of the special committee appointed to consider the proposed tramway scheme of the Manchester Carriage and Tramways Company from Stretford to Peel Causeway were read. The committee, after carefully considering the proposals of the company, recommended the Council to dissent from the application, particularly in regard to the electrical overhead wire system, mechanical haulage, and the attachment of any kind of apparatus whatever to any house or building in connection with the aforesaid system of haulage. The recommendations of the committee were adopted.

Carbon Boride.—Carbon boride, it is stated in the *Journal* of the Franklin Institute, is a new compound of the electric furnace, obtained by H. Moissan, by the heating action of the current in a suitable mixture of boracic acid and carbon. The mode of production is strictly analogous to that of the well-known substance carborundum, or carbon silicide, made by heating in the electric furnace a mixture of silica and carbon. The new product is reported to possess a degree of hardness superior to that of the diamond, which it readily cuts, and to have the great advantage that it is possible to produce it in pieces of any desired size.

Windermere.—During the reading of the Highway Committee's report at the Urban District Council meeting, Mr. Irving said Mr. Fowkes had by agreement arranged to supply electricity of 16 c.p. to the ordinary lamps, and at the junction of the roads near Cook's House he was to supply a lamp with 25 c.p. They might have observed that road was extremely well lighted, being the very best of any in the district. The reason for this was that Mr. Fowkes found there were difficulties in the way of supplying the one lamp with a light of 25 c.p. and others with 16 c.p., so not to break the agreement he had supplied the lamps the whole length of the road with 25-c.p. light.

Electric Mountain Railway.—The proposed electric rack railway to the top of the Jungfrau, in Switzerland, will be 7½ miles long, starting at Scheidegg, and of this distance about six miles would be in tunnel. Grades of 25 per cent. are proposed, and on the Eiger, the Mouch, and other points will be stations selected with regard to scenic features. The maximum speed on grades of 15 per cent. and more will be five miles per hour, and five to six miles on other parts. At the foot of the main peak of the Jungfrau an inclined elevator shaft would be operated by electricity, with a lift of 330ft. leading to the very submit. The estimated cost is £400 000.

Charing Cross and Hampstead Railway.—The Charing Cross, Euston, and Hampstead Railway Company, whose undertaking was sanctioned by Parliament in 1893, have deposited a Bill for next session to obtain an extension of time until 1901 within which to construct the line. According to the preamble of the Bill, only 401 shares have been issued in this Company, although the capital was offered to the public some time ago. In view of a further issue being attempted, the Bill seeks to authorise the directors to pay interest on shares out of capital at the rate of 3 per cent., provided that the aggregate amount of capital so expended does not exceed £85,000.

Bradford.—The Eccleshill District Council have authorised a deputation to enter into a provisional agreement with the Bradford Corporation for the extension of the tramways to Eccleshill on the basis of a 5 per cent. income on the capital outlay. The Corporation have just deposited in the Private Bill Office of the House of Commons for consideration during the ensuing session a "Tramways and Improvement" Bill. The measure will give the Corporation power to raise money for the purpose of constructing tramways—£83 050—and will enable them to work the tramways themselves or by their lessees, and to use steam locomotive, cable, electric, or other mechanical power.

Bath.—A specially convened meeting of the Electric Light Committee has been held to consider the reply received from the Local Government Board as the outcome of the enquiry lately held by their inspector into the application of the Urban Sanitary Authority for power to borrow £58,000 for electric light purposes. The answer of the Whitehall authorities is that a loan of £45,000 is sanctioned for the purchase of the works (but for 20 years only instead of 30), the £13,000 required for the purposes of extensions is refused, and must be made the subject of a future and separate application, the proposed extensions being scheduled and definitely stated. There was a full attendance of the committee, and Mr. R. Hammond, the consulting electrical engineer, was present. The committee decided to take over the works on January 7.

South Shields.—A Local Government Board enquiry has been held by Major-General H. Darley Crozier, R.E., respecting the application of the Council to borrow a further sum of £7,500 for the extension of the electric light in the borough. There were present Aldermen J. M. Rennoldson (chairman of the Electric Lighting Committee), Wardle, and Scott, and several councillors. It was explained that the £7,500 would provide for an installation twice the size of that at present in existence, and would give them a double duplicate capacity. Mr. Jeckell, electrical engineer, said at present they had 14 arc lights and 17 more were in course of erection. They had connected 3,679 incandescent lamps besides, and between 600 and 700 additional lamps have been applied for. At the termination of the enquiry the commissioner visited the station.

Liverpool.—At the meeting of the Chamber of Commerce, Mr. Bindloss mentioned that the complaints previously made about the delays on the telephone trunk line had been very much accentuated since the Government took over the lines from the company. Business, especially with London, was almost entirely neutralised by the unusual delay in getting into communication, the delay amounting in some cases to about two hours. The cause, they understood, was that the present poles were unequal to carrying any more wires. A number of firms had found the telephone absolutely and entirely useless for the furtherance of their business, and had reverted back to the old telegraph service. The Government had intimated to a firm that to give them a wire for their sole use it would cost £1,450 a year and a guarantee for five years.

Carlisle.—At the meeting of the Health Committee Mr. Buck expressed the opinion that the Health Committee ought to have an opportunity of discussing the tramway scheme before it came before the Council. The Town Clerk said the matter would come before the General Purposes Committee next week. Mr. Buck could have a copy of the report when it was printed. The General Purposes Committee acted as a parliamentary committee. At a meeting of the members of the Carlisle branch of the Independent Labour Party recently the following resolution was passed unanimously: "That it is the opinion of this meeting that the Town Council should strongly oppose the advent of any tramway company into Carlisle, and, further, that the Council is the proper authority to own and manage a tramway system; also that the question of the introduction of a system of trams be referred to the citizens at the earliest opportunity."

Coventry.—A Bill "to incorporate the Coventry Electric Tramways Company and to empower that company to make and maintain tramways" has been deposited for introduction into Parliament during the ensuing session. Under this Bill Captain Francis Pavy, Mr. Theodore Martesdorf, Mr. Edmund Alfred Hopkins, and Mr. E. B. d'Erlanger, and "all other persons who may hereafter subscribe," are incorporated into a company with power to construct over 6½ miles of electric tramways at Coventry upon the overhead trolley system. The capital of the company is proposed to be fixed at £105,000, with power to borrow on mortgage of the undertaking a further sum of £35,000. By Clause 58 power is sought to enter into agreements with the Coventry Electric Tramways, Limited, for the acquisition of their system with which the proposed tramways will connect. The first directors of the company are to be the promoters above named.

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Dundee.—At a meeting of the Chamber of Commerce, Mr. John Couper said that since the Post Office had taken over the trunk telephones the system had not been working satisfactorily. When three minutes' conversation elapsed parties were switched off, and it frequently happened that a conversation was left unfinished. If the Post Office were to make the three minutes the standard for regulating the charges, he thought it would be better if they would simply charge so much more for another three minutes, and maintain the connection till one or other of the parties called off. It was very vexatious and annoying to be disconnected when a conversation was not finished. That the matter was not beneath the attention of the Chamber was proved by the fact that other chambers of commerce had taken it up, and he suggested they should add their complaints to those of other chambers of commerce. Mr. J. Ogilvy, the president, said there was a good deal of truth in what Mr. Couper had said, and he thought facilities should be provided for a party speaking longer than three minutes if he so desired. He had no doubt that the directors would be glad to make a representation with the object of having the system placed on a more satisfactory footing.

Bedford.—At the meeting of the Urban Sanitary Authority, the Electric Light Committee recommended: "(*a*) That as an equivalent for discount for cash new lamps be allowed to consumers gratis after the rate of one lamp for every 15s. paid for electrical energy supplied by the Corporation. The consumer will have the privilege of selecting from the following sized lamps—viz., 8 c.p., 16 c.p., 25 c.p., or 32 c.p. In order to obtain this abatement an equal number of old lamps must be returned and the accounts paid by March 1 and September 1 in every year. The committee consider it advisable to give new lamps by way of discount instead of cash, because by the adoption of this method lamps will not be used beyond their efficient life. That this arrangement come into effect December 31. (*b*) That the bills from the Bedford Volunteer Fire Brigade as to electric lamp be not paid. (*c*) That the application of Mr. J. G. W. Aldridge, of London, to run electric cars in the borough on the terms suggested by him be not entertained. (*d*) That notice be given to the Bedford Gaslight Company to remove all gas standards from the public streets rendered unnecessary by the additional electric lamps which will be lighted on January 1 next, and comprise 39 police lamps and 95 ordinary lamps. The number of lamps displaced will be 118." After a long discussion the report was adopted.

Edison and Swan Company.—The issue is announced at par of £200,000 4 per cent. debenture stock, forming part of a total amount of £350,000, for the purpose of extending the business of the Company, with which has been recently amalgamated the business of the Manchester Edison-Swan Company, Limited, and also for redeeming at £10 per cent. premium the £100,000 4½ per cent. debenture stock issued by the Company in 1994. Of the present issue £90,000 is now offered for subscription at par to the shareholders of the Edison and Swan United Electric Light Company, Limited, and of the Manchester Edison-Swan Company, Limited, and £110,000 to the holders of the existing 4½ per cent. debenture stock, in exchange, at their option, for their respective holdings of such stock, provided that application either to subscribe or convert be made on or before January 15, 1897. Holders of the existing 4½ per cent. debenture stock have the option, by giving notice on or before January 15, 1897, to convert their existing stock into the new 4 per cent. stock, receiving for each £100 of their present holding £110 in the new stock, carrying interest from January 1, 1897. Shareholders subscribing will be required to pay 20 per cent. on application, 20 per cent. on allotment, 30 per cent. on March 1, 1897, and 30 per cent. on June 1, 1897, interest accruing on the amounts as paid up. The interest will be paid on January 1 and July 1 in each year, the first payment to be made on July 1, 1897. After June 30 next all interest on the existing 4½ per cent. debenture stock will cease, and certificates must be deposited at the office of the Company at least three clear days before that date.

Hastings.—At the meeting of the Town Council Councillor Hutchings moved: "That the Council hereby places on record its dissatisfaction at the very inefficient manner in which the Hastings and St. Leonards Electric Lighting Company have carried out their contract for the lighting of the front-line, and is of opinion that the said contract should, if possible, by arrangement with the company, be cancelled as soon as practicable, and that this latter question be referred to the Public Lighting Committee, with power to act." Mr. Hutchings said the present contract between the Council and the electric light company was entered into on July 1, 1894, for three years, and might therefore expire about the middle of the year upon which they had just entered. Almost from the very first serious complaints had been made. The company had, of course, had accidents, such as the bursting of a boiler, but the Council were informed that all the appliances were duplicated. Councillor Larcombe seconded. Alderman Bradnam said the Council had only itself to blame for the failure of the light by the removal of the Whitehall lamps. He did not think the company wanted to take advantage of the town. The borough certainly would not be ready to take up the lighting before the contract expired. Councillor Sutter, whilst admitting that the electric company had carried out their duties in a very inefficient manner, moved, as an amendment, that the company be asked to adhere to the terms of its contract. He believed the company were anxious to carry out the contract they entered into with the Council. The directors were honourable men, and did not want to take advantage of the ratepayers. If the motion was carried and sent back to committee it would mean a lot of time wasted. After a discussion, the amendment was carried.

Dudley.—A circular setting forth proposals for the purchase of the Dudley and Wolverhampton Tramway has been issued to the shareholders, and a meeting will be held at Westminster to-day (Friday) to consider the matter and to hear statements from the directors. One proposal is to sell the property to a syndicate at such a price as will pay all the present liabilities of the company, return to the debenture-holders the full amount due to them for principal and interest, and leave at least 7s. 6d. in the pound for the shareholders. Having regard to recent earnings on the line, and the present market price of the shares (now quoted in the share list at 4s. 6d. to 5s.), the terms offered, it is believed, will be readily accepted. The provisional agreement is conditional upon the purchasers obtaining the consent of the local authorities, as well as upon their obtaining parliamentary powers for the conversion of the line into one to be worked by electricity instead of steam, as at present. There is also a condition that the intending purchaser shall obtain the requisite authority to construct the additional lines, which they consider necessary for an efficient public service. The syndicate have deposited a Bill for obtaining these powers in the ensuing session of Parliament, and "the line is to form an integral portion of a great system of tramways for the whole of South Staffordshire, as the purchasers are engaged in a similar negotiation with all the tramway companies in the district." It is said that the arrangement has the support of the holders of more than one-half of the company's capital. The line was opened about 14 years ago, and the initial cost was said to be about £90,000. It is laid from Dudley to Wolverhampton through the populous districts of Gornal and Sedgley. The trams were run by horses, but as the results were unsatisfactory the line was relaid, and worked by locomotives. The concern was subsequently sold by auction at Tokenhouse-yard, London, about five years ago, for about £11,000. The property was afterwards acquired by the present company with a capital of £22,796; but no dividends have been paid. Last year's report showed a loss of £43. 18s. 6d. on the 12 months' working.

Hackney.—A year and a half ago the Vestry invited electrical engineers to send in schemes and plans for lighting the borough by electricity. Eventually those of Mr. F. Hastings Medhurst, of Victoria-street, Westminster, were selected, and his proposals included a scheme for the destruction of dust and the lighting of the principal thoroughfares at a cost of £80,000. The Electric Lighting Committee adopted the scheme, but the Vestry referred it back for further report, and there, so far as the Vestry is concerned, the matter now stands. Mr. Medhurst has written to the Vestry to say that so certain is he of the success of his scheme that he was prepared to construct the whole of the necessary buildings and not to charge the Vestry until the success of the scheme had been assured. Mr. Medhurst stated that he considered he had been appointed electrical engineer to the Vestry, and that he would be entitled to 5 per cent. on the first £20,000 and 4 per cent. on the remainder. It is not true that he has threatened the Vestry with legal proceedings. The whole question is still before the Electric Lighting Committee, and until they report to the Vestry nothing can be done. Mr. Baldock has handed in the following notice of motion for consideration at the next meeting of the Hackney Vestry: "That, in consideration of the large and continually-increasing amounts paid by the Vestry for horse hire and carriage, and with a view to facilitate the work of 'slopping and dusting' being undertaken entirely by the Vestry without the intervention of a contractor, it be referred to the General Purposes Committee and to the Sanitary Committee jointly to report as early as may be (*a*) as to the practicability and possible economy of employing for the purposes of the Vestry carts and vans driven by electric or other automatic motors; (*b*) as to the advisability of fitting suitable motors to the water-carts and other vehicles at present the property of the Vestry; (*c*) as to the advisability of the purchase by the Vestry for experimental purposes of a motor van or vans of the most approved pattern designed for the collection of refuse and scavenging. And, further, that the said joint committee be and is hereby authorised to obtain all such necessary estimates, plans, drawings, and specifications as will enable the fullest possible information (specially as to the probable capital outlay and cost of maintenance) being embodied in the report for the guidance of the Vestry."

Halifax.—At a special meeting of the Halifax Town Council the following resolution previously passed by the Council was confirmed: "That the Council do apply to Parliament in the next session thereof for a Bill for the following purposes—*i.e.*, (1) To empower the Corporation to construct, lay down, and maintain tramways in the following streets in the borough of Halifax—namely, Church-street, Horton-street, Wards-end, Commercial-street, George-street, Silver-street, Bull-green, King Cross-street, King Cross-road, Commercial-street (north end), New Crown-street, and Gibbet-street; to empower the Corporation to work the said tramways or any portion thereof when constructed; to empower the Corporation to work the said tramways either by animal or by steam or electrical, gas, cable, or any other power; to enable the Corporation to make and maintain stations for generating electrical, cable, or other power on lands belonging to the Corporation, or on land to be acquired for that purpose; to empower the Corporation to levy tolls, rates, and charges for the use of the proposed tramways and for the conveyance of traffic upon the same. (2) To authorise the payment of the costs, charges, and expenses, preliminary and incident to the applying for, promoting, and passing such Bill into an Act out of the funds and rates leviable by and under the control of the Corporation. A meeting of the burgesses, convened by the Mayor,

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who presided, took place afterwards in the Mechanics' Hall. There was a large attendance, and the members of the Town Council, with but few exceptions, occupied seats on the platform. The Mayor proposed: "That this meeting does approve of the resolution passed by the Council to promote a Bill in the next session of Parliament to lay down and work tramways in the streets named in the Town Council's resolution." He expressed a hope that the resolution would be passed without opposition, and that soon the public of Halifax would have the blessing of tramways. Alderman M. Booth seconded the resolution. He pointed out the necessity for tramway facilities to the suburbs of the town, and he hoped that they would ere long be able to extend the scheme to the out-districts. There was a feeling that immediately they got the present scheme into working order they must go in for traversing the whole of the suburbs with tramways. He was convinced that the scheme would be a paying one. Although the Tramways Committee had not yet considered the question of haulage, he for one believed there was only one system—namely, electricity. The resolution was then put and carried unanimously.

Johnson and Phillips.—During the past year all the departments of this firm have been uniformly busy. The manufacture of alternators, dynamos, transformers, and central-station accessories has surpassed that of previous years. The firm have been very busy on several large contracts, which include transmission of power plants for South Africa, alternators for St. Helens Corporation, Tunbridge Wells, Hong-Kong, Aberystwyth, and the station plant for the Cape Town and Suburban Electric Lighting Company. Several transformers of 120 and 100 kilowatts are being constructed, the sizes on order varying from this to half a kilowatt. In the cable machinery department the contract for the full equipment of his Imperial Japanese Majesty's telegraph steamer "Okinawa Maru" has been completed, including all necessary machinery with accessories and stores. This was followed up by a similar though somewhat smaller contract for the complete equipment of machinery, stores, etc., for the telegraph steamer "Tutanekai," for the New Zealand Government, and the department has now in hand a large contract, including the transformation of a merchant vessel into a cable-laying steamer, and installing the necessary cable tanks and all machinery, accessories, and stores. In addition to the above, a great many orders have been executed for cable-making and wire-covering machinery. The arc lamp department has been very busy during the last 12 months, more especially at the latter end of the year, when the orders have been very heavy and much in excess of previous years. Amongst other large orders which have been received for lamps are the following: the London and North-Western Railway Company, Halifax and Manchester Corporations, Barry Railway Company, Shoreditch, Hammersmith, Chester, Aberystwyth, Durban, Edinburgh General Post Office, London General Post Office, Liverpool Corporation, Natal, and Western Australia. A large business has also been done in carbons. The cable department has been chiefly occupied with the manufacture of vulcanised rubber cables for wiring purposes and underground use, as well as a large quantity of single mains for various towns at home and abroad. Owing to the expanding business of this department, new cable offices and shops have been erected, necessitating a large increase of staff and workmen, and new machinery of the latest description has been laid down. In the meter department there has been no lack of orders. Besides the demand for the usual sizes of meters up to 200 amperes, there has been a very large increase in the sale of these instruments of 300 to 800 amperes capacity. The firm hope shortly to introduce a new alternating-current supply meter, in regard to which they prophesy great things

Derby.—The Electric Lighting Committee reported at the Town Council meeting that they had at some length taken a review of the origin, progress, and present circumstances of the undertaking, and were of opinion that it was a sound commercial business with a steadily increasing revenue, and that the Council might congratulate itself upon the present position thereof, especially when bearing in mind the fact that the initiation of the business was somewhat forced on by pressure from without. The report continues: "In considering the rapidly decreasing item of deficiency on revenue account (a deficiency being quite inevitable during the infancy of an undertaking like this), the committee must remind the Council that this deficiency is chiefly caused by the payments annually made to the sinking fund towards the redemption of the capital of the undertaking, whilst at the same time full charges are made for the annual cost of keeping the whole of the machinery, works, etc., in thorough repair. Shortly speaking, the committee are of opinion that if the undertaking were looked at on company lines there would be a dividend for the year ending March 31, 1896, the total credit to the net revenue account amounting to nearly 5 per cent. on the capital. This, after but about 2½ years of our working, cannot be regarded as unsatisfactory. In coming for a vote for more money the committee desire to remind the Council that on February 5, 1896, a vote was passed granting £5,443. 18s. 8d., the estimated expenditure on capital account for the year ending March 31, 1897. This sum has been borrowed under sanction of the Local Government Board, and has been expended, with the result of an increase of revenue commensurate with the outlay. The committee now find that unless preparations are made at once they will be unable to cope with the demand upon them during the winter of 1897-8. The committee have for some time past had under their consideration the question of providing for extension of the plant to meet the estimated increase of demand during the three years following March 31, 1897. At present 16,100 lamps are connected to the mains, and it is anticipated that during the next three years there will, at the very least computation, be a demand for 8,000 more lamps. To meet this demand the committee are advised by Mr. Stewart, their engineer and manager, that it will be necessary to put down new machinery and plant, and he estimates the cost as follows: machinery, etc., £10,250; mains and services, etc., £8,650; buildings, £450; accumulators, etc., £650—total, £20,000. The above calculation is made merely to meet the normal increase of the business, the committee being desirous of taking the least sanguine view of the position of affairs. It probably will turn out, and the committee hope that such will be the case, that the increase of business will be such as to render the vote for the next three years now asked for inadequate. If such an abnormally favourable state of things should come about, the committee will, of course, again apply to the Council with the facts and estimates to meet such increase. The accounts up to March 31, 1896, are in the hands of the members. A special abstract of the same has been prepared as applicable to the electric lighting undertaking, and is sent herewith. For the information of the Council the committee can say that for the purpose of giving an indication of the progress of the business they have examined the returns since March 31, 1896, by comparing the corresponding days of the previous year, and they find that such comparisons are favourable, and show a satisfactory and steady increase in the consumption of electricity. The committee therefore recommend the Council to grant the sum of £20,000 for the purposes above indicated, and also to direct that application be made to the Local Government Board for sanction to borrow the amount. The committee greatly regret the continued illness of their chairman, whose services they are unable to make use of on this occasion." After a protracted discussion the question was deferred for the purpose of ascertaining the position of the committee, with regard to the engineers and other matters.

PROVISIONAL PATENTS, 1896.

DECEMBER 21.

29306. Improvements in secondary batteries. Albrecht Heil, 55, Chancery-lane, London. (Complete specification.)

29307. Improvements in peroxide of manganese and carbon electrodes and in the method of producing the same. Albrecht Heil 55, Chancery-lane, London. (Complete specification.)

29325. Means for attaching and detaching electric light globes. Frederick William Mayer, 45, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents, etc.. Act, 1883. Sec. 103, June 26, 1896, being date of application in United States.) (Complete specification.)

DECEMBER 22.

29379. An electric arc lamp for scientific, photographic, and projective purposes, kinetoscopes, etc. Francis Edward Beaumont, 10, Summer-street, Fenton-road, Halifax.

29472. Improvements in electric switches. P. R. Jackson and Co., Limited, and Joseph Slater Lewis, 322, High Holborn, London.

29473. Improvements in or relating to armatures for dynamo-electric machinery. P. R. Jackson and Co., Limited, and Joseph Slater Lewis, 322, High Holborn, London.

29498. Improvements in or connected with the distribution of electricity from a common generating plant for supplying simultaneously current both for traction and for lighting or lighting and power. Alexander Bewicke Blackburn and Ernest S. Woollard Moore, 47, Lincoln's-inn fields, London.

29499. Improvements in alternating-current motors. Alexander Heyland, 47, Lincoln's-inn fields, London.

DECEMBER 23.

29524. Improvements in incandescent electric lamps Thomas Archer Rose and Rose and Bird, Limited, 24 Stamford-street, London.

29527. Improvements connected with the circulation of liquors used in electro-deposition and other analogous processes. Alfred Horswill Gibbings, 15, Water-street, Liverpool.

29565. Improvements in fusible cut-outs for electric circuits. William Edwin Heys, 70, Market-street, Manchester. (Arnold von Wurstemberger, Germany.)

29574. A new galvanic element and exciting and depolarising liquids therefor. Charles Denton Abel, 28, Southampton-buildings. Chancery-lane, London. (Constantin Nikolajewitsch, Seidneff, Russia.) (Complete specification.)

29576. Improvements in or relating to electric furnaces. Wilson Walter Hughes, 111, Hatton-garden, London.

29614. An improved electromagnetic contact-maker for electric traction with underground feed. Reginald Haddan, 18, Buckingham-street, Strand, London. (Leon Piguet, France.) (Complete specification.)

29615. Improvements in and relating to electric contact-bars for electric cars. Reginald Haddan, 18, Buckingham-street, Strand, London. (Leon Piguet, France) (Complete specification.)

29620. An improved method of and apparatus for the production of light by means of electricity for signalling, theatrical effects, and similar purposes. Vladimir Tabulewitsch, 11, Southampton-buildings, Chancery-lane, London.

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29613. Improvements in and relating to incandescent lights. Albert Rammoser and Alfred von Hake, 18, Buckingham-street, Strand, London. (Complete specification.)

DECEMBER 24.

29643. Improvements in insulated electric cables. Isidor Frankenburg, Greengate Rubber Works, Salford.

29651. Improvement in treatment of transparent paper parchment cloth or other transparent materials for shades for electric or other lights, also for window transparencies, lanterns, etc. Thomas Edward Cowburne, 17, The Vale, Blackheath, Kent

29658. An electrical route director to call the attention and direct drivers of vehicles of every description. John Colquhoun Taylor and John Albert Thomas Trim, 45, Pellett-road, East Dulwich, London.

29702. A prepaid electric meter. Alfred Soames and Charles William Scott Crawley, 16, Red Lion-street, Clerkenwell-street, London.

29714. Improvements in electric railways. Addison Norman, Villiers Sankey, and Douglas Ponton, 24, Southampton-buildings, Chancery-lane, London.

DECEMBER 28.

29784. Improvements relating to electric traction on the surface-contact system. James McKenny and Thomas Edward Doyle, 116, Stephen's-green West, Dublin.

29804. Improvements in or connected with apparatus for propelling fans or other machines or appliances by means of electricity. James Henry Pickup, William Oswald Pickup Thomas Henry Ashworth, and Richard McClellan, 47, Lincoln's-inn fields, London.

29831. Improvements in current collectors for electric railway or tramway cars with overhead conductors. Siemens Bros. and Co., Limited, 28, Southampton-buildings, Chancery-lane, London (Siemens and Halske, Germany.)

29837. An improved electric photographic time and position recorder, specially useful for races. Joseph Gaut, 77, Chancery-lane, London. (Complete specification.)

29843. Arc lamp for projection and other uses. Benjamin Joseph Barnard Mills, 23, Southampton-buildings, Chancery-lane, London. (Léo Boulade, Antonin Boulade, and Francisque Pascal, France) Complete specification.)

29866. Improvements in or relating to the electric control of gas. John Henry Kerridge 111, Hatton-garden, London.

DECEMBER 29.

29870. Improvements in electric lighting switches. John Henry Tucker, 16, Oozells-street, Birmingham.

29882. Improvements in motorcars, cycles, and other vehicles driven by electric, steam, oil, gas, or water power. Charles Provis, St. Peter's-square, Emsworth, Hants.

29883. Improvements in electrical ignition apparatus for petroleum and other lamps and candles. William Kaiser, 11, Southampton-buildings, Chancery-lane, London. (Complete specification.)

29907. Improvements in the manufacture and production of elements or plates for electrical storage batteries. Camille Brault, 47, Lincoln's-inn fields, London. (Complete specification.)

29919. Improvements in electric arc lamps. The British Thomson-Houston Company, Limited, 70, Chancery-lane, London. (Elihu Thomson, United States.) (Complete specification)

29923. Improvements in electric clock alarm and time indicator for billiard-rooms, hotels, and other places. David Fraser Laing, 115, St. Vincent-street, Glasgow.

29933. Improvements in controlling apparatus for electrically-propelled vehicles. The Honourable Reginald Thomas Dudley Brougham and Walter Charles Bersey, 24, Southampton-buildings, Chancery-lane, London.

29955. Improvements in commutator brushes. Aldred Kennedy Warren, 40 Chancery-lane, London.

DECEMBER 30.

29981. Improvements in and relating to electric accumulators. Alfred William Turner and Arthur Hiorns, jun., 67, Corporation-street, Birmingham.

29991. Improvements in the generation of gas by means of electricity from coal, oil, or other carboniferous matter. John Henrique Dunn, 28, Parkhurst-road, Wood Green, London.

30023. Sterilisation of water by electric currents of high tension and frequency. Emile Andreoli, 147, Cold-harbour-lane, London.

30024. Improved composition of filling material for electrolytical and galvanic purposes. Floris Wüste, 52, Chancery-lane, London.

30050. Improvements in the manufacture and production of flexible metal cables, bars, or the like, suitable for use as electric conductors or for other purposes. Henry Edmunds, 47, Lincoln's-inn-fields, London.

30061. Improvement in electrical connecting cords. Charles Hugh McEvoy, 18, Buckingham-street, Strand, London. (Complete specification.)

DECEMBER 31.

30088. Improvements in and connected with electric clocks. William Whitehead, 4, Corporation-street, Manchester.

30111. Improvements in street tramcars, especially for cable or electric cars. Andrew McGill, 4, South-street, Finsbury, London. (Complete specification.)

30113. Improvements in means for varying the speed of electric direct-current motors. Henri Pieper Fils, 47, Lincoln's-inn-fields, London.

30115 A new or improved method of and means for combining phonographs with electrical telephone circuits and vice versa. Theodore Van Heemstede Obelt, 1, Broad-street-buildings, Liverpool-street, London. (Complete specification.)

30123. Improvements in means of telegraphing or telephoning through long uninsulated or badly-insulated submarine or other submerged cables and in maintaining communication notwithstanding a break in the continuity of the conductor. Alfred Charles Brown, 129, Algernon-road, Lewisham, London.

30164. Improvements in electric accumulators. Méry de Contader, 46, Lincoln's-inn-fields, London.

SPECIFICATIONS PUBLISHED.

1895.

24398. Means for controlling or directing electric currents. Pollak.

24546. Manufacture or production electrolytically of coatings composed of earthy oxides Langhans.

1896.

306. Manufacture of electrical hot-plates and other electrical apparatus for cooking and heating purposes. Chambers. (Date applied for under International Convention, November 8, 1895.)

1888. Dynamo-electric machines. De Ferranti.

2051. Electrical resistance thermometers. Burstall and Burstall.

7140. Mechanism for driving clocks and dials by electricity. Joyce.

13250. Telephonic apparatus. Adams Randall.

20077. Primary batteries Boland, Hubbell, and Hubbell.

21960. Electric bells. Mohr.

24367. Conduits for electrical conductors. Lavens.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	7⅛-8⅛
Brush Company, Ordinary	3	½-1
—— Non. Cum., 6 per cent. Pref.	2	1-1¼
—— 4½ per cent. Debenture Stock	100	110-113
—— 4½ per cent. 2nd Debenture Stock	100	94-98 xd
Central London Railway, Ordinary	10	9⅞-10¼ xd
——	4	3¾-4 xd
Charing Cross and Strand	5	9⅛-9⅜
Chelsea Electricity Company	5	8⅛-8⅜
—— 4½ per cent. Debentures	100	112-115 xd
City of London, Ordinary	10	15¾-16⅛
—— 6 per cent. Cumulative Pref.	10	16¾-17⅛
—— 5 per cent. Debenture Stock	100	127-131 xd
City and South London Railway, Consolidated Ordinary	100	54-56
—— 4 per cent. Debenture Stock	100	136-138
—— 5 per cent. Pref. Shares	10	15⅛-16
County of London and Brush Provincial Co., Ordinary	10	8-9
—— 6 per cent. Cum. Pref.	10	13⅞-14½
—— 4½ per cent. 2nd Debenture Stock	5	9½-10⅛
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	1⅞-2⅛
—— 5 per cent. Debentures	—	93 98 xd
Edison and Swan United Ordinary	3	1⅞-2⅛
—— 5 per cent. Debentures	5	3-4
—— 4½ per cent. Debentures	100	105-110 xd
Electric Construction, Limited	2	1⅞-1⅞
—— 7 per cent. Cumulative Pref.	2	2⅛-3
Elmore's Copper Depositing	2	⅝-¾
Elmore's Wire Company	2	⅞-1
W. T. Henley's Telegraph Works, Ordinary	10	17½-18½
—— 7 per cent. Preference	10	18½-19½
—— 4½ per cent. Debentures	100	109-114
House-to-House Company, Ordinary	5	4½-5
—— 7 per cent. Preference	5	8⅞-9⅛
India Rubber and Gutta Percha Works	10	20⅝-21⅛
—— 4½ per cent. Debentures	100	105-108
Kensington and Knightsbridge Ordinary	5	10-10⅛
—— 6 per cent. Pref.	5	8-8¼ xd
London Electric Supply	5	1-1⅛
Metropolitan Electric Supply	10	12½-13⅛
—— 4½ per cent. First Mortgage Debenture Stock	100	119-122 xd
National Telephone, Ordinary	5	7⅛-7⅜
—— 6 per cent. Cum. First Pref.	10	17-19
—— 6 per cent. Cum. Second Pref.	10	17-19
—— 5 per cent. Non. Cum. Third Pref.	5	6⅜-7
—— 3½ per cent. Deb. Stock	100	106-108 xd
Notting Hill Company	10	10-11
Oriental, Limited, £1 shares	1	1⅛-2
—— £5 Shares	5	8⅛-9
—— £4½ shares	4½	7⅛-8
Oriental Telephone and Electric Company	1	11/16-13/16
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	103-105
Southampton Electric Company	5	4⅛-5⅛
St. James's and Pall Mall, Ordinary	5	12-13
—— 7 per cent. Pref.	5	9½-10⅛
Telegraph Construction and Maintenance	12	40-43
—— 5 per cent. Bonds	100	102-105 xd
Waterloo and City Railway, Ordinary	6	7⅛-8 xd
Westminster Electric Supply, Ordinary	5	11-12
Yorkshire House-to-House	5	7⅛-8

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NOTES.

St. Petersburg Academy.—The Russian Academy of Science has elected Lord Kelvin an honorary member, and Lord Rayleigh and Prof. Bury, of Dublin University, corresponding members. Dr. Simon Newcomb, of Washington, the American astronomer, was also elected an honorary member.

Sea and Land.—The American Postal Telegraph Company has been amalgamated with the Commercial Cable Company. It now only remains for the Western Union Telegraph Company to buy a cable or two. This is clearly a case where the fable of the alliance between the whale and the lion does not apply.

Society of Arts.—It is announced that on February 11 Prof. J. C. Bose will read a paper on "The Progress of Science Teaching in India" before the Indian section of the Society of Arts. The Cantor lecture this week is on pottery, and the Wednesday meeting on the Bazin roller-boat, Sir F. Bramwell in the chair.

The Physical Society.—The next meeting of the Physical Society of London is at 5 p.m. on Friday, January 22, 1897, at the rooms of the Chemical Society, Burlington House, for "An Exhibition of Some Simple Apparatus," by W. B. Croft, M.A.; and a paper "On the Passage of Electricity through Gases," by E. C. Baly.

Chemical Society.—A meeting of the Research Fund Committee will be held this month. Applications for grants, accompanied by full particulars, should be sent to the secretaries forthwith, to-day if possible. One of the papers at the meeting on January 21 is on the behaviour of chlorine under the influence of the silent discharge of electricity and in sunlight, by Mr. W. A. Shenstone.

Telegraphic Interruption. — A telegram from Melbourne states that telegraphic communication with Port Darwin, which was interrupted by a hurricane, has been restored. The date of the failure is not given. It will be interesting to notice whether this suspension of the inter-Colonial trans-Australian line gets entered in the monthly official list of interruptions on international lines.

The Midland Engineers.—The Midland Institute and the Chesterfield and Midland Counties Institute of Engineers will have a joint meeting at Sheffield on January 23, when papers will be read on "Electric Haulage at Pleasley Colliery," by Mr. Jonathan Piggford; on "By-products from Coke Ovens in Westphalia," by Mr. G. B. Walker and Prof. L. T. O'Shea; and on "A Shaft Enlargement," by Mr. H. E. Maltby.

Conjuring by Telephone.—According to a paragraph, apparently of American origin, which has been going the round of the papers, an Italian conjurer in Paris named Pagliani has been using the telephone with great success in connection with his art. In the description the apparatus is more or less impossible, and the feats do not seem so very wonderful after all. But conjurers usually do not wholly disclose the secrets of their mechanism.

The Junior Engineers.—The Institution of Junior Engineers meet on Friday, January 22, at 8 p.m., at the Westminster Palace Hotel, for a lecture on "Comparisons of Similar Structures, Large and Small," by Prof. A. Barr, of Glasgow. The twelfth anniversary dinner of the institution takes place at the Westminster Palace Hotel on Saturday, the 23rd inst., at 6.30 p.m. The president, Mr. A. R. Binnie, M.I.C.E., will take the chair.

Eureka.—Mr. Thomas Bennett has forwarded us an illustrated description of his cycle with a "Eureka" wheel. We promptly sent our cycle expert to Holborn to view and report. His report was that the machine was at St. Albans. As there is nothing electrical about it, that seemed a little too far. So far as the illustration goes, the thing is a perfect vision of wheels—there are about a score of them—and we do not think it will at all fulfil the hopes of the inventor.

Publications Received.—We have been forwarded a copy of *The Mariner*. It contains an article on liquid fuel, with an illustration of a Sigma-tube boiler to burn it in. There does not seem anything specially relating to electricity, or if there is the writer has missed it.—We have also to acknowledge the receipt of *Lean's Royal Navy List* for January (Witherby and Co., High Holborn). We have nothing which is not favourable to say of this list, but it has already been noticed in our columns.

Queensland Telegraphs.—The officers of the Post and Telegraphs Department of the Queensland Government have sent us a Christmas card. It is not just like other Christmas cards. All the officers of all the telegraphic and telephonic services have our best wishes, and we return them, in particular to the Hon. A. J. Thynne, Mr. J. Macdonell, Mr. J. Hesketh, and the rest of the Queenslanders. The record for the year in that colony is 1,055,000 telegrams, 9,979 miles of line, 17,790 miles of wire, 6 telephone exchanges, and 774 telephone subscribers.

Tanganyika.—Mr. J. E. S. Moore, who was sent out to Africa last year by the Royal Society, has discovered in Lake Tanganyika a large electric fish which gives a severe shock on being touched. The electric organs are contained in the skin. Tanganyika appears to be full of queer fish, and, moreover, contains things which ought to be in the sea, instead of in the middle of Africa. Mr. Moore seems also to have had the happiness of seeing an entirely new and hitherto undescribed species of crocodile and leopard fight. The Tanganyika may be recommended to fishermen in search of novelty, but not to bathers.

Faraday House.—Mr. James Swinburne, M.I.C.E., commences a course of lectures this week upon "Dynamo and Transformer Construction" to the senior students of the Electrical Standardising and Testing and Training Institution. As the result of the recent scholarship examination the following awards have been made by the Board of Control of this institution: to Laurence J. Kettle (Dublin University), a Maxwell scholarship, value 50 guineas, tenable for two years; to C. J. Simeon (Cheltenham College), an exhibition, value 30 guineas, tenable for two years; and to S. W. Humphery (private tuition), a prize of 10 guineas.

The Jungfrau Railway.—It will be remembered that plans and designs for the Jungfrau electric railway were put out for competition. In giving the result, the *Elektrotechnischer Anzeiger* remarks that out of 16 prizes, amounting in all to 30,000fr. (say £1,200), 22,300fr. have gone to Swiss and 6,300fr. to German firms, and the remainder to the only English and American competitors. The complete list is given elsewhere in our columns. From this it will be seen that the American has the German-looking name of Max Halder, and the English firm is Joseph Bernays, of London. The French and Italians do not appear at all in this international competition.

Telegraph and Telephone.—In an article on the conflict between the telegraph and the inter-urban telephones in Spain, *El Telegrafista Español* has expressed the view that it is a quarrel which will end with the death of one of the parties. The view of our contemporary is that the telephone is only a sort of telegraph, and should be so treated by the Government. The article is written in a

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lofty tone altogether, and concludes with a characteristic peroration. We shall not reproduce it, as that sort of thing does not sound so well in our workaday English as it does in Castilian. Whatever the Spanish telegraphic service may have to say for itself, or the public to say of it, there is no denying that its interests are well looked after from the journalistic point of view.

Paris Chamber of Commerce.—A deputation of the British Chamber of Commerce has been received at the Embassy by Sir Edmund Monson. It consisted of Sir Edward Blount (honorary president) and other officers of the Chamber, and was introduced by Mr. Austin Lee, commercial attaché. In the interview it was stated that one of the present aims of the Chamber was the reduction of telegraph rates between England and France, while another was the introduction of the metric system into England. Mr. G. P. Harding, president of the Chamber, also informed Sir Edmund Monson of the desire of the Chamber to be officially represented in any official body that might be formed to organise the British section of the Paris 1900 Exhibition, and the Ambassador replied that his co-operation might be counted on.

Conduit Electric Tramways.—After a sitting of two days the directors of the Metropolitan Traction Company, of New York, have confirmed their previous decision to equip all the remaining horse car lines under their control in New York with electricity. It seems hardly likely that the trolley will be permitted, and hence a conduit or sub-surface conducting system of some kind will in all likelihood be employed. What system will finally triumph is a matter of speculation, but the New York *Electrical Engineer* says "there is an *embarras de richesse* rather than a dearth of conduit systems from which to choose, each making claims to special advantages." Without backing the particular system which our contemporary favours, a trial of the conduit on a large scale in New York is an experiment which must be watched with much interest.

Central Stations in America.—By inadvertence of the writer, it was last week made to seem as though Mr. Max Osterberg's article calling attention to the steady growth of small isolated plants as compared with central stations in the United States originally appeared in the New York *Electrical Engineer* instead of in the *Engineering Magazine* for December. Mr. Max Osterberg is, of course, a distinguished contributor to our New York namesake, and his conclusions on the matter have caused some amount of discussion among American engineers. His article (correctly ascribed) was dealt with in our issue of December 11 before, of course, we had any opportunity of seeing what they would think of it on the other side of the Atlantic. It is satisfactory to note that the view of the subject taken there appears on the whole to coincide pretty closely with our own.

Electric Sounding.—Mr. F. Gwyn Griffith, of Llansanner House, Cowbridge, has invented and patented a new electrical sounding apparatus, and had it described in the *Western Mail*. There is a cone closed at the base with a copper diaphragm, which will bend. Through this passes a weighted rod which, when by contact with the bottom it is deflected in any direction, forms an electrical contact high up in the neck of the cone. This sets a bell ringing on board any part of the vessel to which the apparatus is attached. The difficulty hitherto in constructing electrical sounding apparatus has been to obtain a perfectly watertight compartment in which the electrical contact can be made, as the pressure of the water will enter any moving joint. So far as can be seen from the diagrams the insulated wires are taken into the air-chamber through a plug in the top of the cone.

Lugano Tramway.—The Lugano power line has once before been referred to in these columns. One of its interesting features is the application of polyphase currents to tramway work. In the *Elektrotechnischer Anzeiger* of 3rd inst. there are reproduced several illustrations, obviously from photographs, of the cars and machinery. These are, of course, outside views merely, and leave one nearly as wise as to details as before. The double trolley looks strange at first. The overhead trolley wires are carried on long iron brackets. These seem pretty close together, and, beyond the spacing on the bracket arm, there seems no special arrangement required to prevent occasional contacts between the two wires. The voltage on the line is 400, transformed from 5,000 on the transmission line. There are no details as to cross-overs or passing-places. Each motorcar carries a 20-h.p. polyphase motor. It is a 12-pole machine, and runs at 400 revolutions per minute—the cars going at something over nine miles per hour. The three-phase motor "all in" weighs about 16cwt.

The Channel Tunnel.—Although the Channel Tunnel Company, after its reorganisation, will retain "a sufficient capital to attempt the obtaining of the necessary legislative power to continue the trial works for the tunnel whenever the directors consider that public opinion is propitious to making such a demand with any chance of success," it may be taken as a result of Tuesday's meeting that the Channel tunnel is done with for the present. One can hardly regret it, if for no other reason because we shall hear no more of the insincere nonsense which was talked about a tunnel improving the friendly feelings between France and Great Britain. In the face of the fact that miles of land frontier, distinguishable only by painted posts, are quite incapable of ensuring mutual regard between neighbouring nations, it is absurd to think that one long tunnel or a dozen would affect that desirable result one way or the other. There are railway tunnels much nearer Charing Cross which are crying out for the adoption of electric railway traction without it being necessary to construct one under the Channel in order to force that subject to the front.

Turin Academy.—The Reale Accademia delle Scienze of Turin has announced that under the conditions of the Bressa Prize Trust a prize will be awarded to the scientific author or inventor, whatever his nationality, who, during the years 1895-98, "according to the judgment of the Royal Academy of Sciences of Turin, shall have made the most important and useful discovery, or published the most valuable work on physical and experimental science, natural history, mathematics, chemistry, physiology, and pathology, as well as geology, history, geography, and statistics." The term will close at the end of December, 1898. The sum fixed for the prize, deducting income tax, will be 9,600fr. (say, £384), and competitions must be sent in within the above-stated time, accompanied by a letter to the president of the academy. Books or memoirs must be in print, and manuscript copies will be rejected, and the copies will not be returned to unsuccessful competitors. None of the Italian members, resident or non-resident, of the Turin Academy can obtain the prize. Finally, the academy may award the prize to the most deserving scientific person, even if he does not enter for the competition.

Electricity at the Brussels Exhibition.—There has been published in *L'Electricien* a list of the prizes to be given in connection with the Brussels Exhibition of this year for new and improved apparatus or methods in electrical work. These are much too numerous for reproduction here or elsewhere, and the usual value of them is 500fr. (say, £20). A practical method of transforming chemical or heat energy into electric current is, however,

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considered worth three times that amount. Prizes of 1,000fr. are to be given for an electric lift for trucks and for electric brakes. A decent motor-vehicle is apparently considered of more value than a carbon-consuming battery, for the prize for this is 2,000fr. A similar prize is offered for the best self-propelled tramcar. The usual 500fr. is offered for a special form of rack-railway engine which would run normally as an ordinary locomotive, but could deal with short inclines. Improved voltmeters, wattmeters, and meters of all sorts, including an instrument giving a continuous record of the insulation of a system of wires or mains, have the same sum; and so also does almost everything that is wished for in connection with telephonic and telegraphic work, including a telephonic relay and an automatic switchboard for 20,000 subscribers on the single-wire and on the metallic-circuit system. Lastly, there is one prize for an improvement in lightning conductors.

The Wonders of Electricity.—Here is agriculture going or gone to ruin in Great Britain, and all for the want of a little technical knowledge. Our farmers simply did not know that they could get the really heavy part of their work done for nothing. "So far back as 1881 a farmer at Oisel, America, ploughed a large field by connecting an electric wire with a waterfall." It's so simple, don't you know, when you read it in *Pearson's Weekly*. You have only to connect a wire and a waterfall; and yet no one ever mentioned it. Probably the trouble would come in in specifying the precise manner in which the wire was made "electric." After poor Mr. Bose's experience, we would not question anything that appeared in any of the Pearson publications in the matter of electricity, but so far as geography is concerned we have no reputation to lose in confessing that though we know of Oissel and Oesel (but not in the States), Oisel has up to the present escaped our view. On the whole, however, we should be inclined to recommend anyone embarking on a voyage to discover that farm and farmer, to provide himself, if possible, with an "electric eye" (the Pearson brand), as otherwise he might miss seeing it. The really curious thing, however, is why "Electric Sparks," such as the one quoted, should be considered, and apparently rightly considered, good enough for the public taste. If any other subject requiring a modicum of technical knowledge—horseracing for example—were treated in that way, it would be resented quickly enough.

C.E. by Exam.—A gentleman, who disguises his identity under the pseudonym of "Thorough," has been good enough not only to tell the Civil Engineers that they should not allow anyone to join their institution without passing an examination, but has been good enough to draw up a scheme of what the institution should examine in. The result is published in a letter to the *Engineer*. The idea that the institution might accept an examination by some university or technical college is rejected with scorn. It may be mentioned that "Thorough's" idea of higher mathematics is "the calculus and co-ordinate geometry," and he considers that the subject is twice as important to a civil engineer as "steam or other engines." "Gas and electric engineering" must be taken together as one subject, and there is no sign of any notion of specialising a part of physics for the one or of chemistry for the other. This is the sort of wisdom of the people who believe in examinations. Most of our best teachers are agreed that we have already far too many of them. If anyone wants to show that he has a competent knowledge of certain scientific and technical subjects, there are plenty of bodies that will examine him and give a certificate. But no examination would show that he was a competent engineer; for when original design and sound judgment come in we have to deal with qualities which no examination paper can in any way gauge. Work done, and done well, is the only real test of that.

The Force of a Pound.—It is known that the pure ether inhabited by the professors to whom is given the keeping of the laws of nature does not always stagnate in celestial calm. Of late a portion of it has been rippling agreeably with the echoes of a conflict on the way the mere engineer should be taught to make his calculations and what units he should be permitted to use. The protagonist was Prof. Perry, against whom Dr. Oliver J. Lodge waged valiant war. Prof. Jackson and Mr. Cumming completed a quadrangular fight in which no partners were allowed. Prof. Greenhill gets condemned *in absentia*, and Dr. Lodge goes out of his way to speak scornfully of Prof. Tait. There will doubtless be more in it before it is finished. The battle has been reflected for the benefit of mere men in the columns of *Nature*, and entertaining reading some of it makes. But last week the *Engineer*, which had ideas on the matter of old, did not fear to join the fray. Our contemporary is a little captious in its criticism of Dr. Lodge and "acceleration," but this time ends by preaching very sound doctrine indeed. In saying this much, however, it must not be supposed that any agreement is intimated with the Jacksonian doctrine—that in teaching elementary mechanics reference to "mass" should be avoided. There is no reason why the engineer should be tied down to the surface of the earth any more than the physicist or the astronomer. The student that starts with a clear conception of mass is saved from many pitfalls, and, moreover, may hope some day to be in a position to discuss with Dr. Lodge the "dimensions of g," and hold views of his own as to whether there is anything behind the "phantom" force, or whether it is really completely described as a time rate of transfer of momentum. The whole thing, of course, arises from everybody seeing the complete correctness of his own view of the matter, and failing to put himself in the position of the others who have obtained equally self-consistent pictures from a different standpoint. Moreover, it is difficult to change a mental habit, and it requires a new generation to grow up before a new unit can get wholly fair treatment. In electricity, for instance, once upon a time there were men—and good men, too—who felt no need for amperes, and whose sense of the fitness of things was so undeveloped that—*credite posteri*—they even proposed to measure current in farads. So, too, we do not all of us yet, like Dr. Lodge, think in quaternions, or make things simple by explaining that they are vectors or scalars. That may come in time. So far as units are concerned, the writer confines himself strictly to saying that he does not believe that there are many people who care really to use the poundal.

The Civil Engineers.—At the meeting on Tuesday of the Institution of Civil Engineers, Mr. John Wolfe Barry, C.B., the president, in the chair, a paper read was on "Superheated-Steam Engine Trials," by Prof. William Ripper. During the years that superheating has been in abeyance, there had been a continually increasing gain in steam-engine economy following on the development of the multiple-expansion engine, and the increase of steam pressures. The limit having been now nearly reached in this direction, engineers were again reverting to superheating, from which a further considerable increase of efficiency might be looked for. Trials had been carried out on a 17-i.h.p. "Schmidt motor," a single-acting, simple, non-condensing engine, supplied with superheated steam from a Schmidt superheater, to determine the steam consumption of the engine working with various degrees of superheat and at temperatures considerably beyond those usually employed,

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and also to find to what extent the dryness-fraction of the steam and the heat exchange between it and the cylinder walls were affected by the superheat. The heat expended in superheating reduced the amount of heat employed in evaporation of water, but the heat so diverted for the purpose of superheating was shown to be productive of a considerable gain in thermal efficiency. Thus an expenditure of 5, 10, and 15 per cent. of the furnace heat to superheat gave a net gain of 12, 38, and 70 per cent. respectively of the work done for heat supplied. It was pointed out, however, that no important gain could be theoretically expected from superheating, the actual gain in practice being due to the more or less complete removal of the loss by cylinder condensation, the author considering superheating not as a means of obtaining a thermal efficiency in any way proportional to the temperatures used, but as a device for realising as far as possible the full thermal efficiency of saturated steam, by rendering the cylinder practically non-conducting. It was announced at this meeting that the following associate members had been transferred to the class of members — viz., William Arnot, Thomas Burrell Bewick, George Proctor Carless, Henry Slade Childe, George Farren, Robert Macnish Gale, Henry Herbert Hellins, John Ellis Hughes, John Methven, James More, jun., Edmund Olander, James Noah Paxman, Frank Edward Priest, Edward Sandeman, John Smith, William Willox, M.A., and George Wilson—and also it was reported that 17 candidates had been admitted as students. There is a students' meeting to-night (Friday) on "The 'Monier' System of Construction." On Tuesday next the meeting will discuss Prof. Ripper's paper, and, time permitting, papers read on "The Diversion of the Periyar," by Colonel J. Pennycuick, C.S.I., R.E.; and "The Periyar Tunnel," by Mr. P. Roscoe Allen.

The Royal Institution.—The Friday evening discourse at Albemarle-street next week will be given by Prof. Dewar on "The Properties of Liquid Oxygen," at 9 p.m. The afternoon lectures at three o'clock will begin as follows: on Tuesday, January 19, Prof. A. D. Waller on "Animal Electricity"; on Thursday, January 21, Prof. Henry A. Miers, on "Some Secrets of Crystals"; and on January 23, Mr. Carl Ambruster on "Neglected Italian and French Composers." The programme up to Easter has already been given. There is, however, the following modification: Prof. J. Chunder Bose, of Presidency College, Calcutta, will deliver his discourse on "The Polarisation of the Electric Ray" on Friday evening, the 29th inst.—not on February 5, as previously announced. On the latter night it is to be the Bishop-Elect of London. Prof. Silvanus Thompson finished off his Christmas lectures last Saturday with the Röntgen radiations. He laid some stress on the point that Prof. Röntgen discovered that the radiations affected a fluorescent screen before he ascertained their action on a photographic plate. That, of course, is not very material to anything except claims to the "invention of the cryptoscope." But what is new to many people is that the transparency of wood or cardboard to the new radiations was discovered in this way, and discovered in the course of a deliberate investigation of their properties. It was, of course, this penetrating power which showed that the radiations outside the tube were of an entirely new kind, and quite different from the cathode rays, which produced fluorescence inside the tube. It, however, happened that it was the photographic effect that was first communicated to a wondering world, and it is not understood that Prof. Röntgen claims that this discovery and all that has followed from it was other than accidental. An incidental remark of Prof. Thompson's was that Bavaria, when estimated by the number of its inhabitants, was only a little larger than London, and yet it contained three universities, and supplied more than £100,000 a year for their support, while Wurzburg, the small Bavarian town in which Prof. Röntgen carried on his experiments, had at its university a laboratory which was more than a hundred times better equipped for scientific research than that of the University of London. This lecture has served for the text of a leader in the *Standard*, in which in a marvellous manner a conclusion is arrived at which is quite alien to the subject. It would, however, have been decidedly better if our influential and widely read contemporary had indicated more clearly whether the somewhat poor science and still poorer logic by means of which this is effected were to be ascribed to the writer of the article or to Prof. Silvanus Thompson. Otherwise, those who happened not to be at Albemarle-street on Saturday might be in danger of imagining that Prof. Thompson had broken out in quite a new direction.

City and Guilds Institute.—A general meeting of the governors of the City and Guilds of London Institute on Wednesday received the report of the special committee appointed to enquire into the expenditure of the Central College of the Institute for the Advancement of Technical Education, especially as compared with results. The enquiry was undertaken at the request of the Court of Assistants of the Mercers' Company, certain statements having been made alleging that the Central College had failed to fulfil the purpose for which it was erected, and that the available educational advantages of a costly institution had been directed into a wrong channel. Two sub-committees were appointed by the special committee, one to examine into the finance and administration of the college, and the other into its educational work. In their report the special committee, of which Sir John Donnelly was chairman, entirely concur in and adopt the reports of the sub-committees, which show that the work of the college has been eminently successful, and that the results achieved are fully commensurate with the expenditure involved. In their opinion the governors possess in the Central Technical College an institution which has well and economically carried out the objects for which it was founded, which objects are deserving of every support and encouragement that the Corporation and City companies of London can give them. The sub-committee on finance and administration remark as to cost that the figures are lower than the cost at Coopers Hill, the Royal College of Science, the Massachusetts Institute, the Cornell University, Johns Hopkins University, M'Gill University (applied science), similar institutions in Germany, and at the Zurich Polytechnic. A report made on the college by Mr. Llewellyn Smith, at the instance of the Technical Education Board of the London County Council, is also quoted, the work of the institution being described as of university rank. The report of the second sub-committee deals with the educational work, and stated that the work has been eminently successful and that the institute is to be congratulated on what it has accomplished. Mr. A. Brewin expressed gratification at the terms of the report. He was sorry to say that additional numbers had voted against grants for the institute at the courts of several livery companies, because it was thought that the report would be unsatisfactory. Sir Frederick Bramwell, who, in the absence of the Lord Chancellor through ill-health, occupied the chair, said that Mr. Brewin had given expression to his opinion. The enquiry was made by men of great eminence, who had done their duty very thoroughly. The report was then unanimously agreed to. Lord Kelvin and Dr. W. H. Perkin, F.R.S., were elected members of the council of the

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institute. We have the full text of the report of the special committee, and have given a summary above, but must reserve comment on the matter for another issue.

The Blot Accumulator.—At the Hotel Cecil on Tuesday the Blot accumulator was described and shown in public for the first time, it is understood, in this country. A short account of the accumulator with some reference to the exceedingly favourable reports upon its capabilities from Mr. W. H. Preece and Mr. d'Arsonval was given when the battery was brought out in Paris. That, however, is some time ago, and it may, therefore, be repeated here that the accumulator is a lead one of the Planté type, the plates being formed in the usual way and no paste used. The plates consist of a lead frame in which are suspended a number of spools of corrugated and embossed lead tape wound on a long lead core, the axis of the core being perpendicular to the plane of the plate. In this way a very large effective surface is obtained, and the whole affair is free to expand and contract. A glass containing vessel is used, and glass rods prevent the plates swinging into contact, and it is one of the points of the design that there is nothing but lead and glass in contact with the acid. In some types the convolutions of the lead tape are cut through at the lower end; in others they are intact. All the convolutions and the core are soldered together in what seemed a somewhat rough manner at the top to ensure good electric continuity throughout. This joint is under the surface of the acid, and looked as though it might prove a source of trouble, but it was stated that this had not been found to be the case. In any event there would seem to be no difficulty in substituting a more reliable-looking joint if it is desirable. It is claimed for the Blot cell that its comparative lightness and rapid rate of charge will put it before others in tramcar and motorcar work. Mr. Blot was understood to speak of 30 ampere-hours per kilogramme of plate (say, 13 ampere-hours per pound). Mr. Preece has certified to 12·7 ampere-hours per kilogramme. Possibly one of these counted both plates and the other one only. Whatever the merits of the cell for a stationary accumulator, it appears to the writer that there would be a danger of the lead tapes shaking off the spools sideways under the jolting of tramcar and still more of motorcart work. This might perhaps be prevented by a more liberal use of cross-pieces on the lead frames, or possibly still better by placing two or three glass rods horizontally instead of vertically as separators between the plates. The description of the cell was given on Tuesday by Mr. H. Tyrer Cheswright, and was of a popular character. The Hon. R. O. Dobell, Canadian Minister of Commerce, presided, and the audience appeared to contain a considerable proportion of potential shareholders. Mr. Blot, one of whose accomplishments is the speaking of English, was, however, present and accessible to everyone who wished to enquire more closely into the nature of the cell. Moreover, something more technical as to working and results was promised in the form of a paper before one of the societies.

The Chamber of Commerce.—The meetings of the Electrical and Allied Trades Section of the London Chamber of Commerce are not nearly so frequent as those of many bodies that do their work far less satisfactorily. There was, however, a meeting of the section last Saturday at Botolph House, Eastcheap. Mr. Emile Garcke presided, and briefly reviewed the work done by the section during the two years he had been chairman. At the conference on light railway legislation called together by the Board of Trade the Chamber was represented by Sir E. Carbutt and himself, and he thought they were all very much indebted to Sir Albert Rollit for his action both at that time and subsequently in Parliament. The Act was not everything they could desire, but it was a very great improvement on the former legislation. They were also greatly indebted to Major Flood Page for his action, in conjunction with the Chamber, in regard to motorcar legislation, on the successful issue of which they had cause to congratulate those who were interested. Among other subjects which had received their serious consideration he ought to mention the telephone question, which was dealt with by a parliamentary committee, at which the Chamber was represented by Sir E. Carbutt and Major Flood Page. Valuable services had been rendered by Mr. Sydney Morse in connection with the vexed question of rating, respecting which it was very desirable that discussion and enquiry should continue from time to time in the hope that eventually they might be able to work out some improved condition of legislation. He had desired during his term of office to do some little thing which might be of permanent benefit to the members and to the electrical industry generally, and he therefore took advantage of the facilities which his position had afforded him for producing a manual on electrical undertakings. He hoped that book would be of more benefit to the industry than it was ever likely to be to the author. There had occasionally been some difference between himself and some of the members as to their meetings—whether they ought not to hold more frequent or, at any rate, periodical meetings. His view was that it was not desirable to call the members together unless there were some specific business to discuss upon which their united action was necessary. The organisation of the Chamber, however, admitted of their efficiently dealing with business by calling together those members of the section who were interested in any particular question. He ended by proposing the election of Mr. Sydney Morse as chairman of the section for the next two years. In seconding this, Major Flood Page said it would be an advantage to the section that Mr. Morse was a member of the council of the Institution of Electrical Engineers. Mr. R. P. Sellon was elected the new deputy-chairman, and Mr. Alexander Siemens was re-elected as the second deputy-chairman. In the course of the discussion, a pretty general acquiescence was expressed with Mr. Garcke's views as to the meetings of the section. The secretary (Mr. Murray) said enquiries had been made as to the nature of the forthcoming Newcastle Exhibition. It appeared that it would be in the main a local exhibition. Mr. Sellon said that manufacturers felt that at present they had had about enough of electrical exhibitions. Ultimately it was decided that the Chamber should not officially move in the matter. The subjects of motor-vehicles and light railways were on the agenda. Major Flood Page spoke on the former, and at first it looked as though we were to have some definite information on the electric omnibus which gets tried in the mornings and evenings and other inconvenient times; but nothing definite came out except that it can go more than five miles an hour when a policeman is not looking. In reference to another branch of the subject, Major Flood Page said that "some of them" were doing all they could to prevent themselves from being identified with any of the speculative companies which had sprung up in connection with "automotives," and he hoped that the section would approve of their moving extremely slowly in the matter. Mr. Morse dismissed the subject of light railways with the remark that there was little that could be discussed until the commissioners had dealt with the applications.

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BIRKENHEAD ELECTRICITY WORKS.

The busy town of Birkenhead, situated on the banks of the Mersey, sets an example to many places in the matter of municipal works. It provides its own water and gas supplies, at a capital cost of about £400,000, and now has added electricity works to the list. Many people regard the town only from the dock and shipbuilding point of view, but farther inland there are several rising residential districts, where the new illuminant will find great favour. The public buildings, such as the Free Library, Municipal Offices, and the Theological College are all likely to appreciate the electric light.

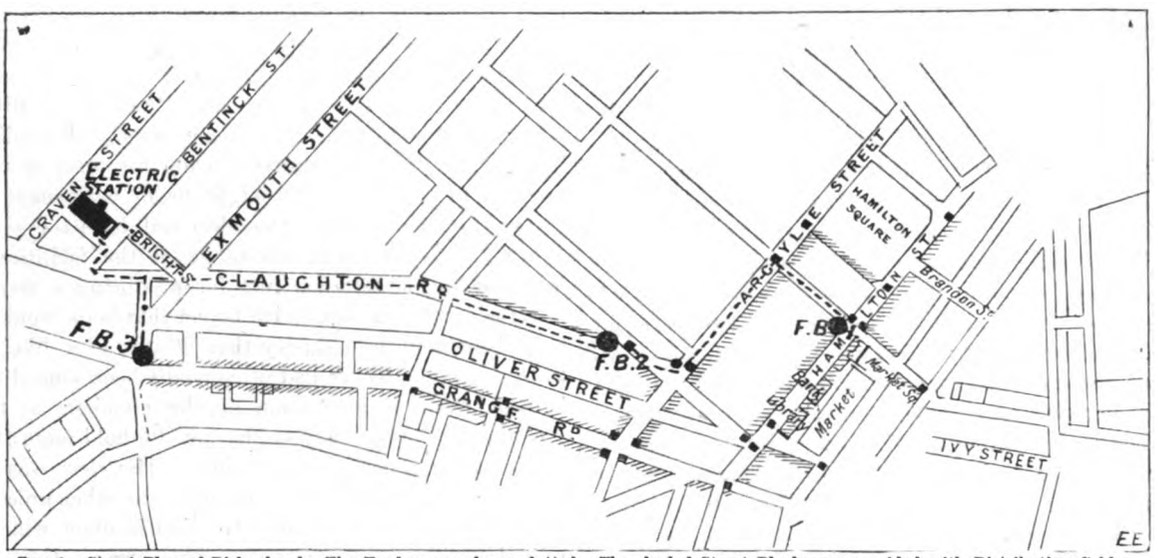

FIG. 1.—Street Plan of Birkenhead. The Feeders are shown dotted. The shaded Street Blocks are provided with Distributing Cables.

The Corporation obtained their provisional order in 1890, but did not immediately put it into force. The matter was allowed to drift till 1893, when an offer was made by a company for the right to supply electricity in the town and to take over the order. The terms of this offer were not considered sufficiently acceptable, but it served to stir up the Council to undertake the work themselves, lest the Board of Trade should revoke the order. Consequently, expert opinions were obtained from both Dr. John Hopkinson and Mr. James N. Shoolbred as to the best means of lighting the borough. The two reports agreed as to the system to be adopted, but varied in details and in estimated cost. After a few months' deliberation the Council authorised Mr. Shoolbred to prepare full plans and specifications for the works. These were issued early in 1895, but building troubles, etc., delayed the completion of the works till September last year. Borrowing powers were sought for, and the Local Government Board, after enquiry, sanctioned loans to the extent of £20,000. This money has been distributed somewhat as follows: cost of site, £1,500; building and stack, £4,500; generating machinery, £9,000; and mains, £5,000.

System of Supply.

Mr. Shoolbred designed the station in the first instance to work on the three-wire system with 230 volts between outside conductors. Accumulators were also to be installed. This was previous to the sanction given by the Board of Trade last year for the use of higher pressures in consumers' houses. When this increased pressure became available Mr. Shoolbred promptly took advantage of the same, although he had proved by calculation that the old pressure could cope with the district to be supplied. He also considered it a mistake to commence a station supply on the three-wire system, owing to difficulties in adjusting the balance when the consumers are scattered. So at Birkenhead a two-wire supply will be given at 230 volts till the demand warrants the change over to the three-wire system. The switchboards, feeders, and distributing mains are, however, all designed for the latter system. The three 80-h.p. steam dynamos now erected are wound to give about 250 volts, and hence will eventually supply one side of the system only. The larger units to be added will, of course, deliver current to the two outside wires at something over 460 volts.

Site and Building.

The map of the mains laid (Fig. 1) does not give a true idea of the position of the generating station with respect to the town of Birkenhead. All the compulsory streets lie on one side of it—that is, between the station and the River Mersey. The borough extends an equal distance in the opposite direction, and the boundaries up and down the river are also about equally distant from the station, which is thus placed most centrally. The site acquired by the Corporation for these works forms a parallelogram about 300ft. long by 100ft. wide. The land is bounded by four streets—*i.e.*, Bentinck-street, Bright-street, Craven-street, and Gordon-street. Across this land, transversely from Bright-street to Gordon-street, have been erected two single-storey sheds,

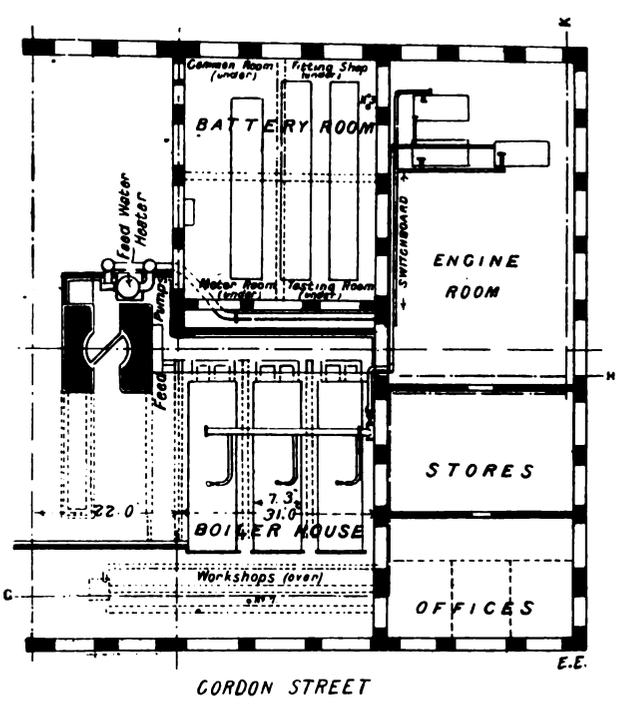

FIG. 2.—Plan of Buildings and Arrangement of Plant.

each 30ft. wide and 21ft. high at the eaves, to serve respectively as an engine-room and as a boiler-house. These were designed by Mr. Shoolbred both in general arrangement and detail. The plan (Fig. 2) shows how the various departments are grouped, while Fig. 3 gives a sectional elevation of the building. The general design provides

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largely for extensions, as the engine-room will eventually take the full length of the building. The new offices will be erected on the strip of land left beyond the engine-room. The boiler-room at present holds three boilers, but more will be added, till the present chimney is surrounded by them on three sides. These extensions will take practically half of the land available, and a similar disposition of plant will then be commenced on the other half of the site. A covered roadway will be then left through the centre of the building, so that coal can be delivered direct into any of the coal-bunkers behind the charging floor. The buildings are of brick with a few stone facings. The engine-room and boiler-room are lined with salt-glazed bricks, a handsome dado running round the engine-room. The section of the two roofs can be seen in Fig. 3. The floor area of the boilers is a fireproof one, made up of arched iron plates between girders under a layer of concrete. The chimney (Fig. 4) is 124ft. high and 6ft. diameter inside throughout. The design contains several new features, and hence we have produced the full section and also details to a larger scale. It will be seen that the inside of the shaft is of uniform section throughout, and has no inequalities on the inside surface likely to affect the draught. It is lined for about 60ft. with firebrick.

crab frame is made in cast iron, mounted on four double-flanged tram-wheels, with gearing for travelling the crab in transverse direction. The hoisting gear is of single and double purchase, fitted with powerful brake, also ratchet wheel and pawl. All the motions are operated from floor by endless ropes over grooved pulleys; the change gear and brake are also operated from floor.

The wiring of the building for electric light was carried out by Messrs. Drake and Gorham, lead-covered wire being largely used.

Steam Generating Plant.

There are three boilers, supplied by Messrs. Tetlow Bros., of Hollinwood. They are all of the Lancashire two-flued type, and are made for a working pressure of 160lb. per square inch. The hydraulic test pressure applied was 220lb. per square inch. The boilers are each 26ft. 6in. long by 7ft. 3in. external diameter. The particulars, briefly, are as follows: The whole of the plates, angles, etc., are of Siemens-Martin steel. The shell of each boiler is built up of seven rings of plates $\frac{3}{4}$in. thick, each ring consisting of one plate only. The seams are butt-jointed longitudinally with straps inside and outside, and are treble riveted—*i.e.*, six rows of rivets. The circular

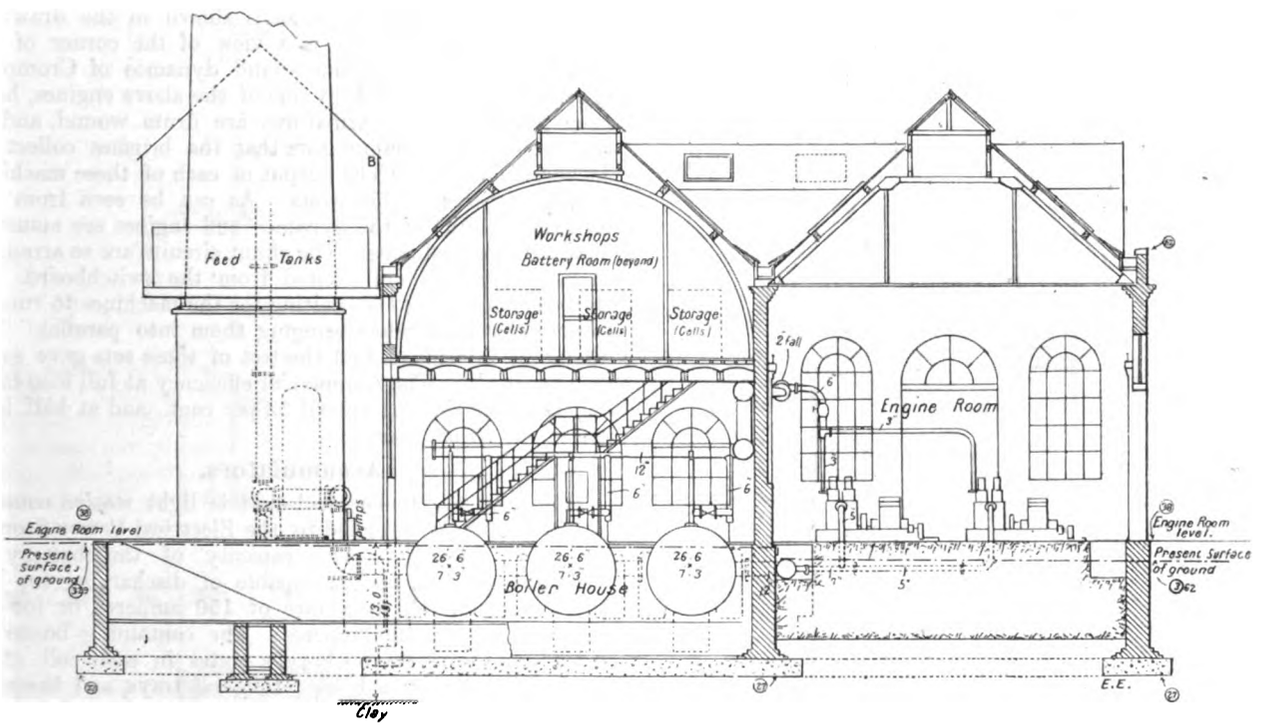

FIG. 3.—Sectional Elevation of the Birkenhead Electricity Works.

The square portion supports the feed-water tanks. The cap of the shaft is built up of cast-iron segments.

The buildings are protected against fire by the almost exclusive use of brick and iron for a height of 21ft. above the ground. Two high-pressure water services are led into the building at 80lb. and 40lb. pressure respectively. Each of these delivers up to the water-tanks, which are placed round the chimney at a height of about 20ft. above the ground. Ten fire hydrants are placed in different parts inside the building and one outside in the street. The pair of feed pumps are also so arranged that each can be converted very readily into a steam fire-pump. As mentioned above, the portion of the engine-room next Gordon-street has been made use of, temporarily, for offices and stores, but the rails for the travelling crane run the full length of the building. A testing-room, a meter-room, a fitters' shop, and a common room for the use of the employés are provided elsewhere, as shown on the plan.

The travelling crane was supplied by Messrs. Isles, Limited, of Stanningley, near Leeds. The crane is capable of dealing with loads up to six tons, and is designed for a span of 29ft. 3in. The cross-girders are made of steel plates and angles in ornamental lattice pattern. The end carriages are made of steel channels riveted together and mounted on flanged tram-wheels, with the necessary gearing and cross-shaft for driving both the ends. The

seams are double riveted. All the standpipes on boiler are of wrought steel, and double riveted to boiler. The manhole is also of wrought steel and double riveted to boiler, being further strengthened by an internal strengthening ring of sufficient width to allow of an outside row of rivets, thus making three rows of rivets. The flues are 2ft. 9in. diameter, each flue consisting of 11 rings of plating $\frac{1}{2}$in. thick, the rings being solid welded longitudinally, and flanged at both ends for attachment to each other. There are five conical or Galloway tubes in each flue. The ends are $\frac{3}{4}$in. thick. The front end is double riveted to an external angle ring, the angle ring being also double riveted to shell. The gusset stays are double riveted both to the shell and end plates, the angles being 5in. × 5in. × $\frac{3}{4}$in. The boilers are equipped with a full and high-class complement of fittings, including dead-weight safety-valve, high-steam and low-water safety-valve, steam stop-valve, etc., all of which are specially designed for the high working pressure. All these fittings are of the Hopkinson type.

Two of these boilers are equipped with Vicars mechanical stokers supplied by Messrs. T. and T. Vicars, of Earlestown, Lancashire. We have described the action of these stokers in previous issues, but the stokers at Birkenhead have certain improvements in detail. As is well known, in this system the small coal and slack is fed automatically into the furnace, when it falls on the fire-bars, which, by a slow

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reciprocating movement, carry the burning mass gradually forward. Two sets of alternate bars are pushed forward together, taking the fire with them, and then drawn back again, one set at a time. One of the new details in the present case consists of having a positive lock to the second set of bars, so that any clinkering between the two sets may not bind them together. These stokers enable inferior fuels to be used, and also give better economy in fuel. The stokers are to be driven by an electric motor.

At present there is no economiser, but space has been left for one on the boiler side of the shaft. The feed-

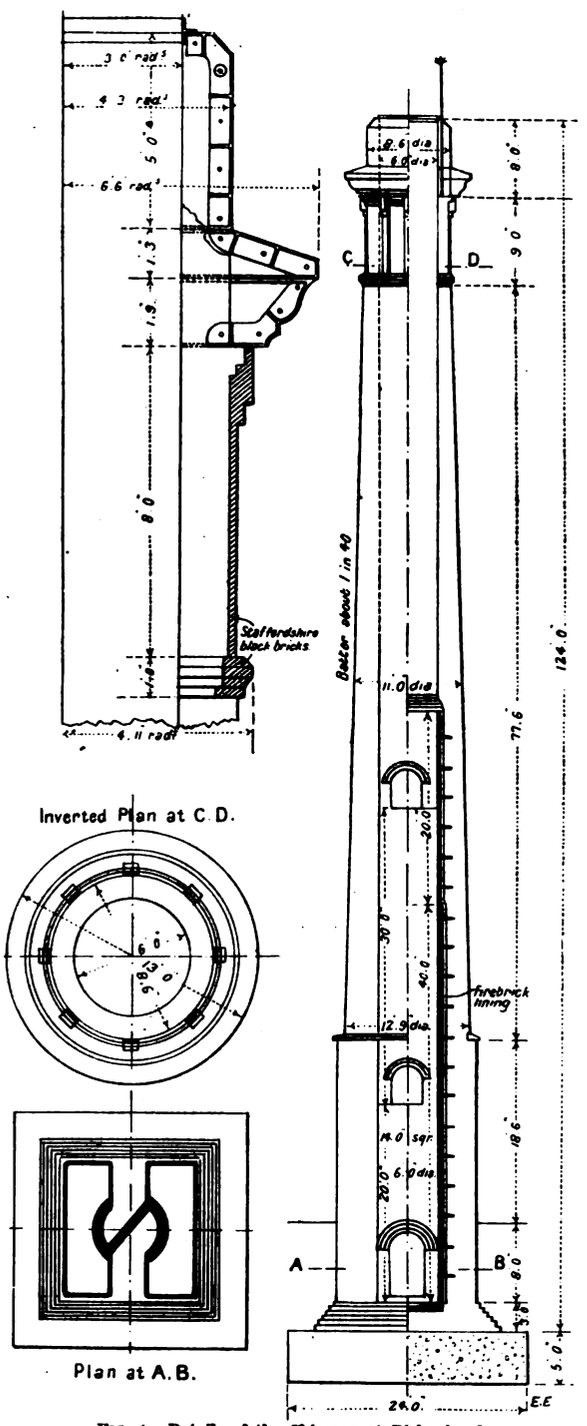

FIG. 4.—Details of the Chimney at Birkenhead.

water is now heated by a Brown's Berryman feed-water heater placed on the opposite side of the shaft. Duplicate feed-pumps are provided and a duplicate set of feed-pipes, so that either a hot or cold feed can be given. As can be seen from the elevation (Fig. 3), the firing floor is at a lower level than that of the engine-room and the street. The bunkers are situated behind the firing floor, and coal is shot into them from the street. The openings through which the coal is discharged are closed by means of hinged shutters.

The system of steam-pipes can be seen from the illustration, and here again ample provision has been left for extension. The main steam-pipe leaving the boiler-room is 12in. diameter, and will eventually take steam from more than twice the present number of boilers. All the steam-pipes are of mild steel, with welded lap joints. The flanges are faced and riveted on. The bends connecting to the engines are of copper. The exhaust pipes are of cast iron. The main exhaust goes up the outside of the chimney, after passing the feed-heater, and discharges into a pent-house built over the feed-tanks. Mr. Shoolbred does not hold with the common practice of placing the exhaust-pipe up the inside of the shaft, as the moisture injures the brickwork. He has accordingly constructed an open-work shed of iron round the shaft, and the exhaust steam will escape from this. The water-tanks are covered over to prevent condensation water dripping into them. The steam-traps draining the steam-pipes were supplied by J. J. Royce, of Manchester, and are of that firm's "Syphonia" type.

Engines and Dynamos.

At present three 80-h.p. sets have been fixed. The three steam-engines are of the well-known Willans single-acting central-valve type, compound non-condensing. When working at 120lb. and running at 450 revolutions per minute, each engine indicates some 80 h.p. The engines are of the two-crank type, as is shown in the drawings (Figs. 5 and 6). Fig. 7 is a view of the corner of the engine-room. Three shunt-wound dynamos of Crompton type, each driven direct by one of the above engines, have been provided. The armatures are drum wound, and so connected to the commutators that the brushes collect on an horizontal axis. The output of each of these machines is 200 amperes at 250 volts. As can be seen from the illustration, each of the dynamos and engines are mounted on a common bed-plate. The shunt circuits are so arranged that the dynamos are excited from the switchboard. In this way no time is lost waiting for the machines to run up to normal voltage when bringing them into parallel. Mr. Shoolbred informs us that the test of these sets gave satisfactory results. The commercial efficiency at full load came out well over the guaranteed 82 per cent., and at half load was about 73 per cent.

Accumulators.

The battery at Birkenhead electric light station consists of 136 K-50 cells, supplied by the Electrical Power Storage Company, Limited. The capacity of the battery is 750 ampere-hours, and is capable of discharging for five hours consecutively at a rate of 150 amperes, or for one hour at a rate of 400 amperes. The containing boxes are of lead, and there are 50 K-type plates in each cell. The lead tanks are mounted on pitch-pine trays, and these on glass oil insulators. All the cells are erected in three long rows of two tiers in each, on pitch-pine bearers, supported by strong cast-iron standards. The stands rest on thick stone slabs. These slabs rest on a foundation of concrete, and upon the concrete and surrounding the slabs is placed a layer of roofing felt, then a layer of bitumen, the whole floor being then covered with felt. This acid-proof floor is ridged to give drainage, so that it can be swilled down if necessary. The end cells are connected from row to row by copper rods. The regulating leads, also copper rods, run over the top cells in wood cleats with ebonite insulators, and are supported by bearers resting on iron girders. Space is provided in the room for another battery of the same size when the change over on to the three-wire system is decided upon, as at present 126 of the cells are connected in one battery. The remaining 10 cells are used as hospital cells. The regulators at each end at present control 19 cells each, so that some 38 can be cut out of the lighting circuit when charging.

Switchboards.

Figs. 8 and 9 show the general arrangement of the switchboards at Birkenhead, which was also supplied by Messrs. Crompton and Co. Spare panels have been provided at either end for extensions, and the following description will show that such extensions can be made without inconvenience to the supply. At the present three feeders and three dynamos are provided for. The letters A A in the illustration denote duplex fuses used in the

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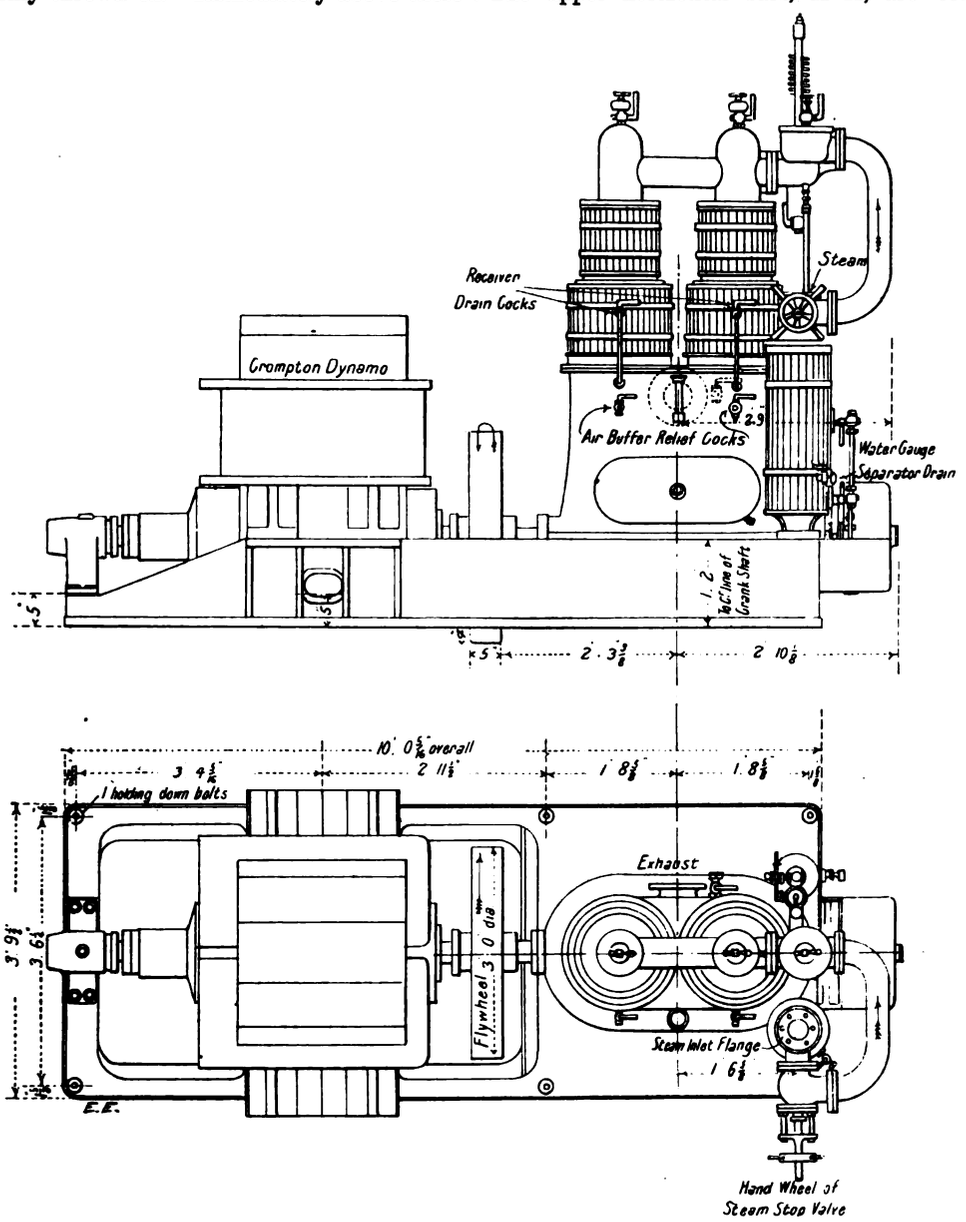
feeder circuits, so that in event of one fuse giving the other can be quickly thrown in. Immediately above these feeders, and those marked D D to the dynamo circuits. The upper horizontal bars, H H, are connected to the



FIGS. 5 AND 6.—Plan and Elevation of the Crompton-Willans Steam Dynamo.

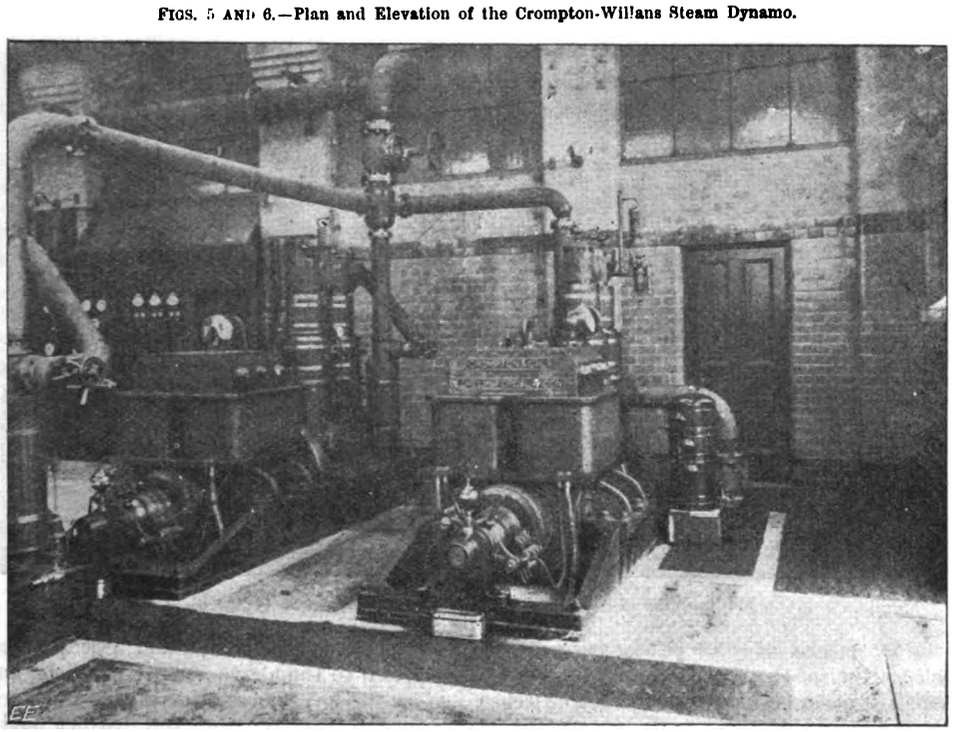


FIG. 7.—View of One Corner of the Engine-Room.

are the feeder ammeters. The system of plug bars below are connected as follows: the vertical bars, F F, to the discharge circuit from the accumulators, while the bars I I are used for charging. The lower bars, J J, are spare, and

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can be utilised to put any individual dynamo on to a special feeder. The switches, S S, below these on the positive panel makes the shunt field connection to the dynamos. These switches are interlocked with the automatic dynamo breaking switches are so connected to the resistances, shown at the right of the board (Fig. 9), that the shunt is short-circuited by the resistance at the instant of breaking contact. The leakage detector can also be seen in this illustration.

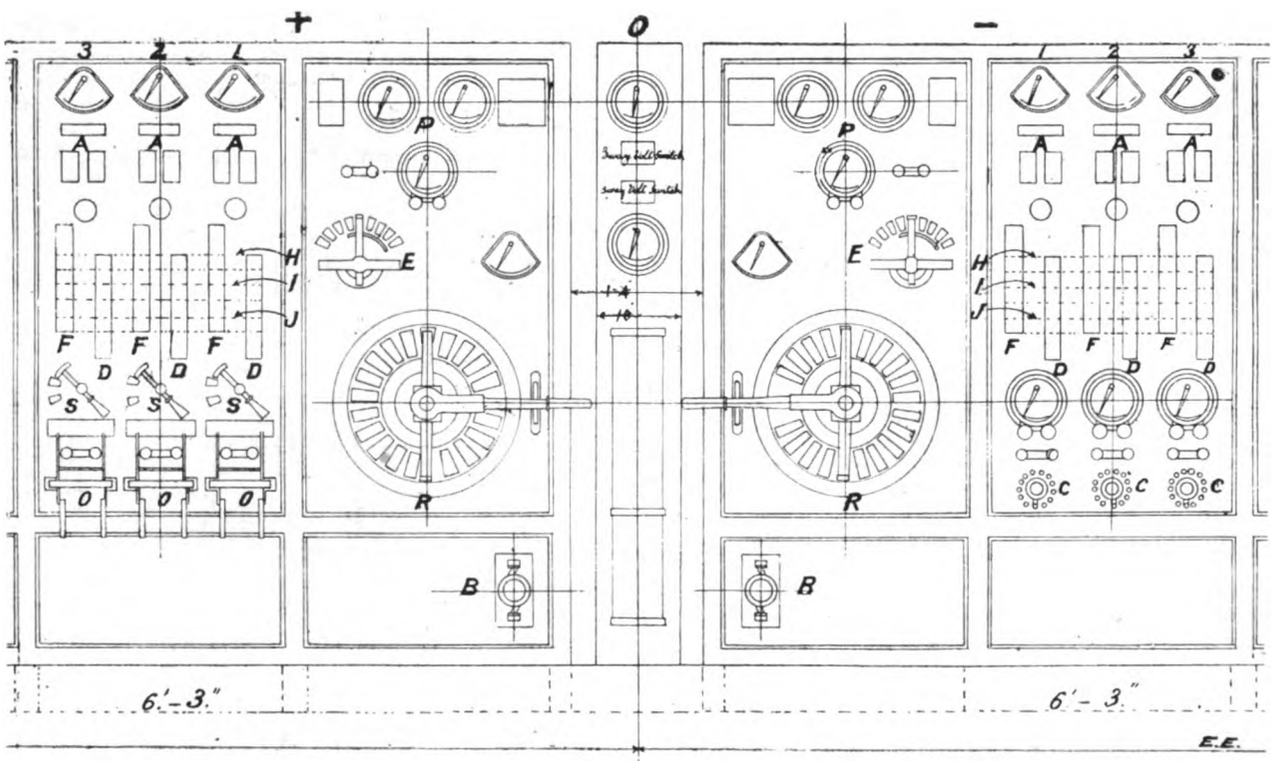

FIG. 8.—Diagram of Switchboard at Birkenhead.

switches, O O, below, so that the shunt circuit cannot be opened when the dynamo circuit is made. On the negative panel are placed the shunt-regulating contacts and the dynamo ammeters. The battery regulators, R R, consist of the usual sets of contacts with two revolving contacts, one from the outer ring connected to the discharging circuit and the other to the inner ring or charging circuit. The one handle works both of these revolving contacts by means of two pawls gearing into two ratchet wheels. Either of these can be easily thrown out of gear if required. The other two multiple contact switches, E E, will be used in future for the equalisers when they are installed. The two large switches, B B, at the base of the board disconnect the whole of the feed from the station when required for testing or other purposes. The shunt-

At present a good insulation is shown on both sides of the system.

Mains.

This work was placed in the hands of the Callender Cable and Construction Company, and two systems have been used. The feeders are laid on the solid bitumen system, and the distributors consist of single lead-sheathed and armoured cables laid direct in the ground. Both the feeders,

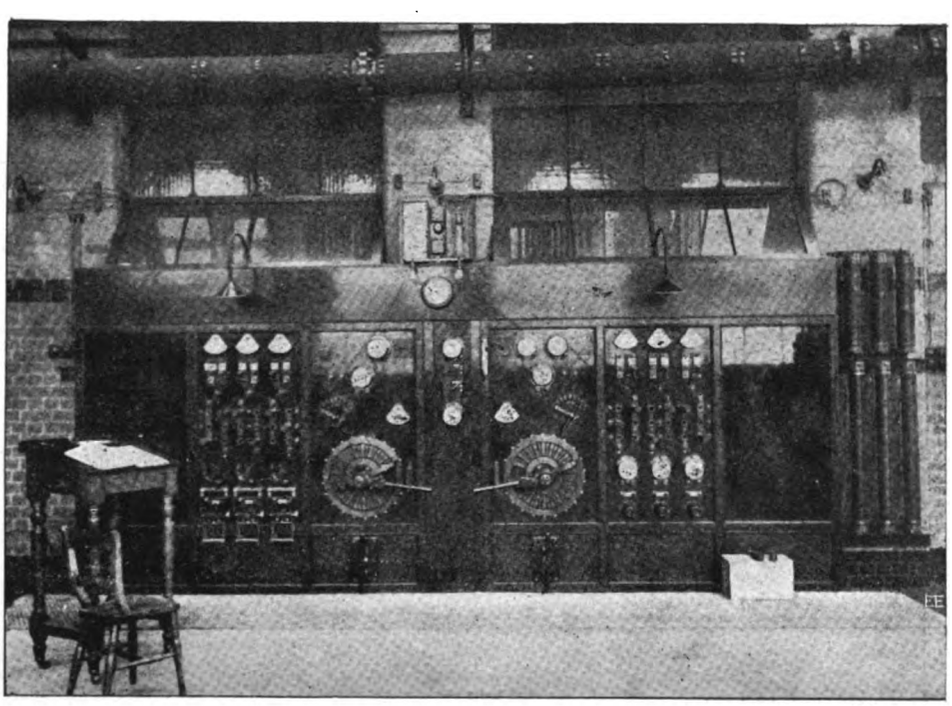

FIG. 9.—View of Switchboard, showing Shunt Resistances on the Right.

distributors, pilot cables, and street boxes were made and supplied to the above well-known firm, and have been laid so as to be available for three-wire working. At present there are three separate and distinct feeders radiating from the generating station in Bentinck-street to three convenient feeding points, F B (Fig. 1), situated in the compulsory area. The first feeder consists of three cables, two having

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a sectional area of ·6 square inch each and the other of ·3 square inch, each cable being insulated with fibre by the Callender process, and protected with a stout lead sheath put on in one operation by hydraulic pressure. This feeder extends from the generating station, along Claughton-road, Conway-street, Argyle-street, and Market-street to the junction of the last-named with Hamilton-street, a distance of some 1,500 yards. The

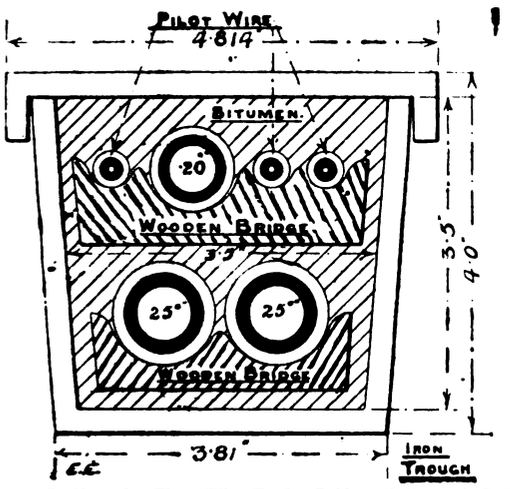


FIG. 10.—Section of a Three-Wire Feeder Laid on Callender's Solid Bitumen System.

second feeder is a two-wire one, each conductor having a sectional area of ·25 square inch. These cables extend from the generating station, along Claughton-road, to a feeding point, marked F B 3, near the junction of Claughton-road and Conway-street, a total distance from the station of 865 yards. The third feeder consists of three cables, two of ·25 square inch and one of ·20 square inch. They extend from generating station to feeding point at Charing Cross, a distance of 326 yards. Each feeder is provided with three pilots (one for each cable), laid in the same iron trough (Fig. 10) with them, and consisting of seven strands of No. 22 copper (in the case of Claughton-road), and of seven strands of ·038 square inch (in the case of Charing Cross and Market-street feeders). These single-feeder cables were laid in cast-iron troughs, as shown in Fig. 10, and filled in solid with bitumen. The size of the trough varies from 5in. by 4in. in Claughton wood, where two sets of feeder cables are laid in the one trough, to 3in. by 4in. where single feeders have to be provided for. The factory lengths were joined through with copper ferrule joints (Fig. 11), laid direct in the iron trough, and each joint was protected mechanically by a glazed porcelain tube of sufficient internal diameter to fit tightly over the lead sheath at either side of the joint. The ordinary cable compound which is used to lay the cables in was stopped off right across the trough for about a foot on each side of the ferrule joint, and the pocket thus formed was run in solid with Callender's patent box

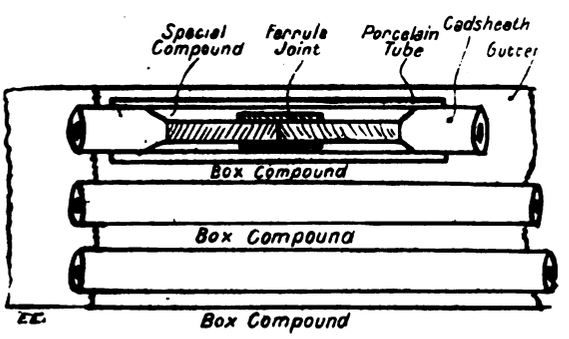
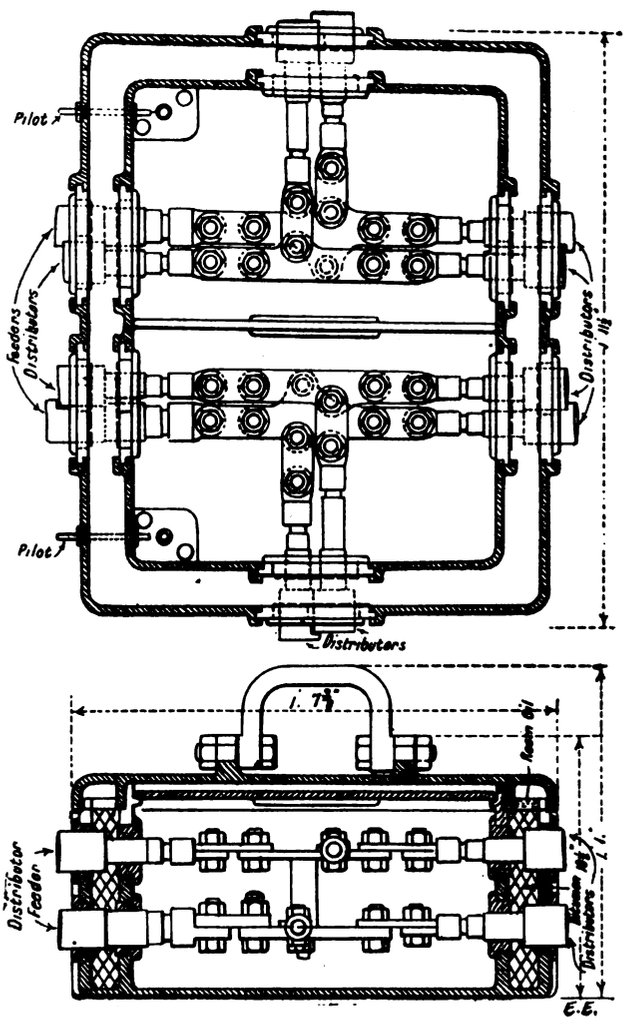


FIG. 11.—Details of Ferrule Joint.

compound, which is of very high specific resistance. Care was taken that the porcelain tube was thoroughly filled with the molten compound, so that there should be no air space between the copper ferrule and the inside face of tube.

The distributing cables are of the well-known type made by Messrs. Callender and Co., and are lead-sheathed and armoured by two steel tapes. They are laid direct in the ground without further protection, an indication of their presence being provided in the form of a 7in. × 1in. tarred board laid flat and vertically above them. The distributing mains radiate from the various "feeding" boxes, and are of two sizes; those starting from feeder-boxes Nos. 1 and 2 being composed of three cables, two of which have a copper sectional area



FIGS. 12 AND 13.—Plan and Elevation of a Double-Pole Box.

of ·2 square inch and the other of ·1 square inch, and those from feeder-box No. 3 being made up of three cables—two of which are ·15 square inch and one ·075 square inch. The first mentioned—namely, those composed of ·2, ·1, ·2—are laid in the following streets: Conway-street, Argyle-street (south side), Hamilton-square, Hamilton-street (both sides), Brandon-street, Market-street, Haymarket,

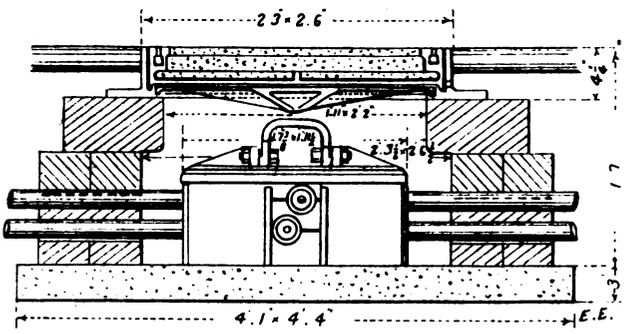


FIG. 14.—View of Box in Street with Cover.

Market-place, and Claughton-road. The smaller size—·15, ·075, ·15—are laid on both sides of Grange-road, from Charing Cross to Argyle-street. The total length of large distributing main laid is 2,400 yards, or 7,200 yards single cable. The total length of smaller size is 1,511 yards, or 4,533 yards of single cable.

The boxes, also supplied by the firm, are a modification

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of their usual double-wall type. Mr. Shoolbred insisted on each individual main being provided either with a separate box or with a distinct compartment in a common box. This latter course had to be adopted in places owing to the limited width of the footpath. In such cases there were two boxes provided for the three-wire network, one containing a single pole and the other the opposite conductor and the neutral cable in separate compartments. Fig. 12, 13, and 14 show sections of the different types of boxes employed and the method of placing the same in the streets. Every box was laid on a concrete bed and a square brick pit built up round it, so as to provide an air space all round the box for drainage and ventilation purposes and to carry the massive iron frame and concrete surface cover for providing access to the box from the pavement level. Each covering for the box pits consists of three distinct castings—*i.e.*, the frame resting on the brick wall; the inner flanged lid, which fits accurately into a rabbet cast on the inner side of the frame, the joint being run in with a heavy resin oil; the concrete cover-plate, which is a shallow iron box strengthened transversely with ribs and filled in with fine concrete so as to match the surrounding flagstones.

FIG. 15.—View of Cable Laying, showing Method of Protecting Cables Under the Roadway.

All the boxes after being connected up are filled in with a heavy resin oil, so as to completely submerge all the bare copper. The whole of the excavation of the streets, and the replacement and making good, was done by the Corporation. The method of protecting the cables when crossing the roads is shown in Fig. 15. A brick culvert was built and covered with flagstones set in concrete. Ample space was left for spare cables to be drawn in. The whole of the cables and street box work was carried out under the superintendence of Mr. Fred A. Pocklington, Messrs. Callender's engineer for the North-Western district.

Load on Station.

The number of lamps connected is now equivalent to 3,000 8 c.p., and is rapidly on the increase. The maximum load at 230 volts has reached 150 amperes, and some 8,000 units have been metered since the station was opened last September. The figures obtained for cost of coal show, even with this small load, economical results. The coal used cost about 7s. per ton. The accumulators are of course of great service at present, as they are capable of taking the full load, so that the engines need not be run every day. The charge per unit will be 6d. Mr. Shoolbred is at present superintending the working of the station, and his chief assistant at the station is Mr. G. P. Shallcross. Praise is due to these gentlemen for the successful completion of the work, in which they received great assistance from Mr. Alfred Gill, the town clerk.

THE MECHANICAL CONSTRUCTION OF ELECTRICAL MACHINERY.

BY F. M. WEYMOUTH.

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THE DYNAMO.

(*Continued from page 42.*)

It seems to the writer, however, that as the subject of bolting and fastenings generally is an important one, and should be clearly understood, it will be as well if at this juncture we interpolate a few remarks specially in this direc-

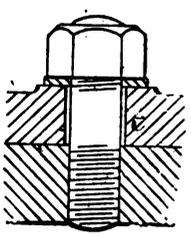

FIG. 17.

tion. Thus a "tap-bolt," sometimes called simply a "screw," is shown at *a* (Fig. 16); and the expense attending their use is, of course, that all holes to receive them require to be "tapped," or screwed, that is. A "bolt" (Fig. 21) is the same as the foregoing, but with a nut added; it is usually the cheapest fastening for a joint, requiring only plain drilled or cored holes. Fig. 17 shows a "stud": one end is permanently screwed down as hard as the screw threads will admit, and the other end has a nut. This is usually the most expensive fastening. In Fig. 22 a "stud-bolt" is shown, though this is not so often used as the other methods. A "collar-bolt" is shown in Fig. 23. This and the stud-bolt will be observed both to be fitted with pins to prevent them from turning when the nuts are manipulated, the section of the bolt through the pinhole, it should be noted, not being reduced to less than that at the bottom of the threads. The term "bolt," however, is sometimes made generically to include them all. The advantages of studs are that, like tap-bolts, they can be used in holes that sink only a limited depth into the metal, and in other situations where "bolts" would be impracticable; but they have the advantage over tap-bolts that they afford the convenience when putting machinery together, especially if this is heavy, of guiding the parts together, leaving only the simple matter of putting the nuts on to complete the fastening. A further not unimportant point, especially affecting cases where machinery has frequently to come to pieces, is that the studs, being permanent fixtures, are not liable to be mislaid, while a lost nut, comparatively, is

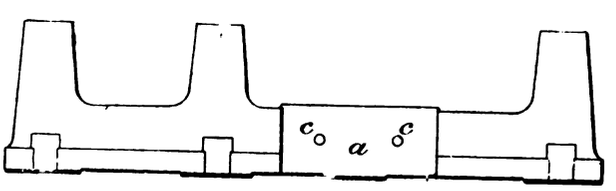

FIG. 18.

easily replaced. Nuts of various sizes are easy to store, and a set is easily kept complete by simply stringing them together. Other kinds of bolts, possessing as they do the disadvantage that they, of course, vary in their lengths as well as their diameter, if lost, their replacement is apt to be a much more serious matter than in the case of a lost nut; and to store them in sizes, or to keep "spares," is also more cumbersome than to keep

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a few nuts. There are thus various things to be considered in deciding on a fastening.

The blank portions in bolts and tap-bolts between the head and threads, termed the "shank," may be turned bright and be an exact fit in the hole drilled to suit, or it may be unmachined or "black," in which case the hole is drilled or cored $\frac{1}{16}$in. or $\frac{1}{8}$in. larger diameter than the bolt, and is termed a "clearance hole," as shown at *c* (Fig. 17). This latter method is of course only used when the bolt is purely in tension and when the parts are kept in position by other means. Turned bolts fitting in drilled holes are

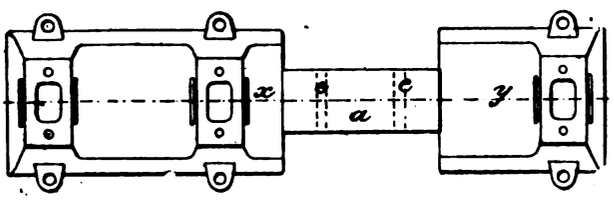

Fig. 19.

necessary when shear has also to be sustained. Such shear, for example, would come on the tap bolts, *a*, in Fig. 16 if the blocks, *h*, were absent. In the case of clearance holes, washers should be put under the nuts as shown (Fig. 17). These tend to spread the pressure of the nut over a larger surface of the facings. Some workmen, however, like to have such washers in all cases, as they facilitate tightening up the nut. The hole through the washer exactly fits the bolt, and its outside diameter is twice that of the bolt. In rough work, of course, where there are no machined facings for the nuts to bear on, a greased washer under the nut is more easy to

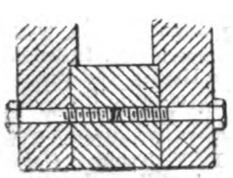

Fig. 20.

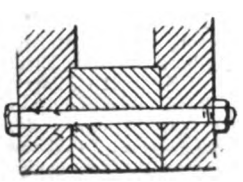

Fig. 21.

tighten up on than the rough skin. The thickness of washers in practice may perhaps be taken as follows: $\frac{1}{16}$in. thick for small bolts $\frac{3}{8}$in. diameter and under; $\frac{1}{8}$in. thick for bolts from $\frac{1}{2}$in. to $\frac{7}{8}$in. diameter; $\frac{3}{16}$in. thick for bolts, from 1in. to 1$\frac{3}{8}$in. diameter; $\frac{1}{4}$in. thick, from 1$\frac{1}{2}$in. to 2in. diameter, and so on. Intermediate thicknesses involving thirty-seconds of an inch can, of course, be put if desired. As from about $\frac{3}{4}$in. diameter and upwards, the dimension across the angles of the nut becomes less than twice the diameter of the bolt, in these latter cases the washer will project slightly beyond the nut angles. This, however, merely enhances the effect, as exemplified in Fig. 17.

We may now consider another type of bed-plate, illustrated in Figs. 18 and 19. We find here three bearings instead of two; also a mass of solid cast iron at *a* forming

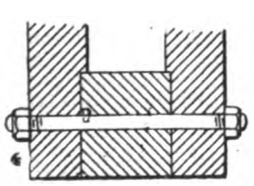

Fig. 22.

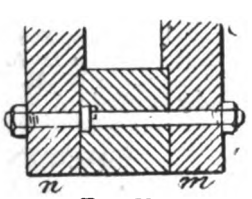

Fig. 23.

the yoke of the magnets, this bed-plate being for an overtype machine. The third bearing is, of course, put outside the pulley, and thus relieves the shaft of strain, for otherwise the pull of the belt tends to deflect the shaft between the bearings. Thus, with the three bearings a smaller shaft will be justifiable than would be required with the two bearings. The mass of metal for the yoke will tend to make the casting go out of shape when cooling. A greater depth will thus be desirable for extra stiffness, and all facings might be made to rise more amply. But experience in casting any particular form and size of bed-plate of this general type must be the best guide as to what peculiarities it may develop when cooling. As cast iron is not so good a magnetic conductor as wrought iron, the section on *x y* (Fig. 19) needs, of course, to be proportionately greater.

The attachment of the magnets to the yoke may be effected in various ways, illustrated to some extent in Figs. 20 to 23. Of these the first shows tap-bolts. The advantage of these is that either limb can be removed without disturbing the other. In Fig. 21 the holes are drilled and long turned bolts are put through, fitting the holes. A more symmetrical method, showing nuts only on both sides of the machine, is to use long turned stud-bolts, with a small pin to prevent their rotating, as represented in Fig. 22. These latter two methods, of course, involve loosening both limbs at once, though a small magnetic advantage is that they will act as good magnetic conductors from limb to limb for what section they occupy. To combine the advantages, a collar-bolt, with a pin to prevent rotation (Fig. 23), might be adopted. This, however, would incur the expense of special forgings to get the collars, or else the bolts must be turned down in the lathe from round iron having an original diameter at least equal to the diameter of the collar, involving greater or less waste. It will be noted, however, that though the limb *n* may be removed without disturbing the limb *m*, the latter cannot be removed without slacking both. A further method, not here illustrated, is to tap studs into the yoke instead of tap-bolts. Nuts would then show on the outside, as in Fig. 22, while the advantage is retained, as with the tap-bolts, that either limb can be removed without dismounting the other. It would be awkward, however, to withdraw the magnets off such long studs; while if clearance holes are put in the magnets the studs would no longer serve to keep them accurately in place. For general facility, the tap-bolts (Fig. 20) are probably the best, and offer the most advantages.

(To be continued.)

A NEW METHOD OF SPEED CONTROL FOR ELECTRIC MOTORS.*

BY PROF. W. A. ANTHONY.

As I was unable, on account of active engagements, to be present at the last meeting of the American Institute of Electrical Engineers when the speed control of electric motors was under discussion, I take the opportunity to present, through the columns of the *Electrical Engineer*, some views of my own on the subject. The H. Ward Leonard system is theoretically an ideal system, giving perfect control of speed from zero to a maximum without waste of energy, but it has the disadvantage that it requires a dynamo for each motor, and that that dynamo does spark when its field is weak. Regulation of speed by variation of field strength of the motor has the same advantage of involving no waste of energy, but it has had the disadvantage that the increase of speed that could be obtained by weakening the field was limited to a comparatively small percentage variation, because the weak field has not the power to control the sparking at the commutator.

It is well known that the control of sparking at the commutator depends largely upon the density and stability of the magnetic "fringe" at the pole corners. It is well known, too, that this fringe disappears very rapidly as the field is weakened, and that to maintain it intact the field magneto-motive force must be kept well in excess of the armature reaction. It occurred to me that if in a multipolar machine having a "two path" armature winding, wherein the E.M.F.'s developed by the several pairs of poles were added together to make up the total E.M.F. of the machine, one pair of poles—a north and a south—could be varied in strength without varying the others, the magnetic fringe at the corners of the unvaried poles would remain, and a much greater variation of speed could be effected than would be possible if the field as a whole were weakened. Let Fig. 1 represent a six-pole motor, wound as usual with a field coil on

* From the *Electrical Engineer* (New York).

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each pole. Assume that all the coils are excited. There will be an equal magnetic flux through each of the circuits *a b c*, *e b i*, *f g c*, etc. (Fig. 1). Now suppose the circuit through coils on pole-cores 1 and 4 to be broken, and consider what will happen on the supposition that the "yoke" connecting the pole-cores is very heavy and presents but a very small magnetic reluctance. The magneto-motive force tending to carry the magnetic flux through the circuits 1 and 4 no longer exists, but the lines which before went through 1 and 4 are by no means lost

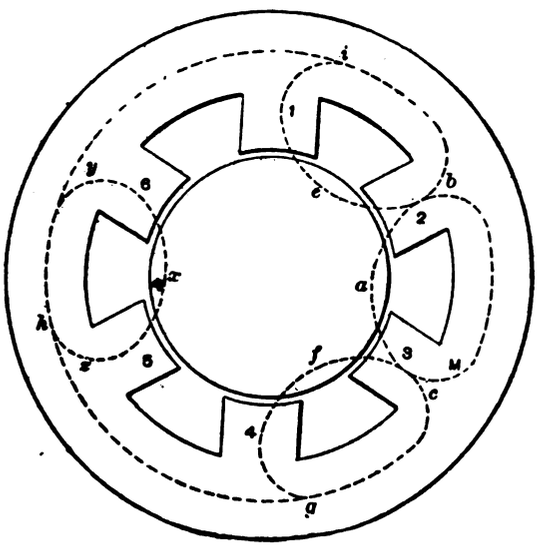

FIG. 1.

to 2 and 3, since they may still find their way by the path, *i h g*, of very low reluctance through the yoke. Hence, if the yoke be sufficiently heavy the poles 2 and 3 will be hardly at all diminished by cutting the coils 1 and 4 out of circuit, or even reversing them. The same is true of poles 5 and 6. It would be easy, if necessary, to so design the machine that *a b c* should form one circuit and *x y z* another, both entirely independent of the circuit through 1 and 4. Poles 2 and 3 and 5 and 6 might, for instance, be made as separate castings, as shown in Fig. 2. Poles 1 and 4 might then be connected by yokes, which would serve also as supports for the armature bearings. Poles 2 and 3 and 5 and 6 could then be magnetically insulated from 1 and 4, so that no change produced in the magnetic strength can in any way affect the strength of the remaining poles.

It is, however, unnecessary to go to the extent of magnetically insulating the poles which are, from those which are not, to be varied. A machine made upon the ordinary plan, but having a considerably heavier connecting yoke, will serve to secure all the necessary independence between the poles. In a six-pole machine the speed with one pair of poles cut out will be about 1½ times, and with that pair of poles reversed will be about three times the speed with all poles active, and, of course, all intermediate speeds may be obtained by gradually cutting down the current in the coils by means of resistance before cutting them out

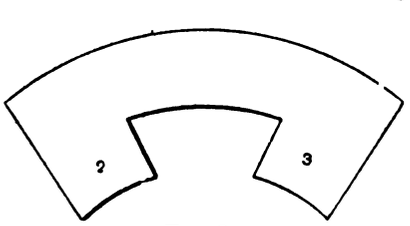

FIG. 2.

altogether and then reversing through the same resistance, which is then gradually cut out. Machines having 10 or 14 poles will be susceptible to much wider ranges of speed variation than can be realised with one of six poles. It is possible to apply the same method of control to multipolar machines having one common field coil for magnetising all the poles.

It will, of course, be understood that where constant torque is required at all speeds, as is approximately the case for elevator or street car service, for running printing presses, etc., the capacity of the motor is limited by the conditions at high speed. At the low speed the capacity would be unnecessarily small, the torque being almost inversely proportional to the speed. Where constant power is required, as is approximately the case for machine tools, such as lathes, boring mills, etc., the motor would fulfil the requirements at all speeds. The range of speed that it is possible to obtain by this method of control is certainly very much greater than has been possible by varying the field strength as a whole, and I believe it will be found an exceedingly valuable method in most cases where variable speed is required.

INSTITUTION OF ELECTRICAL ENGINEERS, Jan. 14.

Sir HENRY MANCE (president) in the chair.

At last night's meeting of the Institution the following were the candidates balloted for:

Members.—S. O. Cowper-Coles, 21, St. Ermin's-mansions, Westminster, S.W.; H. D. Norman, P. O. Box 271, Johannesburg, South Africa.

Associates.—S. Ashby, borough electrical engineer, Maritsburg, Natal; E. S. Bradburne, The Central Technical College, Exhibition-road, S.W.; A. C. Brown, The Eastern Telegraph Company, Winchester House, E.C.; W. F. Bruce, The Manse, New Machar, Aberdeenshire; E. R. Carr, The National Telephone Company, Limited, 58,159, London-wall, E.C.; G. A. Cowles, 9, Cicada-road, Wandsworth, S.W.; A. Fraser, Telegraph Department, Aberdeen, N.B.; J. R. W. Gardam, Post Restante, Sydney, N.S.W.; E. T. Goslin, "St. David's," Mount Nod-road, Streatham Hill, S.W.; D. McD. Grosart, Bank Villa, North Circular-road, Dublin; P. Hamilton, B.Sc., 4, Lansdowne-crescent, Glasgow, N.B.; H. Hewlett, 69, Hubert-grove, Stockwell, S.W.; L. J. Lawrence, 5A, Stafford-street, Old Bond-street, W.; G. H. Llewellyn, Pencraig, Caeran Park, Newport, Mon.; C. E. Lugard, 97, Sinclair-road, Kensington, W.; G. McAlpine, 26, Lovaine-crescent, Newcastle; G. E. Penboss, Standard Electrical Engineering Co., 19, Bligh-street, Sydney, N.S.W.; R. G. Perry, Westacre, Hagley-road, Birmingham; H. J. Read, Greenfield Villa, Liverpool-road, St. Albans; J. Roberts, 44, Pennard-road, Shepherd's Bush, W.; T. Stevens, 71, Balaam-street, Plaistow, Essex; D. J. Strutt, The Firs, Strawberry-hill, Twickenham; G. E. V. Thomas, Government House, Singapore; S. Woodfield, King's College, London, W.C.; J. Wrigley, 8, Abington-street, Northampton; M. R. A. Wyatt-Edgell, Cowley-place, Exeter.

Students.—W. E Barker, Lancaster House, High-road, Balham, S.W.; F. J. Benton, 6, King Edward-road, Rochester, Kent; T. Bowden, 71, Victoria-road, Stroud Green, N.; W. W. Bradfield, 21, Newick-road, Clapton, N.; W. L. Carter, 51, Aynhoe-road, Brook Green, Kensington, W.; C. J. Cunningham, 54, Stafford-road, Bow, E.; H. M. Dowsett, 18, Christopher-street, Finsbury-square, E.C.; C. C. T. Eastgate, 30, Darenth-road, Stamford Hill, N.; C. S. Franklin, 22, St. John-street, West Smithfield, E.C.; M. R. Gardner, Thornleigh, Woodbury Park-road, Tunbridge Wells; A. F. M. Gatrill, 7, Norcott-road, Stoke Newington, N.E.; E. T. Gifford, 27, Basset-road, North Kensington; A. H. Greenwood, The Limes, Highgate, N.; B. Handley, 22, Oberstein-road, New Wandsworth, S.W.; F. J. Hawkins, Grafton House, Worcester Park, Surrey; A. J. Hersant, 49, Lennox-road, Finsbury Park, N.; B. Hopps, 216, South Norwood-hill, London, S.E.; F. K. Jewson, 13, Osborne-grove, Finsbury Park, N.; J. Kingston, 8, Mona-terrace, Cheney-road, Leytonstone, E.; J. H. McDowell, Balliol House, Toynbee Hall, E.; R. V. Macrory, 7, Maryon-road, Charlton; C. W. Messenger, 94, Caledonian-rd., Kings Cross, N.; C. O. Milton, Electric Light Station, Hull; J. L. Morris, 21, St. Ann's-villas, Holland Park Avenue, W.; G. Morrison, 40, Lonsdale-square, Barnsbury, N.; F. Powell, 7, Church-terrace, Union-grove, Clapham, S.W.; E. A. Tunbridge, 64, Josephine-avenue, Brixton Hill, S.W.; W. H. Ward, University College, Gower-street, London, W.C.; A. Wilkes, 2, Southbrook-road, Lee, S.E.; P. R. Wray, 81, Campbell-road, Bow, E.

PRESIDENTIAL ADDRESS.

After the usual formal business had been transacted, the address of the President (Sir Henry Mance) was delivered, the first portion of which we give herewith:

In electing me your president for the coming year, and thus according me the blue ribbon of the electrical profession, you have conferred on me an honour of which any man may be justly proud, and for which I thank you sincerely. If I approach my task this evening with diffidence, it is because I fully appreciate the responsibilities of office. But, gentlemen, I hold the opinion that that mortal is wise who accepts without demur the gifts bestowed upon him by the gods. It is not for me to question the wisdom of your choice, but it is for me to do my best to justify it. My term of office on your council has extended over some years, and I know the sympathy and help which the president of this Institution may always rely on receiving, not only from his colleagues, but also from the general body

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of members. You cannot always expect to have an ideal president, but I trust that when my period of office is over I shall be able to look back and congratulate myself that the dignity of the office and the interests of the Institution have not suffered in my hands, and that whatever developments may occur meanwhile, the Institution will continue, as hitherto, to lead the way in electrical science. There are periods in the lives of societies, as well as in individuals, when it is excusable to pause for a moment and indulge in mutual congratulation. It may have escaped your notice that this Institution is now entering into its twenty-sixth year of existence. It has therefore completed its first quarter of a century. I have recently been glancing through the many volumes of our *Proceedings*, and I think you will agree with me that they form a record of 25 years of useful work. During this period the nominal roll of the society has increased from 100 to nearly 3,000. Founded originally by electricians and telegraph men, it has adapted itself to modern requirements, and is now the oldest and largest institution of electrical engineers in the world. It represents all branches of the profession, and will, I trust, in the future, as in the past, aim to include in its ranks the names of all who are interested and devoted to the development of electrical science. Some of the founders of this Institution are still with us; indeed, I am glad to see Mr. Latimer Clark and General Webber here to-night.

Although I have been closely associated with important applications of electricity to heavy engineering and electrochemistry, I feel that the only claim that I have to the position that I now occupy is the fact that for the best part of my life I have been actively connected with submarine telegraphy. I suppose I am one of the few who can say that they have assisted at the manufacture of a cable, the laying of it, the working of it, its subsequent repair on nearly 200 occasions, and, finally, more than 20 years afterwards, had entrusted to them the duty of laying a new cable in its place—that is to say, I have been closely associated with a submarine telegraph cable from its infancy to its old age. For 40 years I have never lost touch with the telegraph, so that after a few general remarks on other topics I shall naturally turn to submarine telegraphy as the chief subject for my address this evening. If this subject has to some extent dropped into the background of late years in the discussions of this Institution, it is not by reason of its want of importance, but because of the rapid and extensive development of other branches of electrical engineering.

Electric Lighting and Traction.—With regard to these I do not mean to trouble you with statistics, as figures and facts in connection with them must be so fresh in the memories of those who study the weekly technical journals that I abstain from intruding them on your notice. In the matter of traction we have been outstripped by our Transatlantic friends, but there is abundant evidence that this has not been caused by want of knowledge or skill on the part of our engineers or manufacturers; it is, I think, an acknowledged fact that in excellence of design and workmanship our manufacturers cannot be beaten. Our electric light stations are unsurpassed in the excellence and efficiency of their plant, electrical and mechanical, and unequalled in their suitability to the end in view. The best features of the methods preferred by us are all of home growth; and if we have to borrow from American practice in connection with the electric traction movement now upon us, we shall at least be able to point to our tunnel railways as unique, and to the Liverpool Overhead Railway as the first elevated electric railway in the world. We have to deal in this country with local bodies which are somewhat difficult to move. This has handicapped us; moreover, our rivals have had the advantage of natural gas and water power. In America there is no doubt more room for expansion in every direction; here at home we have been suffering from a period of trade depression from which we have only recently emerged. We are now beginning to reap the benefits of the Electric Lighting Act of 1888, both in the number of towns seeking powers for electric lighting and also in the extensions required for those already in existence, the magnitude of these latter promising to exceed that of the original scheme. It is to be hoped that in future the electrical industries will not be fettered too much by officialism and hard-and-fast regulations, which, formulated with the best intentions, with the view to protect the public, tends sometimes to interfere with the public convenience. It is satisfactory to note that manufacturers are turning their attention to the development of cells especially suitable for traction purposes; the advantages already claimed are, that for any fixed output the weight is reduced in the ratio of 28 to 15, and the space occupied reduced from 19 to 10. Should these expectations be fulfilled, there is every reason to anticipate an extensive use of storage batteries. There can be no doubt that from the point of view of cleanliness, freedom from smell, and steadiness in development of power, storage batteries compare favourably with steam or oil engines. Where suitable localities and proper facilities for recharging are available, it may reasonably be hoped that traction by means of storage batteries has a future before it.

Submarine Telegraphy.—Although the ground has been well traversed on one or two occasions by my predecessors in this chair, I hope to find many points of sufficient interest to justify my bringing them to your notice. To deal comprehensively with the history of submarine telegraphy up to recent years would be quite beyond the scope of a presidential address. To those who desire to render themselves thoroughly conversant with the subject, I recommend the perusal of a work now in course of publication by one of our members, Mr. Charles Bright. The earliest record of a subaqueous line is that of the experiment made by Baron Schilling, who in 1812 exploded mines across the River Neva, using wire insulated with indiarubber. It would seem, therefore, that Schilling deserves the credit of being the first to suggest the employment of insulated conductors under water. In 1838 Colonel Pasley, R.E., made experiments at Chatham to demonstrate the practicability of telegraphing through lines under water. In 1839 Dr. O'Shaughnessy made a series of experiments across the Hooghly. In 1840 Prof. Wheatstone demonstrated before a committee of the House of Commons a method for establishing telegraph communication from Dover to Calais. In 1842 Prof. Morse laid down in New York Harbour an insulated wire for telegraphic purposes. In 1845 Ezra Cornell laid a 12-mile cable in the Hudson River; this cable worked well for several months until it was broken by ice. The earliest record at Somerset House of any submarine telegraph company is dated June 16, 1846, when Jacob Brett and Alexander Prince obtained a renewal of their provisional certificate of registration for the General Submarine and Oceanic Telegraph Company. The first concession connected with international submarine telegraphy was also granted to Jacob Brett in 1847—that is to say, 50 years ago—so that this year we may fairly be said to be celebrating the jubilee of the inception of international telegraphy. The adoption of insulated conductors for underground wires, both in Prussia and England, may have contributed to the development of submarine telegraphy. The value of gutta-percha as an insulator began to be recognised about 1847, and we find that in 1849 an English company obtained a charter from the French Government granting to them the exclusive right of sending telegraphic intelligence between England and the French coasts. The concession was conditional on communication being established by September, 1850, and with the object of preventing its loss a single wire invested with a thick coating of guttapercha and sunk by means of leaden weights was successfully laid, and messages transmitted from coast to coast. I have in my hand a piece of the identical core which was recovered some years afterwards. I may say that as a simple core it is quite as good as any made at the present day. Of course, such a slender wire could not be expected to stand the chafing to which it would be subjected against the rocky bottom; but the immediate cause of failure was its being grappled by some French fishermen, who promptly secured a considerable length of it, in ignorance of the real nature of their find. In December, 1850, J. W. Brett obtained a new concession from the French Government; the outcome of this concession was that a cable between England and France was laid during the following year. The establishment of the old Submarine Telegraph Company practically dates from this time. The iron wire-sheathed cable used on this occasion is said to have been suggested by Kuper. The cable was laid by Crampton. In the present day our copper is purer, our sheathing wires of a better quality, and we have learned to adapt different types of cables to different depths; but we must admit that the 1851 type has served as a model for subsequent shallow-water cables. We who are accustomed to hear of the laying of a fresh Atlantic cable with hardly a passing comment may be apt to underrate the skill and perseverance which brought about the laying of the first Channel cable; it may, therefore, be opportune to mention, in justice to the successful pioneers of submarine telegraphy, that the three subsequent attempts to connect Ireland and England all ended in failure. Considerable correspondence has of late appeared in the public Press regarding the inception and development of submarine telegraphy. I have devoted some time to the investigation of the records at Somerset House and the Patert Office, which are sometimes amusing and generally instructive. I have come to the conclusion that to no one individual can fairly be granted the credit of the inception and development of the submarine cable. The work has been the work of many: men of science, men with engineering skill, and men of capital have all contributed to laying the foundation of and building up the network of telegraphs which is slowly but surely being extended to all parts of the world. It is not for this Institution to deal with the rival claims of financier and engineer; but if we, as engineers, desire to do honour to any one individual who pre-eminently distinguished himself in the development of oceanic telegraphy, we have simply to refer to the list of our past presidents and select the name of Charles Tilson Bright. The earlier history of submarine telegraphy is marked by frequent failures. Twenty thousand miles of cable were laid during the first 16 years, but over 9,000 knots of this quantity had been abandoned before 1865.

(To be continued.)

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THE PRESIDENTIAL ADDRESS.

Every man who is anything at all is more or less of a specialist. It goes without saying that therefore each succeeding president of the Institution must be a specialist. He cannot help himself. A general knowledge of the subject electricity and magnetism is possible to every hard worker, but the special knowledge that comes of following the history, theory, and practice of any applied branch of the subject is obtainable to the few. Sir Henry Mance has been connected with telegraphic work, as he tells us, for forty years. His name will be found in every text-book on telegraphy as that of one who long since devised a testing operation, known as "Mance's method" ever since. It is, therefore, not surprising to find the new President dealing largely with telegraphic work in his inaugural address, and especially with submarine telegraphy, or that part of it with which he is personally acquainted. Credit has been given to the work of Brett and Crampton upon the 1850 Channel cable. The latter died a few years since, the former only last week. That, we need hardly say, was the pioneer line for submarine work, although a good deal of experimental work had previously been carried out. There is one point about submarine work to which we have frequently called attention, to which the President briefly refers, but which in our opinion cannot be too often or too strongly supported. Britain is nothing if not a maritime nation. The safe traversing of the ocean, and especially those portions near the coast, the ports, and harbours, depends largely upon accurate charts. The accuracy of the charts depends upon the number and the accuracy of the soundings, and we venture to say that the companies connected with submarine telegraphy have done as much, if not more, than other authorities combined to extend the number and accuracy of soundings and improve our charts during the past half century. Through the exertions of the staffs on board the cable ships, many routes once dangerous to traverse because of inefficient surveys are now ordinarily safe because of the careful soundings made. Further, off many coasts the bed of the ocean is continually changing. The causes are various—currents, detritus brought down and deposited by rivers, volcanic action, and so on, all play their part, and here again, owing to the requirements of cable laying and repair, surveys are frequent, and the charts are thus kept fairly correct. This constant survey work has been an incalculable boon to the nation, though never appreciated at its proper value, and, so far as we know, hardly recognised by the authorities. There is another point, though upon this the President is silent, and we doubt if the view we are about to enunciate has ever entered the minds of the majority of Englishmen. For years past Russia has been adding slice after slice of Asia to her already large possessions. She has reached the borders of Afghanistan, and most men think the ultimate goal is India. Suppose this to be the case. What part is Persia going to play in future history? It seems to us that Persia holds the key to the position, and with her the ally of Britain

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it seems easy to so threaten a lengthy line of communication as to render successful military operations over so long a line somewhat hopeless. But such questions as these are outside the presidential address. A very interesting and most important subject opened out by this address is that relating to cable repair, and the time when it is advisable to renew the cable rather than to repair it. The President shows conclusively that the problem is usually solved by indirect rather than by direct effects. By this we mean that the actual cost of a repair does not guide as to renewal. The question of renewal is decided by the loss of transit dues, the time occupied in a year by repairs. The cost of a repair may vary from a few pounds to ninety-five thousand pounds, an amount mentioned as that of the most costly repair known. But while the cost may be a few pounds, the loss to revenue may be a large multiple of this cost. Thus renewal will be decided, and also duplication. The latter is not always warranted by the traffic, but rendered expedient because of the loss of traffic during repairs. A discursive presidential address always touches many points of interest; and though it may not be generally known some of the suggestions with regard to the increase of speed in submarine cables have been experimentally tested by careful men over years of trial, they have been found wanting. What the future will bring forth we know not, but surely neither in land telegraphy, telephony, or cable work has progress ceased, without touching upon those other applications of electricity which fill the world with wonder, and will probably in history cause the latter part of the nineteenth century to be described as the commencement of the "era" of electrical developments.

OBITUARY.

THE LATE JACOB BRETT.

On Saturday last, at the advanced age of 88, there passed away one whose name must take a high place in the English scroll of fame—one who while still living did not receive that recognition for his services that they deservedly entitled him to; one of that energetic band of pioneers who laboured arduously to introduce telegraphy, both land and submarine; one whose labours assisted to enrich and ennoble others, but who did not himself obtain even that pecuniary reward which they partly through him enjoyed. We do not remember any survivor of that band of workers who, prior to 1850 pressed their views upon an unwilling public, eventually obtained a hearing and succeeded in showing the practicability of submarine telegraphy. The late Jacob Brett was the link which connected us with that past. It was 51 years ago the 16th of last June that he registered the General Oceanic Telegraph Company. We have before us a facsimile of the certificate of registration. It is dated June 16, 1845, No. 384, and signed by Frederic Rogers, the registrar of joint-stock companies. The receipt is to "Jacob Brett, Esq.," and signed George Taylor. The work of Mr. Jacob Brett was admirably summarised by Mr. Latimer Clark upon the occasion of the Institution of Electrical Engineers electing Mr. Brett an honorary member and accepting his portrait from Miss Alice Bolton. That eulogy will be found in the proceedings of the meeting of November 12, 1891. The President of the Institution, in his inaugural address yesterday, mentioned at some length the early work of the brothers Brett. For many years this work was ignored and almost forgotten. Mr. Latimer Clark, however, took the matter up, and in 1888 the Right Hon. W. E. Gladstone granted Mr. Brett a pension of £100 a year. Subsequently, in 1892, Lord Salisbury made a grant of £200 from the Queen's Bounty Fund, and on December 24 last a petition for further aid was sent to the Right Hon. A. J. Balfour. The text of this petition gives the summary of Mr. Brett's work as follows:

SIR,—We have the honour to submit for your consideration this, our petition on behalf of Mr. Jacob Brett, hon. member of the Institution of Electrical Engineers, who is now in his eighty-ninth year, having been born in the parish of St. James, Bristol, on October 16, 1808.

Mr. Brett is the survivor of the two brothers John Watkins Brett and Jacob Brett, who are well known in connection with the invention and introduction of submarine telegraphy, and who established at their own cost the first submarine telegraph laid between England and France in September, 1850.

Mr. Jacob Brett took out his first patent in connection with the telegraph in 1845, and on June 16, 1845, he registered at the Joint-Stock Company's office a company, termed "The General Oceanic Telegraph Company." . . . The objects of the company were specified to be the establishment of communication by electric telegraph between the British Islands and Continental countries, and across the Atlantic Ocean to Nova Scotia, the Canadian and other Colonies. This undertaking afterwards developed into the Atlantic Telegraph Company.

On July 21, 1845, Mr. Jacob Brett appears to have laid before Sir George Cockburn, First Lord of the Admiralty, a plan for connecting the Government offices in London with the most distant parts of the United Kingdom and with the Colonies, which letter was acknowledged by Sir Robert Peel on July 25, 1845.

On July 23 in the same year the brothers Brett addressed a letter to Sir Robert Peel, Bart., pointing out the advantages of the system and its importance to the Government. A copy of this letter is annexed, and in order to appreciate its significance it is necessary to bear in mind that it is the earliest communication extant of this character, or on this subject (submarine telegraphy being at that time wholly unknown), and that the earliest telegraph company in the world, the "Electric Telegraph Company," was not incorporated until the following year, only opening its address for the reception of land messages in 1848.

The Messrs. Brett having failed to obtained sufficient pecuniary support in England for the other General Oceanic Telegraph enterprises, ultimately applied in April, 1847, to the French Government, under H.M. Louis Philippe, for permission to lay a submarine electric cable across the Channel from Dover to Calais. After much correspondence, they obtained on December 9, 1847, a concession for the laying of such a cable at their own cost and without any exclusive rights, and Mr. Jacob Brett obtained the permission of the Lords of the Treasury and of the Admiralty to land the cable in this country. After some delay obtained in April, 1849, a decree from H.I.M. the Emperor of the French granting to him a concession for the exclusive right to lay cables from England to the French coast for 10 years.

On August 25 the Messrs. Brett at their own cost, and with the assistance of other friends, laid the first submarine telegraph—viz., the line connecting England with Cape Gris Nez in France—and transmitted through it type-printed messages. This, the first submarine telegraph wire, consisted of a plain copper wire with an insulated covering of guttapercha, and was almost immediately destroyed by the French fishermen, ignorant of its nature.

In the following year the Messrs. Brett formed the Submarine Telegraph Company, under the chairmanship of the late Sir James Carmichael, who laid a four-wire cable of the iron-sheath type now in universal use. This company proved very prosperous, and it is believed that portions of their original cable remain in working order after 30 years.

The brothers Brett laid the Ostend and Dover cable in 1853. They formed the Mediterranean Telegraph Company, and in 1854 laid the submarine cable from Algiers to Sardinia and Corsica. They also made many endeavours to form a company for cables from Suez to India. In 1852 they formed the European and American Telegraph Company, which afterwards became the Magnetic Telegraph Company, and was eventually amalgamated with the British Telegraph Company.

In October, 1856, the first Atlantic telegraph company was formed, and the first cable was successfully laid in 1858 by the late Sir Charles Bright, though it failed electrically almost immediately after its submergence. The prospectus of the company was issued on November 6, 1856, and the capital of £150,000 was subscribed, Mr. John W. Brett being greatly instrumental in its formation, and subscribed in his own name for £25,000, which was ultimately lost. He died in December, 1863, aged 58, and was therefore unable to assist in the ultimate realisation of their project by the successful establishment of the 1865 and 1866 Atlantic

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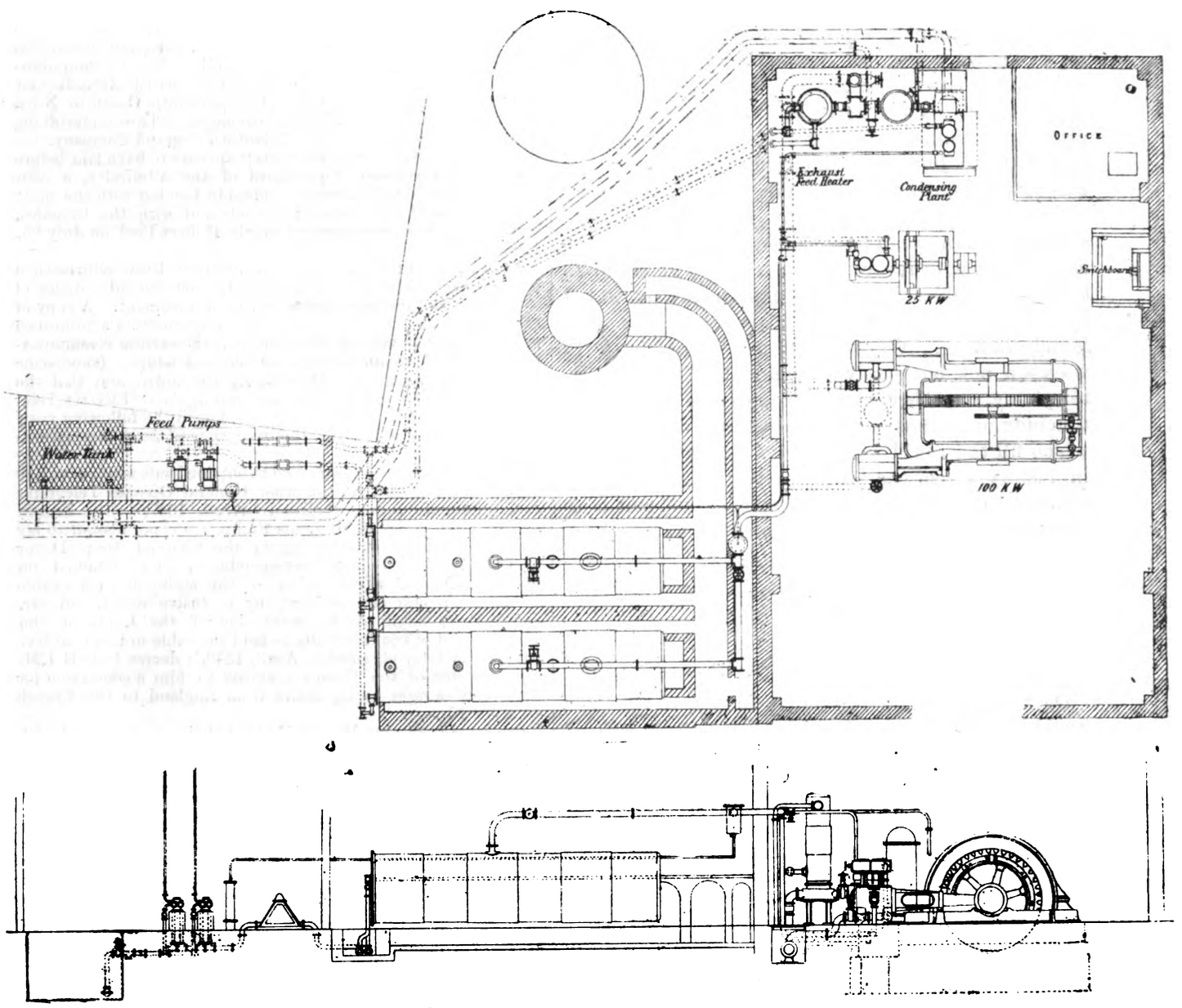
cables. Mr. Brett left one-tenth of his large fortune to various charities. It was singular that among those who received honours at this time the brothers Brett seem to have been totally overlooked.

That this petition would receive careful consideration we all know, but, alas, a favourable reply is even now too late. It may be well to state that Mr. Latimer Clark is in possession of all the papers of the late Mr. Brett, and it is his intention, we believe, to present them to the Institution. We cannot but deplore the loss of one whose name was so intimately acquainted with telegraphic work, but we deplore also the strange characteristic of Englishmen, who ignore a man when living, to make a fetish of his memory when dead. The funeral took place yesterday.

ST. HELENS ELECTRICITY WORKS.

The enterprising town of St. Helens has grown within recent years from a small village to a most prosperous manufacturing town. It owes its rise to the coalfields in its vicinity, and has large alkali, copper smelting, and iron works, but its most prominent industry is that of glass manufacturing. It has now some 80,000 inhabitants, who are keenly alive to their own interests. This is shown by the fact that the water, electricity, and gas works are in the hands of the Corporation. We understand that there is also some prospect of the tramways being taken over by the municipality and worked electrically. There has not been much delay in progress of the electric lighting scheme in St. Helens. The Corporation decided in 1893 to apply for a provisional order, which was accordingly granted to them in the following year. They then engaged Mr. Robert Hammond to advise them professionally, and he has been most ably assisted in the matter by Mr. Samuel Glover, the gas engineer. It was found advisable to erect the necessary buildings on land adjoining the gasworks, and the management of the station is now in the latter gentleman's hands. Tenders were advertised for in 1895, and the works commenced a public supply about two months ago.



FIGS. 1 AND 2.—Plan and Elevation of the St. Helens Electricity Works.

Site and Buildings.

The site chosen by the gasworks has many advantages apart from the unification of the two departments. The fuel supply is cheapened by the use of coke breeze from the gasworks, which, when mixed in the proportion of two parts of coke breeze to one part of coal slack, gives a cheap and good fuel. The mixture is charged to the electric light department at 3s. 4d. per ton. Another economy results from the water-supply question. The gasworks require a large quantity of water daily and have a reservoir for storing the same. Hence Mr. Glover has arranged that

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this water shall be taken from the town mains during the evening and passed through the condenser in the electricity works on its way to the reservoir.

The buildings and stack were designed by Mr. Samuel Glover, the drawings for these and for all the arrangements in the buildings being got out by Mr. E. M. Hollingsworth. The buildings, which are of red brick, are admirably suited to the purpose for which they are intended. The arrangements can be seen in Figs. 1 and 2. The floor of the engine-room is tiled, and the walls have a dado of salt-glazed bricks up to a line 7ft. from the floor. Great care had to be paid to the ventilation of the building

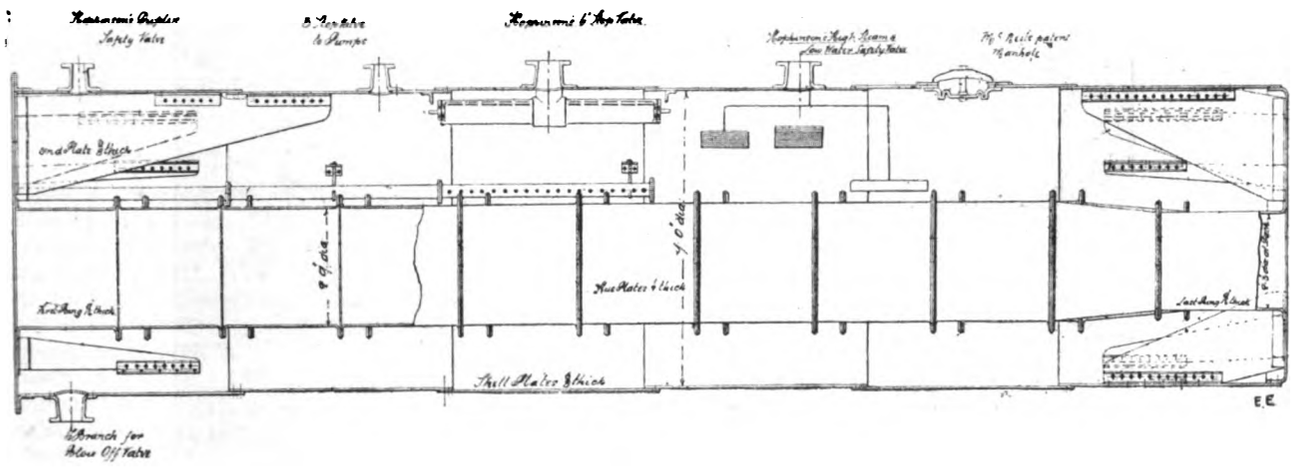

FIG. 3.—Longitudinal Section of the Yates and Thom Boiler used at St. Helens.

owing to the atmosphere peculiar to St. Helens. Thus the top lights do not open, but a limited amount of air can be admitted from the side windows. The air in St. Helens attacks quickly all polished parts, specially if of brass or copper, so that it is difficult to keep a good appearance on the machinery. The glass used in glazing the windows is manufactured by Messrs. Pilkington, Limited, of St. Helens. In the centre of the sheets a galvanised wire netting is introduced in the process of manufacture, which adds greatly to the durability of the produce. The fragments are kept in place by the wire

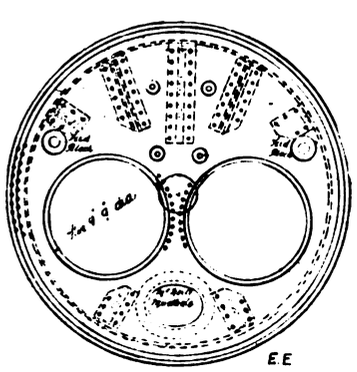

FIG. 4.—Front View of Boiler.

netting after a fracture, which greatly lessens the pleasure of the would-be window breaker. From the plan (Fig. 1) the reader will see that some future machinery can be easily housed in the present engine-room. Extensions can also be easily made to both the engine-room and boiler-shed, as land is available. The present office accommodation will, however, be sufficient all the while the two departments are worked under the one direction.

The chimney shaft is a handsome erection, 150ft. high, varying in diameter inside from 7ft. 3in. at the base to 5ft. 6in. at the top. It stands on a block of concrete 30ft. square by 4ft. 6in. deep, which rests on blue clay. The firebrick lining is carried up for some 30ft. The cap of the shaft consists of segmental blocks of firebrick, keyed together by iron hoops, placed on edge. This gives a good bond. The use of cast iron for chimney capping is not considered to be advisable in St. Helens. The foundations of the machinery had also to be carried down some distance to get on to the clay; in fact, about 320 tons of concrete were used in the foundation of the large set. As it runs now absolutely without a tremor, the care taken has been justified. The buildings were erected by Mr. W. Molyneux, a local builder.

A 10-ton overhead traveller, supplied by Messrs. Carrick and Ritchie, of Edinburgh, traverses the full length of the engine-house. The crane has a span of 38ft. between the centres of rails. The main carriage of the crane consists of two steel girders, having a curved underflange. These are 3ft. deep in the centre and 1ft. 6in. deep at the ends. They are fitted into pockets formed in the end carriages. They are connected by gusset plates, and stiffened by horizontal diagonal bracing between the beams, which are further stiffened by vertical T-irons. A rail is riveted to the top of the beam for the crab to run upon. The crab is formed of two strong cast-iron frames securely braced by cross stays, and having suitable bearings formed in them for the various shafts. All the bearings are fitted with caps, so that any shaft may be removed from the crab for examination or repair without taking the crab to pieces. A special feature in the construction of the crab is the

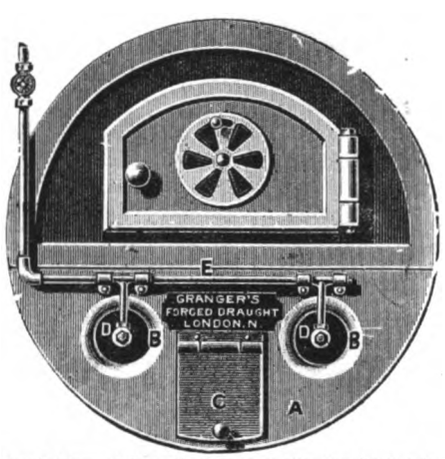

FIG. 5.—Front View of Perrett's Furnace, showing Granger's Blowers.

formation of double bearings, one on each side of each rail wheel. These take all bending strain off the axles, such as is the case when the wheels are overhung, and enable a smaller diameter of axle to be used in the bearings, and thus reduce the friction. The crab is fitted with double

FIG. 6.—Side View of Granger's Blower.

and single purchase gear. A ratchet and pawl are provided for suspending the load when travelling, and a powerful strap brake for controlling the load when lowering. The load is lifted by a fourfold chain and return block fitted with swivel hook. The upper return pulley is supported from a steel beam stretching across the crab. A special feature in this crane is the low headroom occupied from

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the rail-level to the highest point in the crab. This is effected by hanging the working platforms from outrigger beams formed of channel iron, the level of the platform being on the same plane as the bottom of the crane beams. The travelling of the crab is effected by suitable gearing connected to one of the axles, and the longitudinal travelling of the crane is also worked from the crab by an arrangement of gearing connected to a sleeve which slides on a square shaft centered right across the crane and working into spur gearing connected to the axles of the main carriages. The whole arrangement is simple and compact, and all the motion of the crane being worked from platforms on the crab saves the waste of time that takes place in cranes where the gearing for the longitudinal motion is worked at each end only of the main carriage.

Steam Generating Plant

This contract was given to Messrs. Yates and Thom, of Blackburn, who have supplied two Lancashire boilers. Each of these is 30ft. long, and is built up of six shell plates $\frac{5}{8}$in. thick and 7ft. diameter. Each boiler is capable of evaporating 5,000lb. of water per hour at a working pressure of 140lb. per square inch with the feed-water at a temperature of 60deg. F. The construction of these boilers is shown in Figs. 3 and 4, as are the fittings, which are of Hopkinson's own make. These include a safety-valve for high pressure or low water, a duplex safety-valve, two check-feed valves, a 2$\frac{1}{2}$in. blow-off valves, a gunmetal

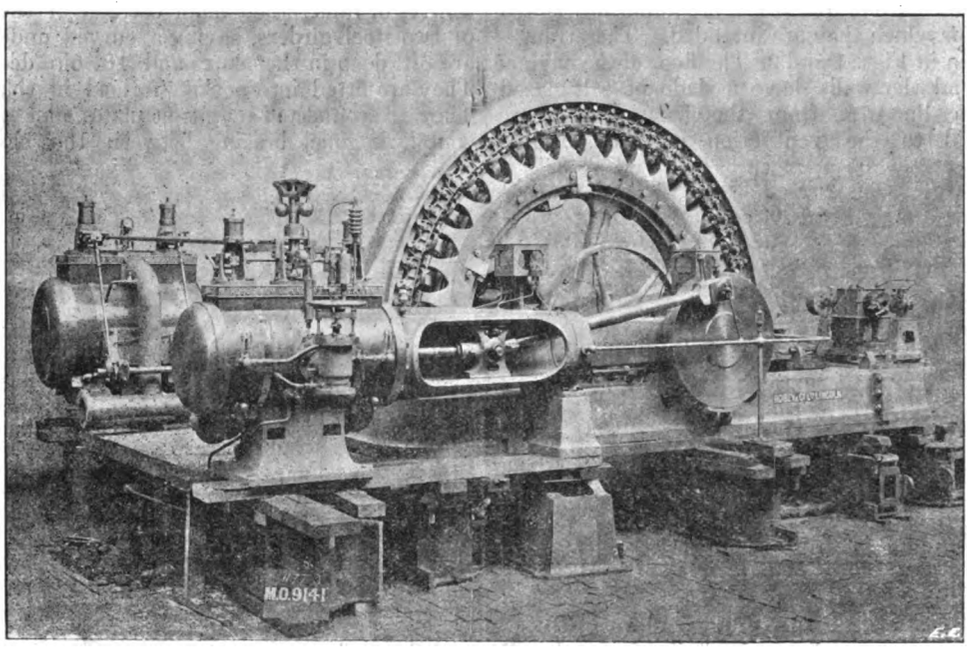

FIG. 7.—View of Robey Engine coupled to 100-K.W. Johnson and Phillips Flywheel Alternator.

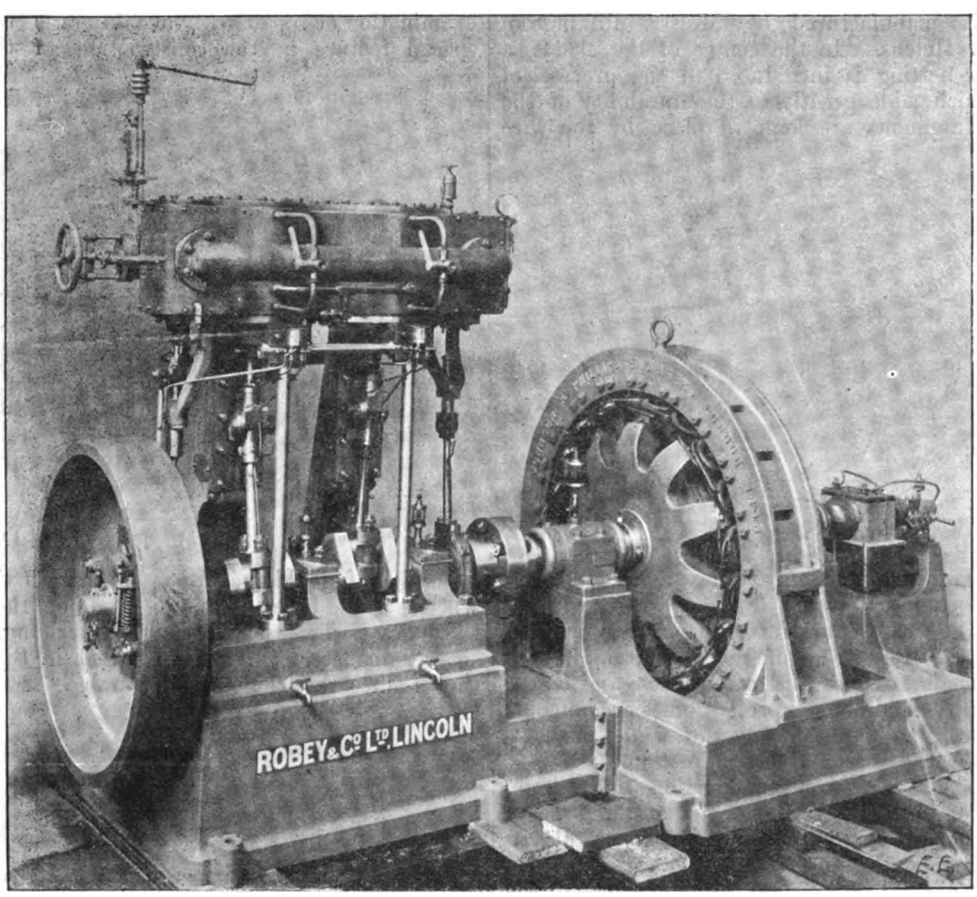

FIG. 8.—Robey Engine coupled to 25-K.W. Johnson and Phillips Alternator.

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water-level pointer, a steam-gauge graduated up to 200lb., two sets of water-gauges, a 6in. stop-valve for main steam-pipe, and a 3in. stop-valve from pipes to feed-pumps, etc.

As will be seen from Fig. 1, a duplicate set of flues has been constructed from these boilers, so that one flue can be cleaned while the supply is kept up by means of the other. These boilers are fitted with Perrett's furnaces and Granger's forced-draught apparatus (Figs. 5 and 6). The last figure shows the nozzle placed under the fire-bars. It will be seen that in addition to the central jet there are three others surrounding it, which can be readily adjusted in area by merely turning the milled rim, E, the adjustment being defined and facilitated by graduations, C, on the body of the nozzle. By its means the stoker can with the greatest ease regulate the strength of the draught up to about three times its normal power if necessary. The bars of the furnace are placed close together on account of the fine fuel used.

Steam and Exhaust Pipes.

All the steam-pipes are of lap-welded steel, and were supplied by Russell and Co. The main steam-pipe is 5in. diameter inside. The system of pipes both to the electric lighting engines and for the subsidiary plant are shown in Fig. 1. They are drained into a receiver connected to the hot-well. The exhaust-pipe is ample in dimension, as it provides for extensions up to 600 i.h.p. The main exhaust-pipe, which is 15in. diameter, is carried underground and connected to a single uptake pipe, so that the exhaust steam, in the event of not working condensing, may be delivered into the atmosphere direct. The uptake pipe is carried up through the drawing-office roof to a height of 6ft. above it. An exhaust feed-water heater of the Berryman type, by Wright, of Tipton, is provided, and the same firm are also responsible for the condenser. This is a surface condenser, with vertical U tubes, similar in construction to the feed heater. It was arranged to pass the

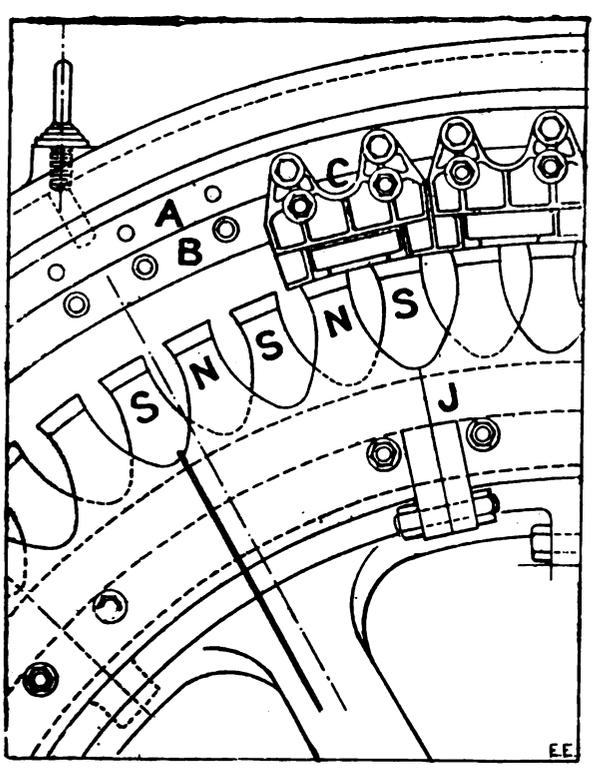

FIG. 9.—View of a piece of the Flywheel Alternator.

water through the tubes, but this did not give satisfaction, so the connections are being altered so that the steam shall be put through the tubes instead. The air-pump used in connection with this condenser was supplied by Messrs. Robey and Co., and runs at 100 revolutions. The two feeder pumps, which are arranged with a duplicate system of pipes, are of the Worthington make.

Engines.

There are two engines for driving alternators, one of 180 i.h.p. and one of 50 i.h.p. These engines were supplied by Messrs. Robey and Co., Limited, of Lincoln. The large unit (Fig. 7) is a coupled compound horizontal engine, having cylinders 14½in. by 23½in. by 33in. stroke, capable of easily developing 220 i.h.p. when running 98 revolutions per minute. The valve gear is of the well-known Richardson-Rowland triple-expansion type, with phosphor-bronze equalising valves. The governor, which acts on both cylinders, controls the speed under varying loads within 2 per cent. The average speed during a recent 10 hours' full-load test was 98·37 revolutions per minute, the steam pressure in high-pressure cylinder steam-chest being 125lb. per square inch. The alternator is fitted direct on to the

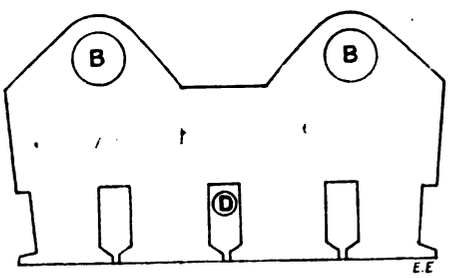

FIG. 10.—Core Plate of the new type Johnson and Phillips Alternator.

disc shaft, the engine and alternator being fitted on a massive cast-iron base-plate. An elaborate system of lubrication has been fitted to the engine, being automatically supplied by oil-pumps driven off the engine shaft. The whole combination is of effective appearance, and the workmanship is of the highest class. The United States metallic packing is used throughout these engines. The smaller 50-i.h.p. engine is an open-front vertical compound high-speed engine, having cylinders 7½in. by 13in. by 8in. stroke, and is capable of developing 60 i.h.p. when running 350 revolutions per minute. The alternator is coupled direct on to the crankshaft, both engine and

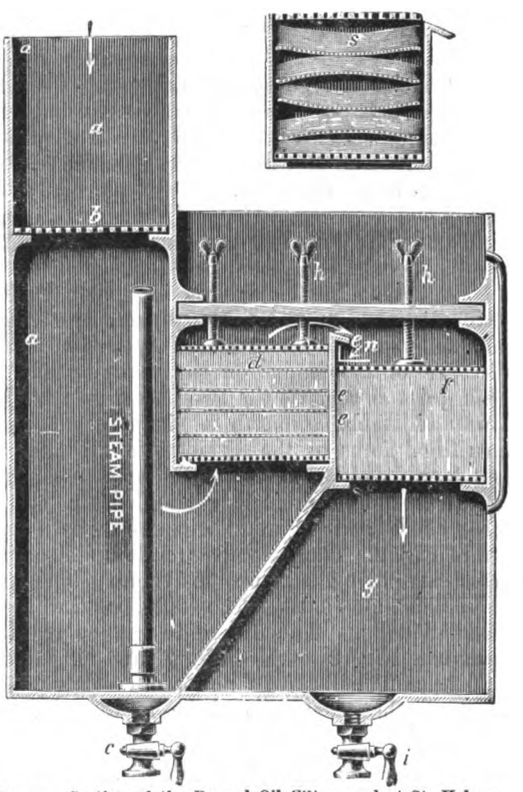

FIG. 11.—Section of the Berend Oil Filter used at St. Helens.

alternator being mounted on a massive cast-iron base-plate. All working parts are of large bearing surfaces, and the engine is fitted with very complete oiling arrangements. The valves used are of the piston type for the high-pressure and the ordinary slide valve for the low-pressure cylinder.

Alternators.

These were supplied by Messrs. Johnson and Phillips, of Charlton. The smaller one has a normal output of 25 kilo watts at 2,000 volts, and is capable of giving an output of 30 kilowatts for two hours on emergency. This machine, which runs at 350 revolutions, is of the type supplied to

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Tunbridge Wells, Bedford, and Aberystwith. The illustration (Fig. 8) gives a general view of this set. The diameter of the revolving field magnets is 35in., and the weight of this revolving part is 18cwt. The official test of the plant is yet to be made, but the makers have guaranteed that at full load this small set shall not take more than 34lb. of steam per kilowatt-hour when running condensing. At half load the consumption is guaranteed not to exceed 41lb.

The large flywheel alternator coupled to the horizontal engine described above contains several interesting improvements on the old type. The alternator gives normally 100 kilowatts at 2,000 volts when running at 100 revolutions, but can go to 115 kilowatts if required. The field-magnet system has 72 poles, and hence the frequency is 60 complete periods per second. The flywheel itself is built up of two segments (Figs. 7 and 9) bolted together, and the field coil is wound directly on the rim. The coil, owing to the large diameter, was wound *in situ* after the flywheel had been erected at St. Helens. The segments on which the poles are formed were then bolted on to the sides of the rim. There are six segments on each side of the flywheel, each having six polar projections. These are clamped on in such positions that the joint between two segments on one side of the rim is opposite to the centre of a segment on the opposite side. They also break joint as regards the two halves of the flywheel. In this way additional strength is given to the structure. The centrifugal force of the segments is not taken by the bolts, but by a faced projection in the segments, which key under a corresponding projecting ring on the rim of the flywheel. There are four bolts for clamping each segment, as shown in Fig. 9. The pole-tips are laminated to prevent eddy currents being set up in them. The greatest novelty in this alternator is, however, in the armature, which is stationary. The difference can be readily seen by comparing Fig. 8 with Figs. 7 and 9. There are only half the number of coils and removable segments in the new type that there would be in the old, and the arrangement of the core-plates gives a much more uniform magnetic resistance for all positions of the field magnets. Fig. 10 shows the new core-plate, which is twice the angular size of the old core-plate. The join between adjacent segments thus comes in what may be termed the centre of an armature core, and hence little or no induction need pass the air-gap left between these adjacent segments. This is the great advantage of the new construction. Coupled with it is the consideration that only one-half the number of coils are used, although, of course, the number of active wires and weight of armature conductor remain constant. This reduces the surface exposed to leakage, and thus helps the insulation of the circuit. The removable segments are still clamped by the old method, as can be seen in the illustrations. One clamping bolt, D, comes through the spare gap in the centre of the core-plate (Fig. 10). The following are a few particulars of this alternator: diameter across pole, 125in.; weight of revolving parts, about nine tons; weight of armature and frame, also about nine tons; density of current in field coil, 800 amperes per square inch; density of current in armature conductor, 1,700 amperes per square inch. The official trials have yet to be made, but a 10-hour full-load run was made recently, and the contractors have no fear but that the following guarantees will be met: steam consumption less than 28lb. per kilowatt-hour when running condensing, and less than 34lb. per kilowatt-hour at half load. These tests are to be made shortly, and the water will be measured into the boiler and not on leaving the engine. The regulation of these two alternators is said to be good, and they work well in parallel, the synchronising current being under five amperes.

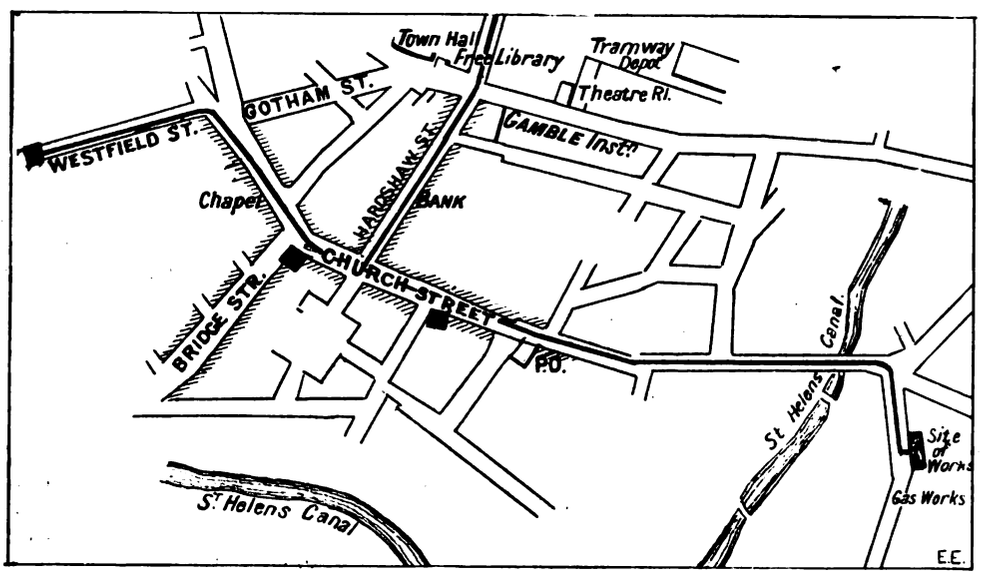

FIG. 12.—Map of St. Helens. The black lines denote high-tension cables. The shaded blocks are served by low-tension cables.

Exciters.

The exciter for the large set is fixed to the frame of the alternator, and driven by ropes from a wheel on the main axle. It is capable of giving 42 amperes at 50 volts, and runs at 400 revolutions per minute. The exciter of the small alternator is directly coupled to an extension of the shaft. Both these machines are of the two-pole type. The erection and preliminary running of these machines has been superintended by Mr. F. M. Short for Messrs. Johnson and Phillips.

Switchboard.

The switchboard was built by the Ferranti Company, and embodies the many advantages covered by their single-pole system. At present provision is made for only two dynamos and one circuit, but the construction of the board is such that extensions can be added easily at any time. In a board of this type each circuit only occupies 6in. centres, so that a board of 12 circuits only occupies a space of 6ft. The board is designed so that no special synchronising board is required, and it has the great advantage that everything relating to any one dynamo is arranged in one vertical line—the ammeter, switch,

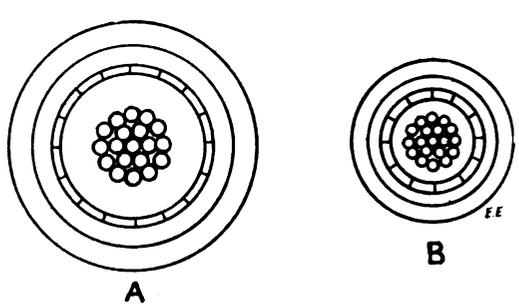

FIG. 13.—Sections of Cables used at St. Helens—A for high-tension, and B for low-tension distribution.

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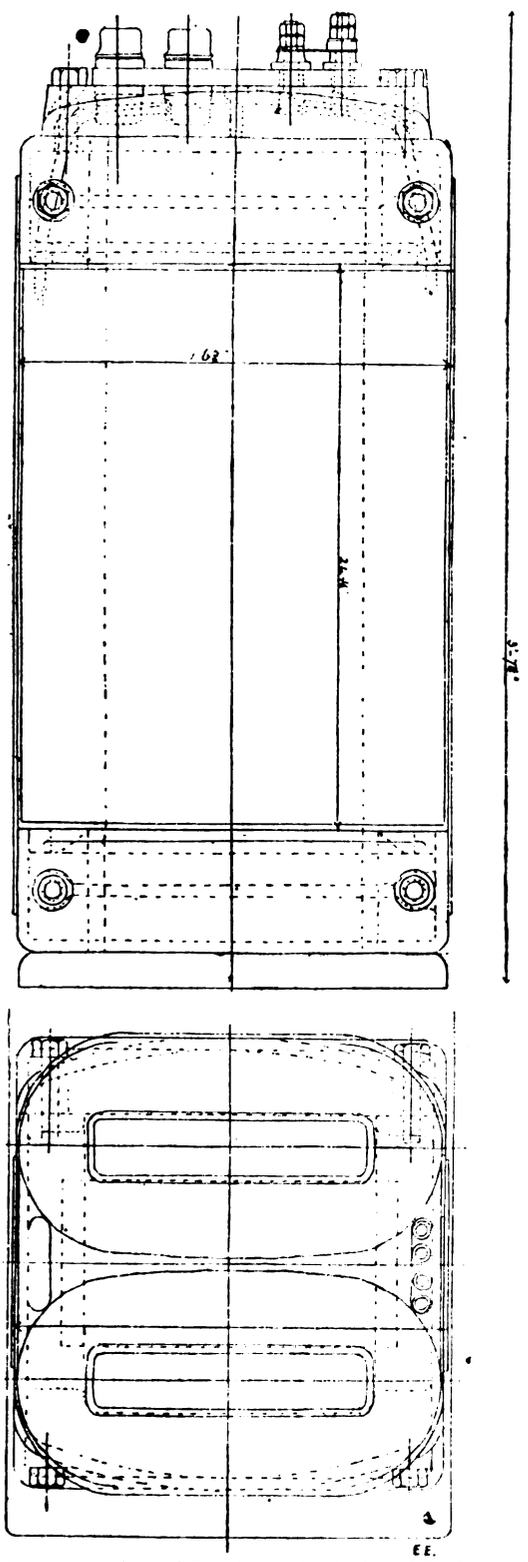
synchroniser contact, main fuse, main cable, exciter ammeter, switch, and regulator. This arrangement greatly adds to the simplicity, as the board shows at a glance a complete diagram of the connections. The board is used on a 2,000-volt circuit, but it has been submitted to a test pressure of 5,000 volts. Great care has always been adopted in the design with the question of insulation, the high-tension bar being placed at a great distance from the earth



FIGS 14 AND 15.—Plan and Elevation of the Leeds and London 21-K.W. Transformer.

bar, and specially carried by porcelain insulators sulphured into enamelled slate. In order to prevent a dynamo or cable breakdown affecting the 'bus bar, both pass through a fuse and switch before being connected, so that there is no circuit on which a failure can occur which will not instantly blow its fuse, and so become disconnected. The actual switches are made to carry 150 amperes, but will break 300 amperes at a pressure of 2,500 volts. The fuses, which are of the Ferranti patent oil type, are capable of breaking a high-tension circuit of 800 kilowatts without any danger of the arc being maintained. Messrs. Ferranti are also providing a special signalling apparatus to enable the switchman to communicate quickly and without chance of any misunderstanding with the drivers. A specially designed artificial load capable of dealing with 100 kilowatts on the 2,000-volt circuit is being installed by the same firm.

Mains.

This part of the work was placed in the able hands of the British Insulated Wire Company, of Prescot, who supplied and laid all the necessary cable and street boxes. The district served is shown by the map, Fig. 12, while Fig. 13 shows full-size sections of the cables used. The high-tension cables, A, are paper-insulated type and lead covered. The core consists of $^{19}/_{14}$ S.W.G. wires, equivalent to a section of ·0976 square inch. These cables are drawn into 5in. cast-iron pipes, for which purpose some 20 draw-boxes have been provided. Where the cable lines cross the canal just after leaving the works, the mains are carried underneath the canal in the main sewer. At this point armoured high-tension cables were used, which were firmly attached to the top of the sewer.

The low-tension distributing mains, B, were also concentric cables of ·0525 square inch section ($^{19}/_{16}$ S.W.G.). These were served over the lead with jute yarn, then armoured with a double layer of steel tape, and finally served with another layer of jute yarn and compounded. They were laid direct in the ground in the street, where cross-hatched. The capacity of the high-tension cables was found to be ·335 microfarad per mile, and that of the low-tension ·650 microfarad per mile. The position of the transformer sub-station is shown on the map. A few transformers are also being put into the houses of large consumers, such as the Gamble Institute and Messrs. Beecham's pill factory.

The transformers are in all instances put into iron boxes. The transformers were supplied by Messrs. Fowler and Co., and are of their new Leeds and London type, shown in Figs. 14 and 15. There are three main transformers of 21 kilowatts capacity, but each transformer is capable on an emergency of sustaining a load of 30 kilowatts for two hours. Each transformer is fitted with double-pole high and low tension switches and double-pole high and low tension fuses. The high-tension coils of transformer are separated from low-tension coils by an earthed metallic sheath. We understand that at normal output the temperature rise is about 25deg. F., and that the open-circuit loss in hysteresis is 210 watts. The efficiency of the transformers at full load is 97 per cent., and 96 per cent. at half load. The weight without case is about 900lb.

Load on Station.

Mr. A. H. Clarke, the resident electrical engineer under Mr. Glover, informs us that some 3,000 8-c.p. lamps are already connected to the mains, and that applications for supply are still coming in. Supply is at present given between a hour before sunset and midnight, and it is not likely that a constant supply will be undertaken till next autumn. The meters in use were supplied by Messrs. Chamberlain and Hookham and by the Thomson-Houston Company.

The town clerk, Mr. W. J. Jeaves, has taken great interest in the scheme, as has also Alderman T. Cooke, the chairman of the Electric Light Committee.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

FREE WIRING, ETC.

SIR,—I must apologise for again trespassing on your valuable space in answer to the letter from Mr. A. H. Gibbings. Perhaps a little further explanation will clear up some of the debatable points.

I cannot see why the working of the free lamp system I have recommended for Fermoy would be an impossibility in a town where the consumers are numerous. The arrangement would be quite optional, and those consumers who

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agree to the system would have to submit to an inspection of their fittings, etc. Fraud can be prevented by the obvious detail of insisting on the return of the old lamps, which can be specially made with a distinctive mark. The objection that the inconsiderate consumer will avail himself of the offer to investigate defective lamps is easily met by fixing a charge for testing, to be paid by the consumer if the lamp is within the prescribed limits. A similar case is that of meter-testing, where it has been found that the charge for testing has reduced the applications to a very small number. The point I wish to emphasise is that there is no charity in the system; it is a business arrangement similar to accumulator renewals. So far from anticipating dissatisfaction, it is hoped that complaints as to bad lamps will be prevented in this way, and that the good consumers will have more benefit from it than the bad ones; but I quite agree with Mr. Gibbings that time will prove the effect of the system, and when 12 months have elapsed I shall be pleased to communicate the results.

As Mr. Gibbings has given the conditions of his system in full, I might perhaps be permitted to say a word with reference to them.

It seems to me that "free lamps" is a misnomer. The consumer will have to pay for his lamps indirectly, as the cost of the lamps will be an extra works cost, and consequently the price of current will not be reduced as soon as would otherwise be the case. Again, I think it is a question whether the demand will rise to such an extent as to justify the extra expense, but we shall no doubt have more information from Mr. Gibbings at the beginning of next year on this point.—Yours, etc.,

F. J. WARDEN-STEVENS.

34, Victoria-street, S.W.

AN ASSOCIATION WANTED.

SIR,—Is it not time that we had an association for the protection of the electrical industries? The expensive pioneer work is done, up to a certain point; town after town is being lighted by electricity, plant after plant is being laid down; on every hand one sees evidence of the enormous strides that electrical engineering has made; yet one hears everywhere how difficult it is to make any money in it.

When a lighting plant is installed in a town, or a large building is fitted up, it is to no one's interest that the work should be done cheaply. The consulting engineer is paid in proportion to the money he spends, not on what he saves; the permanent borough or county engineer is thoroughly imbued with a dread of cheap work, as it usually means additional unpaid work for him; the ratepayer derives no benefit from any saving that may be effected, and no one ever considers him in the matter; yet when tenders are asked for, the successful firm nearly always takes the work at considerably less than cost.

Again, when the electric light is introduced in a town, the shopkeepers and others who adopt the light, though naturally anxious to get the work done as cheaply as possible, are always ready to pay any reasonable price. They may not have so many lights put in at once as they would if prices were lower, but they will have them all done in time. Yet as soon as the plant is down, sometimes before, down come a lot of contractors, fiercely contending among themselves for the honour of fixing the consumers' lights at half the actual cost, or less. Sometimes the work is well done, and the consumer is presented with a substantial sum by the contractor. Sometimes it is badly done, and the consumer has to pay later on more than it would have cost him to have the work well done at first, or he abandons the use of the light altogether. Usually, too, the contractors retire from the scene of their labours after a certain interval, having done no one any good but the few consumers aforesaid.

Again, as soon as any kind of electrical apparatus has passed beyond the pioneer stage, whether it be bells, telephones, lights, motors, X-ray apparatus, or anything else, every plumber and ironmonger enters the field. Usually he has not the faintest notion of the work at all; sometimes he has a faint notion, derived from the careful study of a manufacturer's catalogue. Generally he employs a sort of handy man who is competent to do gasfitting, plumbing, deal with hot-water apparatus, water motors, electric bells, telephones, lights, motors, etc. He always puts the prices down, and often in the most inconsistent manner. I heard the other day of a large firm of ironmongers who tendered for electrical work, involving a considerable expenditure in labour, at half the cost of the apparatus alone. Why should these things be?

And look again at the magnificent salaries that are being offered for the services of highly-educated trained men who have great responsibilities thrown on them—salaries that the unions would absolutely forbid a mechanic from accepting, and sometimes even less than is offered to a common day labourer. And if we ask what is the cause, the answer is simple—excessive and illegitimate competition. How can a firm of electrical engineers who have to pay all their expenses out of the profits of electrical work compete with firms who do not know what the work costs them, and who do not care? Why should they be compelled to compete with them? Surely electrical engineering is at least as scientific and demands at least as high an education as either law or medicine. No man can practice as a solicitor or as a barrister who has not been properly trained for the work and who does not belong to the lawyers' guild. No man can prescribe and no man can mix drugs for others who has not been educated and who does not belong to one of the medical or pharmaceutical societies. Surely the office of the electrical engineer is as important, as beneficent as that of either lawyer or doctor. It may be said that we have an institute which jealously guards our interests. Yet what does our Institute do for us beyond taking our fees and sending us the *Transactions*? What does it do for us more than any local bookseller will be only too pleased to do? Oh! but no one can put those initials after his name unless he belongs to the Institute. What does that benefit us. Our clients rarely ever know of the existence of the Institute. There is only one remedy, and that is, to go back to mediæval times. Let us form an association for our protection and for the prevention of the cut-throat competition that threatens to set the dial of progress backwards. It may be asked, what can such an association do? If properly supported, as it would be in the interest of all *bonâ fide* electrical engineers, it could obtain an Act of Parliament forbidding the employment of unqualified men. No one would object to the ironmonger doing electrical work if he employed a properly qualified electrical engineer and properly trained men to do his work. It could forbid the cut-throat competition at present ruling by refusing to sell apparatus to those who lowered the price beyond a certain figure. It could forbid corporations placing men in responsible positions at half or a third the salary the position should command. It could discourage youngsters who are thrown out of work from setting up in business. At present every youngster who is temporarily out of a berth sets up for himself, losing his own or his friends' money, and taking work from the rest. It could defend electrical engineers and their clients from the often absurd requirements of the insurance companies. In short, it could do all that the trade guilds of the middle ages did and that the legal and medical societies do now. It could place the electrical engineer in his proper position, the position that his education and his training warrant—viz., at the head of the scientific professions. Is not this worth working for?—Yours, etc.,

SYDNEY F. WALKER.

Cardiff Electrical Works, Severn-road, Cardiff.

HACKNEY VESTRY ELECTRIC LIGHTING.

SIR,—As there appears to be some misconception concerning my appointment as consulting engineer to the Hackney Vestry, and as you have recently published statements (which are not quite correct) concerning my recent correspondence with the Vestry, I shall be glad if you will kindly allow me to draw your attention to the resolution of the Vestry whereby my scheme was adopted and I was appointed consulting engineer to the Vestry. The resolution to which I refer is as follows:

"Your committee beg to report that in accordance with

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reference from the Vestry, dated June 12, 1895, they have inspected the electric light works at Dover, Bedford, Portsmouth, Cambridge, and Oldham, and the refuse destructors in operation at Cambridge, Leeds, Oldham, Warrington, and Southampton. The result of these visits has been to enable your committee to pronounce in favour of the practicability of the combined scheme of electric lighting and refuse destructor proposed by Mr. F. Hastings Medhurst. Your committee is of opinion that Mr. Medhurst's estimates of the cost of burning and collecting the refuse are safe. A careful comparison of his estimate of the working expenses of the electric lighting portion of the scheme, and the expenses which have actually been incurred in other London and provincial electric lighting works, shows that he has made liberal allowance, whilst his estimate of revenue appears to be founded on published returns of similar undertakings. Your committee beg to recommend the Vestry to adopt Mr. Medhurst's scheme, and to refer the matter back to this committee with instructions to engage Mr. Medhurst to prepare the necessary plans and specifications, and also for the committee to invite tenders for the immediate carrying out of the combined scheme. The capital account does not include any provision for the erection of stables or the purchase of horses and vans, etc. Your committee recommend an addition to the capital account of £10,000 for these purposes. All which is respectfully submitted."

The above resolution was carried by 38 votes against 5 on January 28, 1896. Since then I have been constantly employed by the committee, and the resolution in question has not been rescinded.—Yours, etc.,

F. HASTINGS MEDHURST.

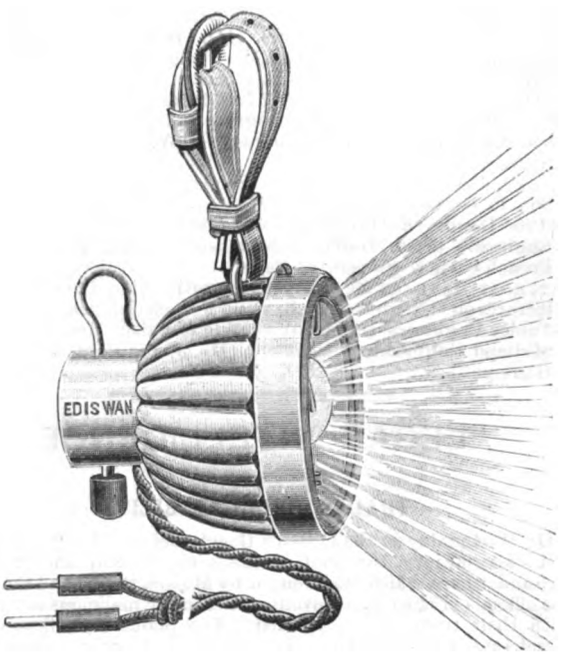
[It will probably be for the convenience of our readers if we insert below the following report of Wednesday evening's meeting of the Hackney Vestry instead of summarising it and burying it among our other "Business Notes." As Mr. Medhurst does not appear quite satisfied as to the correctness of something of what we have given before as to the proceedings of the Vestry, it may be said that the report has the authority of the *Times* of January 14.—ED. *E. E.*]

At the usual meeting of the Hackney Vestry last night the electric light question again came up for consideration. Mr. Hulland moved that the resolution of the Vestry, dated January 28, 1896, and being as follows: "That the Vestry adopt Mr. Medhurst's scheme and refer the matter back to the Electric Lighting Committee with instructions to engage Mr. Medhurst to prepare the necessary plans and specifications, and also for the committee to invite tenders for the immediate carrying out of the combined scheme," be rescinded. Mr. Hulland said that after mature consideration the committee had come to the conclusion that on both financial and scientific grounds this particular scheme could not be carried out without considerable risk. Mr. Richmond seconded the motion, which was carried. The Vestry then adopted unanimously a report of a special committee declaring that they "were of opinion that Mr. Medhurst had not been in any way engaged as electrical engineer to the Vestry."

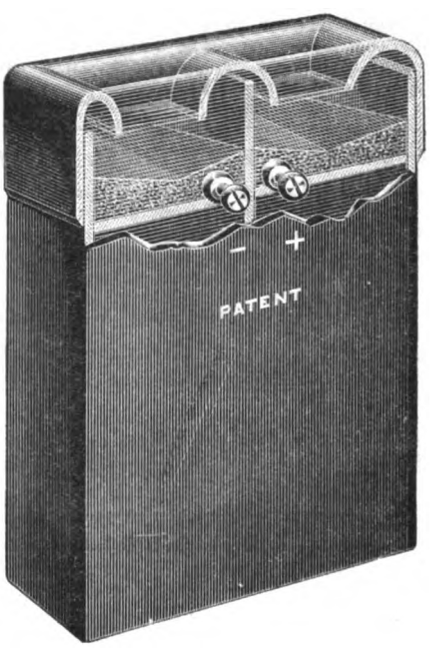
Pole-Finding Papers.—Our experience in the use of pole-finding papers has not been of such a character as to cause us to care very greatly about them. As, however, some people may feel curious as to what is the stuff which is used to make that particular sort of pole-paper which gives a red line, the following description, which came originally from the *Annales de Chimie Analytique*, may be reproduced. From one to two grammes of phenol phthalein are dissolved in 10 cubic centimetres of alcohol. The solution is poured into a glass vessel and about 110 cubic centimetres of distilled water are added to it. The result is a milky emulsion. In another vessel 20 grammes of sulphate of soda are dissolved in about 100 cubic centimetres of distilled water. The first solution is then poured into a porcelain tray, and several sheets of slightly porous paper are dipped into it one after another. These sheets, after being allowed to drain, are immersed, while still damp, in the soda solution. The paper after being dried is extremely sensitive to the action of the electric current. (And unfortunately to other things also.)

A NEW BICYCLE LAMP.

The Ediswan Company have recently brought out a useful little invention in the form of an electric bicycle lamp, called the "Cat-eye," to which the accompanying illustrations refer.



There are people who cycle against time, and there are people who cycle purely for pleasure. The latter is by far the more numerous class, and to them the saving of bother and trouble in the perpetual cleaning and lighting of oil lamps, with their manifold disadvantages, will more than compensate for any slight addition of weight to the machine, and that addition will be very slight indeed.



The illustration of the lamp explains itself. With regard to the battery, that is so constructed as to prevent any possibility of the liquid "spilling" or "leaking," for this spilling and leaking from the battery has been one of the greatest difficulties which has had to be overcome. The outside measurement of the battery in its leather case is 6in. high, 4½in. wide, and 2in. deep. If the battery is used under ordinary conditions, no leakage or waste of energy will take place.

FORTHCOMING EVENTS.

The following are some of the announcements for the week.

TO DAY (FRIDAY).—Institute of Civil Engineers. Students' meeting (Mr. W. Beer, on "Monier Girders"), 8 p.m.

MONDAY, JANUARY 18.—Society of Arts. Cantor lecture (Mr. Burton, on "Pottery").

TUESDAY, JANUARY 19.—Royal Institution (Prof. A. D. Waller's lecture "Animal Electricity"), 3 p.m.—Institution of Civil

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Engineers, Great George-street, 8 p.m., discussion of Prof. Ripper's paper and papers on the "Periyar Diversion".—Scottish Engineers (James Watt dinner at Glasgow).

WEDNESDAY, JANUARY 20.—Institution of Electrical Engineers Students' meeting (Mr. B. Hopp on "Experiences in a German Workshop"), 7.30 p.m.—Society of Arts ("The Bazin Roller Boat"), John-street, Adelphi, 8 p.m.—Annual meeting of the Meteorological Society (at the Civil Engineers'), 7.45 p.m.—North-East Coast Engineers (Mr. Sharp on "Transverse Sections," and discussion of Mr. Weighton's paper), at Newcastle.—Liverpool Engineering Society, Liverpool.

THURSDAY, JANUARY 21.—Royal Institution (Prof. H. A. Miers on "Crystals"), 3 p.m.—Civil Engineers' (students' visit Simpson and Co.'s works, Grosvenor-road, S.W.), 2 p.m.—Chemical Society's meeting.

FRIDAY, JANUARY 22.—Physical Society (Mr. Baly, on "Conduction in Gases"), Burlington House, 5 p.m.—Royal Institution (Prof. Dewar, on 'Properties of Liquid Oxygen"), 9 p.m.—Junior Engineers (Prof. Barr), Westminster Palace Hotel, 8 p.m.—French Civil Engineers, at Paris.

SATURDAY, JANUARY 23.—Royal Institution (Mr. Carl Ambruster's lectures on "Neglected Italian and French Composers"), 3 p.m.—Junior Engineers' Dinner, Westminster Palace Hotel, 6.30 p.m.—Midland Engineers at Sheffield (Mr. J. Piggford, on "Electric Haulage").

LEGAL INTELLIGENCE.

TRADES' UNION LIABILITY.

On Wednesday in the Queen's Bench, before Mr. Baron Pollock and a special jury, the trial of the action Bailey and another *v.* Pye and others, which was brought by Messrs. Bailey and Co. against the officials of the Glass Bevellers' Union for malicious interference with their trade, was concluded. The plaintiffs, a firm of glass merchants, claimed damages and an injunction against the defendants, who were members of the Glass Bevellers' Trade Union, for unlawfully and maliciously procuring certain persons who had entered into contracts with the plaintiffs to break such contracts, and for maliciously conspiring to induce certain persons not to enter into contracts with the plaintiffs. Mr. Lawson Walton, Q.C., and Mr. H. C. A. Bingley appeared for the plaintiffs; and Mr. Asquith, Q.C., Mr. E. Morten, and Mr. Reginald J. Neville for the defendants. After the close of the plaintiffs' case **Counsel** for the defendants said that on his advice they would consent to a verdict and judgment for the plaintiffs for the injunction. The assessment of damages was left to the jury, who fixed the amount at £674. 13s., for which judgment was entered, with costs, and a perpetual injunction was granted.

ALLEGED DEFECTIVE ELECTRICAL APPLIANCES.

In the Marylebone County Court on January 11 the case of Gooch *v.* Fuller was before his Honour Judge Stoner, and was an action by the plaintiff, an electrical engineer carrying on business at Westminster, to recover the sum of £7. 10s in respect of electrical fittings supplied to the order of the defendant.

The **Plaintiff's Manager** was called, and proved the order and delivery of the goods, and said that until this action was brought no complaint was made.

The defence was that all the goods supplied were defective in quality and make, and quite useless for the purpose for which the things were intended.

His **Honour** said if that was so the defendant's complaint had come too late, inasmuch as the goods were supplied over two years ago. In view of that fact there must be judgment for the plaintiff for the amount claimed, with costs.

CLAIM FOR ELECTRIC LIGHT.

In the Westminster County Court on January 12, his Honour Judge Lumley Smith, Q.C., had before him the case of the Lithanode Electric Storage Company *v* Eaton, in which the plaintiff company sought to recover payment of an account of £6. 7s. 9d. in respect of the hire of electric appliances and the supply of electric light.

Mr. Nisbet was called, and said he was managing director of the plaintiff company, and it was within his knowledge that the defendant was supplied with accessories and light from September, 1892, to January, 1893. It was agreed that the defendant should pay a sum of £3 per week, and the present claim was in respect of two weeks, which had not been paid, together with a small sum for extras. The defence was that the account was paid regularly every week and that nothing was owing.

After hearing the evidence, however, his **Honour** gave judgment for the full amount claimed, with costs.

COMPANIES' MEETINGS AND REPORTS.

DUDLEY AND WOLVERHAMPTON TRAMWAY COMPANY, LIMITED.

An extraordinary general meeting of this Company was held last Friday at the Westminster Palace Hotel, S.W., Mr. J. Fell presiding. The object of the meeting was to obtain the sanction of the shareholders to the sale of the undertaking to the British Electric Traction Company.

The **Chairman** said from the time the Board had had the management of affairs they had felt the absolute desirability of getting more capital; but the reconstruction of the Company had only enabled them to bring in £5,000, all of which had been spent on the line, new rails having been laid down and the greater portion of the line having been got into a fairly good working condition. Want of means had handicapped the directors, and had made it impossible for them to provide the necessary rolling-stock in order to make the line a paying concern. They had never been able to sufficiently reduce the expenses per mile. They had taken 1s. 4d. per mile, but if they had had a larger mileage and the necessary engines to do the work they could have got the expenses down to 1s. a mile, but that would have left a very large surplus. It was something to say that during the administration of the present Board they had paid their way, had put by something for depreciation, had paid debenture interest, and after providing for everything they lost last year only £43 on the year's trade, and that with insufficient rolling-stock. The directors at their own risk provided one new engine and became responsible to the bank for the cost. Local authorities, however, having given facilities to tramway companies to work their lines by electric power, the Board felt that it would be in the interests of the shareholders if they took advantage of this new means of locomotion, especially as the term of their lease was rapidly running out. They were approached by the British Electric Traction Company, and after negotiations extending over nine months a contract had been agreed upon which was especially favourable for the shareholders. He held proxies in favour of the sale representing 15,400 shares out of a total of 22,800. They would notice that it was proposed to set apart out of the purchase-money £1,000 for the Board. He would like to point out that that sum would not go into the pockets of the directors. It would be appropriated for defraying the expenses which had been incurred by them during the negotiations—a large number of railway fares and various other expenses. They would, of course, get some small sum for themselves, but he thought they were entitled to that. It would also be noticed that the sum of 7s. 6d. had been put down as the amount which the shareholders would receive on their shares. He thought the actual figure would be more than that, but the directors did not wish to come before them with a too glowing account.

The **Solicitor** (Mr. Milward) having read the contract which stated the purchase-money,

The **Chairman** moved: "That the terms of the contract now read, expressed to be made between the Dudley and Wolverhampton Tramways, Limited, of the one part, and the British Electric Traction Company, Limited, of the other part, for the sale to them, or to a company to be promoted by them, of the undertaking of this Company, be, and such terms are, hereby approved," and the motion was seconded and carried.

A resolution was also carried setting apart out of the purchase-money the sum of £1,000 to be divided among the directors as a recognition of their services in the negotiations for sale, and in repayment of the expenses incurred by them in connection therewith.

The **Chairman** said that, although last year showed a balance against the Company of £43, he had no doubt that at the end of this year there would be several hundred pounds to the good, showing that the purchasing company had got a sound and good property; and a further resolution was passed expressing approval of the Bill in Parliament for carrying into effect the terms of the contract, and authorising the Board to execute any deeds or documents which may be necessary.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Scarborough.—Tenders are invited for lighting corridors and rooms of Cambridge Hotel, South Cliff, with electric light. Tenders to be sent in by 20th inst. For particulars apply at the hotel.

Erfurt.—The Prussian State Railway Authorities (Königliche Eisenbahn Direktion) will receive tenders on January 20 for the supply of wooden telegraph posts. Particulars are obtainable for 25pfg. (3d.); the address is Erfurt, Bahnhofs-strasse 23.

Visé (Belgium).—The authorities (l'administration communale) of the town of Visé desire propositions from companies and others for town electric lighting. The proposal is an open one, both as to method and date, and offers or enquiries should be made to the Collège echevinal, Visé.

Alexandria.—Tenders are required for the supply of miscellaneous stores connected with lighting and signalling by the Railway, Telegraph, and Harbour Board. Particulars at the Gabbary Stores. Tenders, on stamped paper, to the President of the Administrative Council, Cairo.

Hanover.—Tenders are wanted by the Prussian State Railways for 32,600 telegraph insulators, with and without screwed attachments; 260 tons of wire (not line wire), 2¼ tons of insulated wire, and 1¼ ton of wire rope. Particulars for one mark from the Railway Authorities (Königliche Eisenbahn Direktion), Hanover, Joachimstrasse 7.

Paris.—The French Telegraphic Authorities will receive tenders at Paris, rue de Grenelle 103, on January 28, for 600,000 galvanised

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iron screws (two lots), about 25 tons of bronze wire, and for wood fibre packing, for the requirements of the telegraphic service during three years from February next. Application to tender must be made by January 16.

Hull.—The Corporation invite tenders for a lease of the tramways authorised to be constructed by the Tramways Orders Confirmation (No. 1) Act, 1896. Tenders to be delivered by February 1, endorsed "Tramway Tender," at the office of Mr. R. Hill Dawe, town clerk, Town Hall, Hull, from whom all particulars and conditions of tender may be obtained.

Milton (Portsmouth).—The Guardians of Portsea Island Union invite tenders for electric lighting and hot-water and engineering work at the new infirmary buildings at the union house. Persons desirous of tendering either for electric lighting or hot-water and engineering work may inspect the specification and obtain any other information on application at the offices of Mr. C. W. Bevis, F.R.I.B.A., architect, Elm-grove-chambers, Southsea. Tenders to be delivered at the Union House by 3 p.m. on 20th inst.

Edinburgh.—Tenders are required for the complete wiring of the Royal Infirmary. Specifications and drawings can be inspected at the office of Mr. William S. Caw, treasurer and clerk, or at that of the consulting engineer to the infirmary, Prof. Kennedy, 17, Victoria-street, Westminster, S.W. Firms desirous of tendering can have copies of the specification and drawings on making a deposit of £5. 5s., which will be returned on receipt of a proper tender. Tenders must be received by the Clerk, in sealed envelopes, marked "Tenders for Electric Lighting," by 10 a.m. on 28th inst.

Bristol.—The Electrical Committee of the Corporation require tenders for the supply and erection at the Electric Lighting Station, Temple Back, Bristol, of five mild-steel Lancashire boilers, with fittings, etc. Plans and sections of the station may be seen at the office of the Engineer, Temple Back, and copies of the specification and form of tender seen and obtained at the office of Mr. Frank M. Prosser, secretary, Electricity Department, Temple Back, on payment of three guineas. Tenders, endorsed "Tender for Boilers," must be addressed to the Secretary, and delivered to him by 4 p.m. on 21st inst. Only boilermakers will be permitted to tender.

London, N.W.—The Vestry of St. Pancras invite tenders for supplying and laying earthenware conduits, lead-covered armoured cables, and bare copper strip conductors in culverts. Copies of specification, conditions of contract, quantities, and form of tender in duplicate to be obtained upon application to the Electricity Department Offices, 57, Pratt street, N.W., on payment of a deposit of £1, which will be returnable on receipt of a bona fide tender and specification. Tenders to be sent to Mr. C. H. F. Barrett, vestry clerk, Vestry Hall, Pancras-road, London, N.W., endorsed "Tender for Earthenware Conduits, Lead Covered Armoured Cables, etc.," by 12 noon on 26th inst.

Morley.—The Electric Lighting Committee require tenders for the various works required in erection of engine and boiler houses, offices, chimney stack, etc., Fountain-street, Morley. Plans, specifications, and conditions of contract may be seen and quantities obtained at the offices of Mr. Robert Hammond, the consulting engineer to the Corporation, Ormonde House, Great Trinity-lane, London, E.C., or at the offices of the Borough Surveyor, Town Hall, Morley, on payment of £1. 1s. for each copy, which sum will be refunded on the return of the quantities with a bona fide tender. Sealed tenders, endorsed "Tender for Electric Light Buildings," must be addressed to Mr. R. Borrough Hopkins, town clerk, Town Hall, Morley, by 19th inst.

Wallasey.—The Urban District Council are prepared to receive tenders for the supply and erection of a 200 kilowatt alternator, with engine combined, and for the requisite switchboard extensions. Copies of the specification may be obtained on application to the engineer, Mr. J. H. Crowther, at his office at the Great Float, near Birkenhead, on payment of the sum of £2. 2s, which be returned on receipt of a bona fide tender. Sealed tenders, on the form provided for the purpose, addressed to the Chairman of the Gas and Water Committee, and endorsed "Tender for Steam Alternator, etc.," to be delivered to Mr. W. Danger, clerk to the Council, Public Offices, Egremont, Cheshire, not later than 4 o'clock in the afternoon of Thursday, February 18, 1897. The contractor will be required to enter into a bond with approved sureties for the due performance of the contract.

RESULTS OF TENDERS.

Monmouth.—The Town Council have accepted Messrs. Siemens Bros.' contract for machinery and electric lighting mains for the sum of £6 980.

Harrogate.—The following are the accepted tenders for fitting public buildings with wire for the electric light: Victoria Baths and Municipal Offices—G. H Steinthal, Bradford and Harrogate, £321; Market Hall—Paterson and Cooper, £148. 7s; Free Library—C. O Dawson, Harrogate, £64. 17s. 6d.

Southampton.—The Corporation have accepted the following tenders for electric mains, etc.: W. T. Glover and Co, 37, Victoria-street, Westminster, S.W., high-tension cables; Reid Bros., 12, Wharf road, City-road, N., supplying and fixing earthenware conduits and drawing in boxes; Fowler-Waring Cable Company, Limited, 110, Fenchurch-street, E C., low-tension and twin twisted armoured and unarmoured cables. The following other firms also sent in tenders: Connolly Bros., Limited, Blackley, Manchester; Siemens Bros. and Co., Limited, 12, Queen Anne's-gate, Westminster, S.W.; W. T. Henley's Telegraph Works Company Limited 27, Martin's-lane, Cannon-street, E.C.; India Rubber, Gutta Percha, and Telegraph Works Company, Limited, Silvertown, E.; British Insulated Wire Company, Limited, Prescot, Lancs.; Callender's Cable and Construction Company, Limited, 90, Cannon-street, London.

Hampstead.—The Vestry have received the following tenders for supplying and erecting additional plant in the new engine-room at the electric lighting station:

Travelling crane.

Vaughan and Son	£180
Higginbottom and Mattock	173
T. Smith	155
Tangye	170

Exciter.

Antill	625

Steam alternator.

Ferranti	3,130
Siemens	3,300

These have been referred to the Lighting Committee for consideration and report. The Works Committee have accepted the estimate of Messrs. Maple and Co. for the installation of electric light in the additional offices at the Vestry Hall.

BUSINESS NOTES.

Catford—A trial has been made of an electric tandem cycle to be used for pacing purposes.

Great Northern Telegraph Company.—For the month of December the receipts were £24,200.

Llanelly.—At the invitation of Mr. J. C. Howell, several members of the Council have made an inspection of the electric lighting of New Dock-road.

Leeds—The Tramways Committee have resolved to relay the permanent way with rails which will suit the existing method of haulage and also the electric system.

Amsterdam.—The Nederlandsche-Indische Electricitat Naatschappij of this city has declared a dividend of 12fl. per share for the half-year ending December 31 last.

Reading—The Town Council have accepted the offer of the Reading Electric Supply Company for the lighting of the whole of the public buildings at 5d. per unit.

St. Pancras.—The Vestry have decided to invite tenders for the work of lighting publicly and privately the Highgate district. The proposed expenditure is estimated at £8,490.

Gomersal.—At a District Council meeting it was agreed that the Lighting Committee should be a deputation to Birkenshaw to discuss the question of an electric lighting scheme.

Bury—The Corporation have agreed to supply electricity to the technical school for 12 months for the sum of £50. A discount of 5 per cent. is to be allowed to customers for prompt payment of accounts.

Morecambe.—The Board of Trade have informed the Council that several landowners had objected to the proposed site for electric light works, on the ground that such works would prove a nuisance generally.

Electric Safety Lamps.—Portable electric lamps, fed by accumulators, the total weight of each set being 4¼lb., are now used in the collieries at Sekul, Hungary. The lamp gives 1½ c.p. to 2 c.p. for 10 hours.

Correction.—In our last issue we stated that the Oxford Electricity Company had declared a dividend of 3½ per cent. for the last year, which we are informed is a mistake, as the accounts for 1896 are not yet made up.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended January 10 amounted to £1,265, as compared with £1,120 in the corresponding week of the previous year, being an increase of £145.

Liverpool.—The City Council have decided to promote a Bill in Parliament for the purchase of the goodwill and travelling stock of the tramways company. The maximum amount likely to be required is mentioned as £75,000.

Penicuik—Messrs. James Brown and Co., Limited, manufacturers of magazine paper, have now an extensive plant driven by electric motors at Esk Mills, and a new electric lighting installation has recently been put in.

Plymouth.—Members of the Plymouth Postal Telegraphs Department held their annual dinner a few days ago, the chair being occupied by Mr. R. H. Williams, and the vice-chair by Quartermaster-Sergeant Leleux, R.E.

Bristol Tramways and Carriage Company, Limited.—The traffic returns for the week ended January 8 were £2,012. 6s. 9d., compared with £1,660. 12s. 9d. for the corresponding period of last year, being an increase of £351. 14s.

Northfield.—The Parish Council have decided to defer consideration of the application from the City of Birmingham Tramways Company for an extension of their running powers from Bournbrook to Chapel-lane, Selly Oak.

Swinton and Pendlebury.—The Urban District Council have instructed the clerk to take the necessary steps for securing clauses in the Manchester Carriage and Tramways Company's provisional order for protecting the interests of the district.

Change of Address.—The Electricity Supply Company for Spain, Limited, notifies that its offices have been removed to College-hill-chambers, College-hill, E.C., and that Mr. Charles Hill has been appointed secretary to the company.

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Basle.—The Kohlen-Electroden Industrie Gesellschaft is the name of a company which has lately been formed at Basle, with a capital of £12,000, to manufacture carbon electrodes.

Taunton.—At a recent Town Council meeting, the Electric Lighting Committee reported that the Local Government Board had sanctioned the application for permission to borrow a further £4,000 for the purposes of electric lighting in the borough.

Salisbury.—The electric lighting question is to remain in abeyance for six months by the Town Council, who consider that it is advisable for them to allow the provisional order to be extended to the undertakers of the Salisbury Electric Lighting Order, 1895.

Brussels.—A company has just been formed in this city, with a capital of £340,000, to be known as the Compagnie Hongroise de Gaz et d'Electricité. The municipal authorities of Vise are at present inviting tenders for the electric lighting of the public streets.

Kirkby-in-Ashfield.—At an ordinary meeting of the District Council, Mr. Furse, of Nottingham, agreed to give an estimate of the probable cost of lighting the parish with electricity for 10 guineas. It was decided by seven votes to six that the estimate be produced.

Radcliffe.—The Electric Lighting Committee having received a lengthy report as to the proposed electric lighting from the surveyor, the District Council have resolved that the committee be empowed to visit such towns lighted by electricity as they might consider advisable.

City and South London Railway.—The returns for the week ended January 10 were £1,111, compared with £1,020 for the corresponding period of last year, being an increase of £91. The total receipts for the half-year 1897 were £2,188, compared with £2,037 last year, being an increase of £151.

Sheffield.—The *Leeds Mercury* says that it is now an open secret that the committee appointed by the Sheffield Corporation to inspect the various methods of tramway traction both on the Continent and in this country will recommend the adoption in Sheffield of the overhead electric system.

Personal.—Mr. H. L Leach informs us that he has resigned his position as resident and superintendent engineer of the St. James's and Pall Mall Electric Light Company, Limited, and has joined the staff of Mr. F. J. Warden-Stevens, Connaught-mansions, 34, Victoria-street, Westminster.

Levenshulme.—At the District Council meeting, a letter was read from the Gorton Urban District Council, dated December 10, *re* electric lighting, and the clerk was directed to acknowledge receipt thereof, and to state that this Council had already made arrangements with the Manchester Corporation.

Appointment Vacant.—There is a vacancy at the London Homœopathic Hospital for a medical electrician. Applications and testimonials must be sent in for examination by the medical council not later than March 1, 1897, to the secretary-superintendent, of whom further particulars can be obtained.

Rochdale.—At the monthly meeting of the Town Council, when the minutes of the Gas Committee were produced, Alderman W. J. Petrie, in answer to a question, said the idea of providing the electric light was floating in the minds of the committee, and they hoped that shortly it would take some definite form.

Birmingham.—Only slow progress is being made at present in connection with the negotiations relating to the new tramways promoted by the City of Birmingham Tramways Company and the proposed alterations in the working of the lines already in existence. The overhead system seems to be most in favour.

Paisley.—Mr. Teague has prepared a report outlining a scheme for the municipal electricity works and distributing mains. The cost of the scheme is estimated at £33,750. The Town Council have adopted the report, and have also agreed to take the necessary steps for the borrowing of £35,000 to carry out the scheme.

Leyton (Essex).—At a meeting of the Urban Council it was reported that the Highways and Lighting Committee had given instructions for several arc lamps and 32-c.p. incandescent lamps to be fixed experimentally in High-road, Leyton, and High-road, Leytonstone, to supplement the light already given by the 26-c.p. lights.

Submarine Cables Trust.—This Trust gives notice that on and after January 15 the sum of 12s. 6d., balance of the coupon due October 15, 1896, will be paid by Messrs. Glyn, Mills, and Co., of 67, Lombard-street, between the hours of 10 a.m. and 2 p.m. The coupons should be left with the bankers for examination four clear days before payment.

Saughall.—A local contemporary makes the following mysterious announcement: "The establishment of the electric light at Chester has been a great benefit to people in this village and neighbourhood, as our dark roads have been perceptibly illuminated since the installation at Chester." The village is about three miles distant from Chester.

Burslem.—At a meeting of the Town Council a letter was read from the British Electric Traction Company, stating that they proposed to extend the tramway from Trubshaw Cross, Longport, to the High Gate Inn, Brownhills, and the town clerk was instructed to bring the question forward again when a copy of the draft provisional order had been received.

Walsall.—The Town Council have decided not to comply with an application made by the Electric Lighting Extension Syndicate, Limited, for a supply of current at a reduced price for the purpose of enabling the company to retail it by means of penny-in-the-slot meters. A petition is to be presented against the Birmingham, Wolverhampton, and District Tramways Bill.

Direct United States Cable Company, Limited.—The Board have resolved upon the payment of an interim dividend of 2s. 6d. per share free of income tax, being at the rate of 2½ per cent. per annum for the quarter ending December 31, and payable on and after 30th inst. The directors have also set aside £12,000 to reserve fund account and carried forward a balance of £4,843.

Penarth.—At a committee meeting held after the usual monthly meeting of the District Council the question was gone into as to what steps should be taken by the Council concerning the proposed tramway. It was decided by 10 votes to 1 to support the tramway scheme subject to certain restrictions laid down by the Council, and nearly all of which, it was stated, would be agreed to.

Madrid.—A concession has just been granted for the electric lighting of the public streets of Balaguer during a period of 10 years. The municipal authorities of La Carolina (Jaen) are inviting tenders until the 15th inst. for the concession for the electric lighting of the town during a period of 20 years. Plans are being prepared for a projected electric tramway between Cadiz and San José.

St. Helens.—At a meeting of the Finance Committee of the Corporation the town clerk reported that arrangements were in progress for the acquisition by the Corporation of the St. Helens and District Tramways undertaking, and that, if the arrangements were completed, the sum of £23,000 would be required early in the ensuing year, and the further sum of £23,000 in the course of next five or six years.

Electric Omnibuses.—We read in the daily papers that the new 'bus of the London Electric Omnibus Company, Limited, has successfully passed through another trial. London pressmen are supposed to know everything, and therefore, perhaps, we may believe that this invention is as wonderful as they say it is; but it is curious to observe that the technical journals are not invited to attend these "trials."

Stockton.—At the meeting of the Town Council, the surveyor (Mr. K. F. Campbell) reported strongly in favour of the adoption of electric power for tramways within the borough, and it was decided, after considerable discussion, to appoint a sub-committee to confer with the other authorities interested as to the best course to be adopted as to the application, and also to formulate the conditions to be exacted from the company.

Derby.—The Corporation are offering a reward of £25 for information respecting the unlawful and malicious damage done to the arc lamps in the borough. The supply of electricity to several of these lamps has been cut off, and the committee are of opinion that the damage has been done by someone practically acquainted with electric lighting apparatus, otherwise, they say, the person who had severed one of the wires would have been electrocuted.

City and South London Railway Company.—The accounts for the half-year ended December 31 show a balance, after providing for preferential charges, sufficient to allow the payment of a dividend on the consolidated ordinary stock at the rate of 1¾ per cent. per annum, carrying forward a balance of £1,313 to the new account. The dividend for the corresponding period last year was at the rate of 1¼ per cent. per annum, the balance carried forward being £1,220.

Newmarket.—At the meeting of the Urban District Council, an application from the National Telephone Company for permission to erect 12 new poles on certain thoroughfares was refused, the suggested positions of the poles not being approved. A copy of the objection to granting an electric light provisional order was received from the Board of Trade, and was referred to a committee to report upon and draft a reply to this and any other objections that might be received.

Accident.—An accident, which it is feared may be attended with fatal results, occurred last week in Wood-lane, Shepherd's Bush. A number of workmen were engaged in pulling down an old building in order to make room for the new Electric Central Railway works, when a wall suddenly collapsed, and four men who were working underneath were buried in the *débris*. They were rescued with as little delay as possible, when it was found that all had received serious injuries.

Downham.—At the meeting of the Urban District Council, Mr. A. B. Bird made an application for the consent of the Council to enable him to apply to the Board of Trade for a license to place an electric wire from his flour mills along the same course as the present telephone wire is carried, in order that he might light his house in Bridge-street by electricity. The consent of the Council was granted, subject to such conditions and regulations as the Board of Trade might prescribe.

National Telephone Concert.—A Bohemian concert was given at the Cannon-street Hotel on Wednesday night by the National Telephone Company's officials and staff. There was a representative executive and committee. Mr. C. B. Clay took the chair, and Mr. C. J. Phillips the vice-chair. Among others present was Lord Harris. A long programme was gone through, which we have not time to particularise, and everybody seemed to enjoy himself. Among the artistes was Madame Hughes Poltzer.

London.—At a meeting of the Sewers Commission recently held a deputation, including, among others, the rector (the Rev. J. A. L. Airey) and the vestry clerk (Mr. R. T. Wragg), attended at the bar of the Court with a petition asking the Court to improve the public lighting in Great St. Helens. The deputation suggested that instead of the four gas lamps at present in use a central electric lamp should be put up with a view to thoroughly lighting the thoroughfare. A motion to refer the question to the Streets Committee was approved.

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Rowley.—A special meeting of the Rowley District Council has been held at Old Hill for the purpose of considering the Bill being promoted in Parliament by the Birmingham, Wolverhampton, and District Tramways Company; also a letter from Messrs. Milward and Co. solicitors to the promoters of the scheme, applying for the consent of the Council to the construction of the tramways within their district. A resolution was passed unanimously deciding to oppose the Tramways Bill with the view of securing a modification of certain clauses.

Stockport.—At a meeting of the Gas Committee the Chairman reported that it would be necessary for this committee to form itself into a separate committee for the purpose of carrying out the electric lighting order. He also reported that during the past 18 months he had taken every opportunity of visiting the electric light plants of various towns, and gave general outlines of the systems now in use in towns of a similar size to Stockport It was resolved that a meeting be called as suggested. The minutes of the committee have been confirmed by the Town Council.

Wolverhampton.—A discussion took place at the Town Council meeting with regard to the action of the Tramways Committee appointed to consider the action of a company promoted to purchase the tramways in the borough, and it was decided that the committee be authorised to memorialise the examiner of standing orders complaining that they had not been complied with; and further, to present a petition against the Birmingham, Wolverhampton, and District Tramways Bill, which is now being promoted in Parliament, in default of satisfactory terms being arranged between the Tramway Committee and the promoters of the Bill.

Grimsby.—At an adjourned meeting of the Corporation it was decided to lodge formal objection to the application for a provisional order by the Grimsby Tramway Company authorising extensions into Cleethorpes, and the use of electricity, the overhead system being intended. It was further pointed out that within about five years the Corporation would have power to compulsorily purchase the tramways, and if they purchased they might be saddled with unnecessary expense. It was therefore decided to add this as an additional reason for the Corporation's objection.

Caversham.—At the District Council meeting the committee of the whole Council reported that the Reading Tramways Company, Limited, having applied to the Council for permission to execute certain works of extension, the committee recommend that the consent of the Council be not given to the proposals. The Clerk stated that he heard that the Imperial Tramways Company had decided to abandon for the present the proposed scheme of extension. It was impossible for them to proceed under the provisional order in view of the opposition raised by the Reading Corporation.

Wood Casing.—In the note last week on Mr. J. Skegg's new form of wood casing the word "spot" got printed "slot." As a matter of fact, when Mr. Skegg's moulding is fixed in its place there is left between it and the ceiling a space, which, by a stretch of terms, might be spoken of as a slot, and the casing goes into it. All that was meant to be said was, however, that the idea was to put the casing in a place where it required nothing but the lightest possible fixing. and where it was not likely to have nails and screws and that sort of thing driven into it by people who know no better.

Hull.—At the Town Council meeting Mr. Crook, when the minutes of the Electric Lighting Committee came up for confirmation, enquired whether it would not be wise to engage the services of Mr. Hammond in the carrying out of the extension scheme, which would cost £52,000. He asked the Council to accept the resolution which he proposed in the committee, that Mr. Hammond be engaged as a consulting engineer at a fee not exceeding 500 guineas, to include the fee of 50 guineas, payable by the Corporation for his report. Mr. Hanger seconded the amendment, which, after some discussion, was lost.

Chislehurst.—At the meeting of the Bromley Rural Highway Board a letter was read from Mr. Edward Charrington on the subject of electric lighting of Chislehurst, in reply to the letter from the Council consenting to the Board of Trade granting a license to a company for the purpose, and pointed out that under the stringent conditions of the Board of Trade regulations, practically all the Council asked for would have to be conceded. The General Purposes Committee recommended that Mr. Charrington be asked for a copy of the draft provisional order when prepared, and the clerk was directed accordingly.

Bootle.—The Parliamentary Committee of the Town Council recommend that no opposition be offered to the Liverpool, Bootle, and Litherland Tramways Order on its merits, provided satisfactory terms be come to with the tramways company, including (*inter alia*) (*a*) the previous consent of the Corporation to the use of electrical traction on conditions approved by the Council; (*b*) the supply of electrical energy by the Corporation; (*c*) protective clauses as to breaking up of streets, removal of rails, erection of posts and wires; (*d*) the renewal of the company's lease; and (*e*) generally such other clauses as the interests of the borough require.

Blackburn.—A prolonged debate took place at a meeting of the Town Council on a proposal that the Corporation should lay down generating plant and supply electricity to the local tramway company on the overhead wire system. Alderman Eastwood, ex-Mayor, strongly contended that it was not the duty of the Corporation to assist private companies; but, on the other hand, they should municipalise tramways, as had been done in other towns. The scheme, however, was confirmed, the terms agreed on being 2½d. per unit, of which 1d. represents expenditure on plant. It is stated that under this arrangement the tramway company will be able to effect a saving of 50 per cent.

Middlesbrough.—At the last meeting of the Town Council the Streets Committee's minutes showed that certain objections had been formulated to the proposals of the Imperial Tramways Company to greatly extend their lines and adopt the overhead electric system. Alderman Bell moved, and Alderman Jones seconded, that a special meeting be called to consider the matter in detail. It was explained that the proposal was not hostile, but was simply to preserve the *locus standi* of the Corporation. Several members expressed the opinion that the trams ought to be in the hands of the Corporation. The motion was rejected by 17 votes to 14, and the Streets Committee's formal objections to the Board of Trade confirmed.

Colwyn Bay.—At a recent meeting of the District Council the Surveyor stated that he had about a dozen schemes sent in with regard to the electric lighting of the district. Mr. Porter (clerk) read a report of the meeting of local authorities in the district, at which the scheme of Messrs. Dickenson, Birmingham, to construct an electric tramway from Colwyn Bay to Llandudno was discussed. The meeting made several suggestions as to the route, one being that the tramway should start from Old Colwyn. The Chairman moved that the report be adopted. Mr. Blud moved that it be a condition that Colwyn Bay, with Llandudno, have the option of supplying the electric energy, as this would benefit Colwyn Bay in its electric lighting scheme. The amendment was carried and added to the report.

Entertainment.—The annual entertainment given by the Edison and Swan United Electric Lighting Company, Limited, to their employés took place on Friday last (8th inst.) at the People's Palace, Mile End. There was a very good programme, a notable feature of which was the animatograph. The latter part of the evening was given up to dancing, which the company seemed to enjoy immensely. In a corner of the hall a Röntgen ray exhibition was kept going all the evening, and was a great attraction. The only thing against the entertainment was the weather, which was abominable. The following acted as stewards: Messrs. H. Brooker, A Copelin, J. Davison, A. Dodd, J. W. Elliott, A W. Hill T. Keeling, and O. Young, with Mr. W. H. Chambers as secretary. There were more than a score of carriages on the "special" from Ponders End.

Berlin.—A central station has just been completed and put in operation at Hermannstadt. One has also just been put in operation at Bietegheim. The plant at the latter station, which has been supplied by Messrs. W. Reisser and Co., of Stuttgart, is driven by water power. The municipal authorities of Polzin have just decided on the establishment of a central station. It is proposed to light the public streets of Heppenheim by electricity. The Gesellschaft für Electrische Anlagen und Bahnen of Dresden has secured a concession for an electric railway from Flöha to Kriebethal, in the Zotopau Valley. Messrs. Siemens and Halske, of this city, have acquired the horse tramways in the town of Wurzburg with the object of converting them into electric lines. The Helios Company, of Ehrenfeld, Cologne, has secured a contract for the construction of an electric tramway between Wemding and Nordlingen.

Pembroke.—A letter was read at the meeting of the Township Commissioners from the registrar of the Royal Dublin Society (Mr. R. J. Moss) enclosing the following resolutions which had been passed by the council of the society: Resolved, "That, having examined the plans of the Dublin United Tramways Company for the proposed extension of their system from Rathmines to Ballsbridge, the council approve of the same as likely to still further develop the use of the society's premises at Ballsbridge." Resolved, "That the council have learned with satisfaction that the Commissioners of the Pembroke Township have made it a condition of their approval of the proposed tramway extension that Ballsbridge be widened sufficiently to admit of the free passage of the traffic at the times when shows or exhibitions are held on the society's premises, and suggest that with any widening to be really effective 24ft. at least should be added to the roadway."

Greenwich.—At the meeting of the District Board of Works the Greenwich Committee reported that they had considered a notice by the Blackheath and Greenwich District Electric Lighting Company of their intention to apply for a provisional order under the Electric Lighting Acts, and recommended that a letter be written to the Board of Trade (without prejudice to the right of the Board to hereafter refuse its consent to the provisional order) making suggestions as to the power of the local authority to charge the company with expenses, and the manner in which they shall be recoverable, etc., and further recommending that it be referred to the committee to consider and report on the desirability or otherwise of the local authority, so far as Greenwich is concerned, retaining powers for the supply of electricity in their own hands, and that with that view they be empowered to engage the services of an electrician. This matter, together with a letter from the solicitor to the company suggesting an interview, was referred back to the committee.

Colchester.—The Electric Light Works Committee reported at the Town Council meeting that, in conjunction with the officer in charge, they had inspected the new military hospital, which is lighted by electricity, and they expressed their entire satisfaction with the lighting. The town clerk submitted a draft proposed agreement between the Council and the Secretary of State for War for lighting the hospital, with alterations made therein after consultation between Colonel Skinner, Mr. Massey, and himself;

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and it was resolved that the draft, as altered, be approved and submitted to the War Department. A letter had been received from the Electric Construction Company, stating that they had appointed two men to drive the machinery for temporarily lighting the military hospital, as light will be required from 3 p.m. until 8.30 a.m., and that as their tender for providing and working the plant included only one man's time—which would have been sufficient had the order to proceed been given before July 1—they must make a charge of 30s. per week to cover the wages of the second man. The committee resolved that the matter be left in the hands of the surveyor. This report was adopted.

Leatherhead.—A letter was read at the Urban District Council meeting from Mr. J. L. Higgs, solicitor to the Leatherhead Electric Lighting Company, enclosing the certificate required by the Board of Trade, which he asked the Council to fill up with their consent to the application for a provisional order. The order placed the Council in a very advantageous position without the risk of outlay upon works, etc. He therefore trusted that the Council would be good enough to give their consent. The Clerk said he had prepared a draft reply to the effect that the Board of Trade be requested to withhold their consent to the company's application on the ground that the Council considered that such powers should be in the hands of the ratepayers; also that the capital of the company was inadequate except for speculative purposes, and that he said company had not been registered at the date when formal notice was given the Council of their intended application. The etter further pointed out that the Council proposed at once to take the necessary steps for applying for a provisional order during the current year. On the motion of Dr. Davis the clerk was instructed to write to the Board of Trade accordingly, and to communicate with the company to the same effect.

Bradford.—At a meeting of the Town Council the Mayor moved the adoption of the minutes of the Gas and Electricity Supply Committee, of which he is chairman. Mr. C. E. Dowson said there was a very strong feeling in Heaton and Frizinghall as to the way in which the residents were treated by the Shipley Gas Company, and he thought the present time was favourable for taking some steps for fighting this monopoly. It would be possible, he believed, to obtain leverage for dealing with the company by extending the lighting cable at Lister Park round Heaton and through Frizinghall. In Brighton streets were being lighted with electric light, and if that system could be carried out in combination with house-lighting, he believed a saving could be effected by the change. At present the Corporation rented 175 gas lamps in Heaton and Frizinghall at a cost of £554. The Mayor said that the subject of lighting Heaton and Frizinghall by electricity from the new works was at present under consideration, and the engineer was preparing a report to be presented at the next fortnightly meeting of the committee. Whether they would consider it wise to go ahead or to wait for some further developments, such as those suggested by Mr. Pratt, he could not say. The minutes were adopted.

Jungfrau Railway.—The following are the successful competitors for prizes for plans, etc., for the Jungfrau Electric Railway: E. Strub, Interlaken (rack railway), 5,000fr; C. Wüst-Kunz, of Seebach, and L. Thormann, of Zurich, both connected with the Oerlikon Company (tunnel, electric construction, and rolling-stock) 4,000fr.; Brown, Boveri, and Co, Baden, Switzerland, Escher, Wyss, and Co., Zurich, and T. Bell and Co., Kriens, Lucerne, joint (power station and electric construction), 4,000fr.; the Rieber Company, Winterthur (hydraulic work), 2,500fr.; Compagnie de l'Industrie Electrique, Geneva (electric construction and rolling-stock), 2,200fr.; the Winterthur Locomotive Works, in conjunction with R. Abt, Lucerne, and the Neuhausen Industrie Gesellschaft (rolling-stock and line), 2,000fr.; Prof. F. Kreuter, Munich (tunnel), 1,500fr.; Rudolf Meier, Mülheim a. d. Ruhr (tunnel), 1,500fr.; E. Kiebitz, Magdeburg (elevator and rolling-stock), 1,300fr.; A. Koller, Apples, Vaud (tunnel), 1,000fr.; A. Boissonnas, Geneva (electric construction and rolling-stock), 1,000fr.; Max Halder, Pittsburgh, United States (electric construction), 800fr.; Krebes, Trèves (elevator), 600fr.; J. Bernays, London (elevator), 600fr.; G. Dieterich, Hanau (elevator), 500fr.; Paulsen, Dessau (tunnel), 500fr. Prizes of 400fr. and 300fr. were also awarded to K. A. Sohm, Mannheim, and P. Tappolet, Zurich, for buildings, and E. Cucchianini 300fr. for tunnel building.

Belfast.—At the meeting of the Electric Committee Councillor George Andrews, J.P., and Councillor Otto Jaffe, J.P., were elected chairman and vice-chairman respectively. A deputation was appointed to wait on the Improvement Committee with a view to some definite settlement being come to as to the site for the proposed central station. A meeting of the Council in committee has also been held to take into consideration the question of electric traction for the tramways. There was considerable discussion, during which the last letter sent to the tramway company granting them permission to introduce electric traction was read by Mr. Meyer, chief clerk, and its terms were fully considered. The offer contained in this letter was to remain open for one month, the period terminating on January 1, 1897, and that on December 29, 1896, the tramway company wrote refusing the offer. Ultimately Alderman Sir Daniel Dixon moved, and Councillor Sir Wm. M'Cammond seconded, "That the tramway company be informed, in reply to their letter of the 29th ult., that the Council cannot entertain the proposal of the company for an extended term, which was declined, and to which the Council adhere, but, as already intimated to the company, they were willing to accept the offer made by the company for the remainder of the term, and to allow electric traction and the doubling of certain lines without further payment." The resolution was adopted.

A Canadian Electric Railway.—The equipping of the Aylmer branch of the Canadian Pacific Railway with electric service has been described in the New York *Electrical Engineer*. This line extends from Hull, a suburb of Ottawa, to Aylmer, where it connects with the Pontiac Pacific Junction Railway. The traffic has been far beyond expectations, and the train service has increased until there are now running 36 regular trains each way per day, besides special excursion trains. Power is obtained from Deschesne Rapids, where the lake of the same name empties itself into the Ottawa River, at a point midway between the termini of the road. The turbine wheels operate under a head of 9ft. Four 60in. wheels are now installed, and space is provided for two more. By means of "Barbour" waterwheel regulators, the current output of the generators is automatically kept constant by cutting in or out dead resistance as the load varies on the line, so that the speed of the machines is kept constant, and the variation in voltage is held within a very close limit. As to the rolling-stock, all the cars are mounted on double trucks (bogies), and are each equipped with two motors. A locomotive, the first of its kind operated in Canada, is used for the through goods service. This locomotive weighs over 20 tons, and is provided with double trucks, each axle being equipped with a motor. As all the wheels are driven, full tractive advantage is obtained from the total weight, and a draw-bar pull of 10,000lb. can therefore be exerted, equivalent to the power of the average 35 or 40 ton steam locomotive. This was designed and built by the Canadian General Electric Company.

Guildford.—At a meeting of the Town Council a letter was read from Messrs. Sharp and Kent, the contractors for the Guildford Electricity Supply Company, in reply to the letter of the Council calling upon them to properly reinstate the pavements recently taken up for the laying of the distributing mains. They stated that it was clear the Council were not in full possession of the facts. The bulk of the pavements had been properly reinstated, but others had not, and, as they were coupling up new customers daily, so long would there be a number of large stones not properly reinstated. They had gone very carefully over the ground, and found there were some stones which had become loose, and these they would put right. Before they commenced the work they pointed out to Mr. Maltby, the late surveyor, the deplorable state of many of the stones, and these they had relaid in a broken condition. In another letter, dated December 30, Messrs. Sharp and Kent said they had been over the whole ground with the surveyor (Mr. Mason), who had handed to them a complete list of the damaged stones. As that included a very large number admitted by the late surveyor to be damaged before they commenced the work, they had requested the surveyor to go into the matter as to what, if any, they were responsible for. Mr. Salsbury, who said he had a correct list of the cracked stones, moved that the resolution of the last meeting—that the Council do the work themselves if not done by the contractors in nine days—be carried out. Alderman Mason seconded, and said that the paths, and especially some parts of North-street, were in a deplorable state. Ultimately, on the motion of Alderman Swayne, the town clerk was instructed to write again to Messrs. Sharp and Kent.

Cork.—At the meeting of the Board of Guardians Mr. D. J. Coakley, engineer to the Board, submitted the following report in reference to the proposed introduction of electric light into the workhouse: "As directed, I have prepared the following report on the cost, etc., of lighting the house with electricity. At present there are 574 lights in the house, and in view of the two buildings proposed to be erected I have provided for 600 lights. The capital outlay would be £2,000. This would include two engines, two dynamos, either engine being capable of lighting two-thirds of the total number of lights in the house, so that in the case of the breakdown of one engine or dynamo the other engine would be able to do two-thirds of the total number. Besides this I would include a large battery of accumulators to take the necessary lamps that would be burning all night, and which would also be able to light for a short time all the lamps in the place—this set of accumulators, in conjunction with either engine or dynamo, being quite sufficient to light all the lamps at the time. The working expenses would be as follows: £90 for extra coal burned, £40 for man's time, £30 for renewal of lamps, etc., £20 for oil waste, and sundries—total, £180 per annum. There being no new buildings required, I would suggest that a portion of the room at back of drying-room and boiler-house, called the mangling-room, be asked for the engines and dynamo." Mr. Wright said that was a most important report, and arose originally out of the immense bill sent in for gas. He proposed that the matter be referred to a committee for consideration. Mr. Lenihan suggested that an expert be employed, at a reasonable remuneration, to advise the committee on the matter. The suggestion was unanimously agreed to, and the committee were requested to bring up their report on the matter as soon as possible.

Brighton.—The Works Committee reported at the Town Council meeting that they had received a letter from Mr. Volk forwarding plans of waiting-rooms proposed to be constructed by the Rottingdean Seashore Electric Tramway Company on the beach, east of the Paston-place groyne. It was resolved that the same be disapproved, but that Mr. Volk be informed that upon the company entering into an agreement, in a form to be approved by the town clerk, for protecting the rights and interests of the Corporation in the site of the proposed waiting-room, the plans will be approved by the Council. The Pavilion Committee have resolved, on the report of the surveyor, to fix plugs in the music-room and banqueting-room, so that electric light may be used for footlights instead of gas. The cost of the work was estimated at

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about £5. 5s. for each room. The Lighting Committee reported that they had received a letter from Mr. H. M. Richardson, addressed to Councillor Richards, with reference to the position of the electric lamp standard at the west end of Grenville-place. It was resolved that Mr. Richardson be informed that the committee deem it inexpedient to alter the position of the standard in question. A letter was read from Mr. J. M. King, complaining that the lighting in the neighbourhood of the market is defective, and requesting that electric arc lamps may be erected. It was resolved that Mr. King be informed that the committee have decided to increase the lighting of the eastern part of Bartholomews, but they cannot at present entertain his request for electric arc lamps in the neighbourhood of the market. At a further meeting of the committee a complaint by Councillor Richards as to the lighting of Little Russell-street, Milton-place, Wellington-place, and Blucher-place was considered. The Surveyor presented a plan showing the lighting of the streets referred to. It was resolved that Councillor Richards be informed that the committee deem it unnecessary to make any alteration in the lighting of either Little Russell-street, Wellington-place, or Blucher-place, but that they will be willing to consider the question of erecting a lamp in Milton-place if the gate at the entrance is removed. The proceedings were confirmed.

Hampstead.—The Lighting Committee reported at the Vestry meeting that they had fully enquired into the reasons whereby the strength of the electric current was not maintained on Thursday evening, 17th ult., the date of the recent earthquake, and found that the causes were as follows: "Atmospheric stillness or depression which affected the draught of the chimney shaft, a similar difficulty having been experienced on the same night at other electric stations in London; and a harder class of coal had been supplied by the contractors, requiring a stronger draught to burn it. They further stated that they were strongly of the opinion that the engineer could not have foreseen the difficulties which arose, and was in nowise to blame in attending the meeting of the Vestry on the evening in question. The subject of lighting the High-road, Kilburn, by electricity has been before the Vestry and the Willesden District Council since March, 1895, but the two bodies have not been able to come to an understanding. Recently sub-committees representing both bodies met in conference, and the Lighting Committee now brought up certain recommendations, the terms of which, in the view of the committee, would probably be acceptable to the Willesden District Council. A long discussion ensued, and, after one or two slight amendments had been made, the recommendations of the committee were agreed to, it being resolved to inform the Willesden District Council that the Vestry will be prepared to lay down the necessary mains, plant, etc., for the lighting of the High-road, Kilburn, by means of arc lamps, on the condition that the Council enter into an agreement as follows: to pay to the Vestry the sum of £15 per annum for each and every arc lamp used in the lighting of the road; to pay to the Vestry half the value of the mains, lamps, etc. (as a going concern), placed in the High-road for the purposes of such lighting, at the termination of such agreement, the value of the mains, etc., to be determined jointly by the engineer of the Vestry and the surveyor of the Council, and further that such agreement shall be determinable by the Council, at their option, at 7, 14, or 21 years, subject to the usual six months' notice being given to the Vestry to that effect. The report was approved

Monmouth—The following letter was read at the Town Council meeting from Messrs. Bramwell and Harris: "Monmouth Sewage and Electric Lighting.—Contract No. 1.—Machinery. Dear Sir,—We have now had interviews with the four firms whose tenders were the lowest for the above. If you will remember, the names of these firms, with the amounts of their tenders, were as follows: Messrs. Siemens Bros. and Co., Limited, £6,650; Messrs. Johnson and Phillips. £6,475; Messrs. The Brush Electrical Engineering Company, Limited, £6,405; Messrs. Crompton and Co., £6,330 After discussion with the responsible representatives of each firm, and after explaining to them exactly what was wanted and arranging that the tender in each case should be for the same articles, we have to-day received from them four amended tenders, in which also provision is made for ordering at present only two alternators, turbines, and their engines at the generating station, leaving the third alternator, engine, and turbine to be ordered at any time during the period of maintenance of the first portion of the work—that is to say, practically at any time during the next 18 months. In our letter of report, dated December 10, read to the Council by our Mr. Harris when he attended their meeting on December 15, we stated that Messrs. Siemens's tender, when properly revised, was probably even at that time the lowest. This is still practically true. The amounts of the four amended tenders are as follows: For all the work included in our specification, with the exception of one alternator, one turbine, and one engine, with the necessary switchboard instruments—Siemens Bros, £4,950; Johnson and Phillips, £5,010; Crompton and Co., £5,095; the Brush Company, £5,282. For the third alternator, engine, and turbine to be ordered within the 12 months period of maintenance of the first portion of the work—Siemens Bros., £1,220; Johnson and Phillips, £1,150; Crompton and Co., £1,230; the Brush Company, £1,345. It will be seen by the above that while Siemens Bros. are the lowest for the first portion of the work, when the second portion is ordered their total amount would be £10 in excess of Johnson and Phillips. It will be remembered, however, that Messrs. Siemens Bros. tendered for the two electrical contracts—that is, for the machinery and for the electric lighting mains. As regards their tender for the mains, this was practically as low as anyone else as it stood, but if the price of the feeder for Lord Llangattock's house with its trenching and laying be left out of all the three tenders which are lowest for this contract, then Messrs. Siemens will be found to have slightly the advantage, their price being £2,128. 10s. 10d., as against Messrs. The Callender Company, £2,150. But in sending their amended tender for Contract No. 1, Messrs. Siemens point out that if the work of the two contracts is placed in their hands they will be able to save the cost of the superintendent for one of the contracts, as one man only will be necessary for superintending both, and they will also save the cost of some of the members of the staff which it will be necessary for each contractor to have at Monmouth during the progress of his work. They say they are willing to give the Council the benefit of this saving, or a portion of it, and they offer to carry out the work of the two contracts if placed in their hands as specified and arranged (leaving out of the "main" contract, Lord Llangattock's feeder) for a total sum of £6,980, thus showing a saving on the two contracts of practically £150 to £180. Of course, if the feeder to Lord Llangattock's house is still to be provided, it would have to be added to the above sum. Its cost is about £650, and when the third engine, alternator, and turbine are ordered, a further £1,220 will have to be expended. Having regard to all the facts Messrs. Siemens Bros.' offer is the most advantageous, and we recommend the Council to accept it, instructing them to carry out the work of the two contracts, No. 1, machinery; and No. 4, electric lighting mains, for the sum (at present) of £6,980. We shall be glad to have the decision of the Council upon this at the earliest possible moment, as until it is absolutely settled it is impossible to finally complete the drawings and specification for the building contract. P.S.—The Council will note the above amount is considerably below the £7,500 of our estimate." The Council have accepted Messrs. Siemens's contract.

PROVISIONAL PATENTS, 1897.

JANUARY 1.

12. Improvements in and connected with electric motors for the propulsion of vehicles and navigable vessels. Robert Neilson and Walter Neilson, 70, Wellington-street, Glasgow.

15. An improved electric light fitting. George William de Tunzelmann, 2, Penywern-road, Earl's Court, London.

43. Improvements in electric motors and apparatus for propelling cars, carriages, cycles, and boats. Henry Francis Joel, 74, Windsor-road, Forest Gate, London.

73. Improvements in apparatus for the manufacture of metallic pipes and rods and for covering electric telegraph and telephone cables and wires. Alexander Wylie, 8, Quality-court, Chancery-lane, London.

30. Improvements in or connected with means for generating and applying electric currents. Charles Edwards and Edward William Brown, 27, Southampton-buildings, Chancery-lane, London.

86. Improvements in or connected with means for electric lighting. Charles Edwards and Edward William Brown, 27, Southampton buildings, Chancery-lane, London.

JANUARY 2.

119. Producing letters, figures, or designs for advertising purposes upon the globes of "silvered" electric lamps and the like. Edward Augustus Ingold, 8, Great Portland-street, London.

127. Improved means for electrically brazing the joints or connections of cycle frames. William Speirs Simpson, 166, Fleet-street, London.

129. Improvements in dynamo-electric machines. Siemens Bros. and Co., Limited, and Eduard Friedrich Hermann Heinrich Lauckert, 28, Southampton-buildings, Chancery-lane, London. (Complete specification.)

130. Improvements in multiplex telegraphy. James Mark Barr, 28, Southampton-buildings, Chancery-lane, London. (Complete specification.)

JANUARY 4.

171. Improvements in electric light and power fittings especially adapted to boxes used in connection with armoured conduit systems of wiring. Frederick Bathurst, 73 St. Stephen's-road, Upton Park, London.

203. Improvements connected with accumulators or secondary batteries in electrically-propelled vehicles. Carl Roderbourg, 4, South-street, Finsbury, London.

JANUARY 5.

246. Improvements in means for adjusting electric light carbons. Alfred Horswill Gibbings, 15, Water-street, Liverpool.

248. Improvements in or relating to apparatus for supplying a certain definite amount of electric current for lighting or other purposes. William Dobson Watson, 4, St. Ann's-square, Manchester.

251. Improvements in secondary batteries and process of forming same. George Washington Harris and Richard Josiah Holland, 62, St. Vincent-street, Glasgow. (Complete specification.)

265. Electrical indicating railroad signalling. George Griffith, 5, Carlton-terrace, Sydenham-park, Sydenham, London.

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272. **Improvements in secondary battery supports or grids.** John Joseph Rooney, 46, Lincoln's-inn-fields, London. (Complete specification.)

293. **An improvement in commutator connections for dynamo-electric machines and motors.** Siemens Bros. and Co., Limited, and Augustus Grotefeld, 28, Southampton-buildings, Chancery-lane, London. (Complete specification.)

332. **Improvements in carriers for incandescent electric lamps.** Henry Max Salmony, 226, High Holborn, London.

335. **Improvements in fitting electric incandescing lamps with "leading-in" wires.** John Archibald Sinclair, 191, Fleet-street, London.

336. **Improvements in incandescent lampholders for electric light.** Leicester Bradney Stevens, Darlington Works, Southwark Bridge-road, London.

JANUARY 6.

352. **Improvements in connection with paying out electric cable.** Charles Scott Snell, Culver Park, Saltash, Cornwall.

363. **Improvements in incandescent electric lamp plugs.** Sidney Crawford Cashel, 70, Wellington-street, Glasgow

384. **Improvements in electric governing devices for alternating currents.** Frank Michael Lewis, 34, Leinster-gardens, Hyde Park, London.

393. **Improved means for generating and storing electric energy in railway carriages and similar vehicles for lighting and other purposes.** Charles Dunsford Jenkins, 11, Southampton-buildings, Chancery-lane, London.

398. **Electric traction system with stationary and portable accumulator batteries.** Johannes Schuil, 20, Gladsmuir-road, Whitehall-park, London.

423. **Improvements in primary and secondary voltaic batteries.** Desmond Gerald FitzGerald, 53, Chancery-lane, London.

425. **Improvements in or connected with secondary batteries.** Frank King, 47, Lincoln's-inn-fields, London.

426. **Improvements in dynamo-electrical machines.** Valere Alfred Fynn, 47, Lincoln's-inn fields, London.

JANUARY 7.

439. **Improvements in incandescent electric lamps.** Carl Otto Weber and Isidor Frankenburg, Heathfield, Middleton-road, Crumpsall, near Manchester.

454. **Improvements in or relating to electric arc lamps for photographic or other purposes regulated by hand.** George Dowie, 127, Bothwell-street, Glasgow.

479. **A method whereby in an electric arc lamp the carbons may be maintained at a suitable distance for efficient lighting purposes.** Percy Henry Howard, 17, Ashley-road, Hornsey-rise, London.

483. **Improvements in electric arc lamps.** Alfred George Stockwell, 46, Delafield-road, Old Charlton, Kent.

488. **Improvements in dynamo-electric machines and electro-motors.** Alfred William Marshall, 433, Strand, London.

490. **Improvements relating to the electric deposition of metal on pipes, tubes, and other articles.** Walter Wright, 18, Southampton-buildings, Chancery-lane, London.

498. **Improvements in apparatus for the electrolytic treatment of alkaline salts.** Adolf Koch, 55, Chancery-lane, London.

509. **Improvements relating to dynamo-electric machines.** Hubert Henry Grenfell, 45, Southampton-buildings, Chancery-lane, London.

JANUARY 8.

550. **Improvements in and relating to conduits for electrical conductors and joints therefor.** Frederick Bathurst, 73, St. Stephen's-road, Upton Park, London.

JANUARY 9.

614. **Automatic electric fire-alarm and temperature indicator.** Richard Beach, 11A, Fortess-road, Kentish Town, London.

627. **Rectifying alternating currents.** David Cook, 30, Lancaster-park, Richmond, Surrey.

631. **Improvements in primary batteries.** Warren P. Freeman, 73, Cheapside, London. (Complete specification.)

632. **Improvements relating to electrical switchboards.** Percy Walter Ogilvie Hodges, 70, Chancery-lane, London.

652. **Improvements in or connected with primary electric batteries.** Duke William Bullard Edward Thomson and Henry Clay Bull, 57, Chancery-lane, London.

666. **Improvements in couplings for incandescent electric lamps.** Henry Alexander Mavor, William Arthur Coulson, and Sam Mavor, 46, Lincoln's-inn-fields, London. (Complete specification.)

667. **Improvements in dynamo-electric machines.** William Morris Mordey, 46, Lincoln's-inn-fields, London.

SPECIFICATIONS PUBLISHED.

1895.

24021. **Switches for connecting two or more electromotors.** Siemens Bros. and Co., Limited, and Bartlett.

23459. **Electro-depositing gold, silver, and other precious metals, and subsequently stripping the same from the cathodes.** Andreoli.

24232. **Multiplex telephony.** Sinclair.

24443. **Portable electric lamps for use in mines and other places.** Walker.

24885. **Apparatus for electrically controlling the supply of gas and other fluids and for like purposes.** Gale.

1896.

547. **Devices for joining or connecting electrical cables or conductors.** Edmunds.

701. **Electrical signalling apparatus.** Marinovitch.

1979. **Conduits for conductors of electricity.** Lane.

2197. **Preparation of electrolysed chloride solutions for disinfecting and like purposes.** Hermite, Paterson, and Cooper.

2570. **Telephone systems.** Houts.

2674. **Armatures for dynamo-electric machinery.** P. R. Jackson and Co., Limited, and Lewis.

3213. **Treating or flashing filaments for electric incandescent lamps.** Douglas-Willan and Bowen.

3256. **Electric cables.** Nisbett.

3796. **Electrically-driven machinery for cutting coal or other minerals.** Atkinson.

4261. **Electrical lamp.** Dowsing and Keating.

6481. **Apparatus for supplying electricity to electrically-propelled vehicles on railways and tramways.** Mégroz.

7650. **Armourings or coverings for electric cables.** Edmunds.

8323. **Process of electrically treating various materials for the purpose of waterproofing them.** White. (The Electro-Waterproofing and Dye Fixing Company.)

19507. **Electrical arc lamps.** Madsen.

22144. **Electric or other motor trucks.** The British Thomson-Houston Company, Limited. (Bassett.)

22173. **Telephonic apparatus.** Böse.

22402. **Switches for electric currents.** Rawlings and Rawlings.

24152. **Signalling apparatus for electric railways or tramways.** Lake. (Parrish.)

24551. **Electric railways on the closed-conduit system.** Reagan.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	7⅞-8⅛
Brush Company, Ordinary	3	⅝-¾
—— Non. Cum., 6 per cent. Pref.	2	1-1¼
—— 4½ per cent. Debenture Stock	100	110-113
—— 4½ per cent. 2nd Debenture Stock	100	94-98
Central London Railway, Ordinary	10	9¾-10¼
——	4	3¾-4
Charing Cross and Strand	5	9¼-9¾
Chelsea Electricity Company	5	8¾-9
—— 4½ per cent. Debentures	100	112-115
City of London, Ordinary	10	15¾-16¼
—— 6 per cent. Cumulative Pref.	10	16¾-17¼
—— 5 per cent. Debenture Stock	100	128-132
City and South London Railway, Consolidated Ordinary	100	56-58
—— 4 per cent. Debenture Stock	100	136-138
—— 5 per cent. Pref. Shares	10	15¾-16
County of London and Brush Provincial Co., Ordinary	10	8-9
—— 6 per cent. Cum. Pref.	10	13¾-14¼
—— 4½ per cent. 2nd Debenture Stock	5	9¼-10¼
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	1¾-2¼
—— 5 per cent. Debentures	—	93 98
Edison and Swan United Ordinary	3	1¾-2¼
—— 5 per cent. Debentures	5	3-4
—— 4½ per cent. Debentures	100	105-110
Electric Construction, Limited	2	1⅝-1⅞
—— 7 per cent. Cumulative Pref.	2	2¼-3
Elmore's Copper Depositing	2	⅛-¼
Elmore's Wire Company	2	¼-½
W. T. Henley's Telegraph Works, Ordinary	10	17¼-18¼
—— 7 per cent. Preference	10	18¾-19¾
—— 4½ per cent. Debentures	100	109-114
House-to-House Company, Ordinary	5	4¼-5
—— 7 per cent. Preference	5	8¾-9¼
India Rubber and Gutta Percha Works	10	20¼-21¼
—— 4½ per cent. Debentures	100	105-108
Kensington and Knightsbridge Ordinary	5	10-10¼
—— 6 per cent. Pref.	5	8-8¼ xd
London Electric Supply	5	1-1¼
Metropolitan Electric Supply	10	12¼-13¼
—— 4½ per cent. First Mortgage Debenture Stock	100	119-122
National Telephone, Ordinary	5	7¼-7¾
—— 6 per cent. Cum. First Pref.	10	17-19
—— 6 per cent. Cum. Second Pref.	10	17-19
—— 5 per cent. Non. Cum. Third Pref.	5	6¾-7
—— 3½ per cent. Deb. Stock	100	105-108
Notting Hill Company	10	10¼-11¼
Oriental, Limited, £1 shares	1	1¼-2
—— £5 Shares	5	8¼-9
—— £4½ shares	4½	7¼-8
Oriental Telephone and Electric Company	1	11/16-13/16
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	103-105
Southampton Electric Company	5	4¼-5¼
St. James's and Pall Mall, Ordinary	5	12-13
—— 7 per cent. Pref.	5	9¼-10¼
Telegraph Construction and Maintenance	12	40-43
—— 5 per cent. Bonds	100	102-106
Waterloo and City Railway, Ordinary	6	7¼-8
Westminster Electric Supply, Ordinary	5	11-12
Yorkshire House-to-House	5	7¼-8

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NOTES.

North-East Coast Engineers.—The dinner of the North-East Coast Institution of Engineers and Shipbuilders has been fixed for February 8 at Newcastle-on-Tyne.

Book Received.—We have received from Messrs. E. and F. N. Spon, Mr. W. E. Langdon's book on "The Application of Electricity in Railway Working," and hope to be able to give some notice of it in due course.

Municipal Electrical Association.—A special general meeting of this association has been fixed for Thursday, January 28, at the Westminster Palace Hotel, at 10.30 a.m., to consider fire risks at electricity works. Mr. Pearson, of Bristol, will read a paper, and discussion will be invited generally on the matter.

Another New Accumulator.—The Gülcher accumulator is described in *L'Electricien*. The plate is made up of a kind of tissue, in which lead wires one way are interwoven with glass fibre the other way; the resulting fabric is pasted, and the paste adheres in the interstices. In this way it is stated that plates about $\frac{1}{8}$in. thick can be used at the same distance apart.

The Calculation of Electric Motors.—We must express our great regret that the valuable articles by Mr. Alfred E. Wiener on the subject of the calculation of electric motors, which were reprinted in our columns, were unfortunately credited to the wrong source. These articles first appeared in the columns of our New York contemporary the *Electrical World*, and, not as stated, in those of our American namesake, the *Electrical Engineer*.

Personal.—It may be interesting to note that Captain Boisragon, one of the survivors of the Benin affair, is a brother-in-law of Mr. Rosling, of the firm of Rosling and Appleby, electrical engineers, of Trafalgar-street, Bradford. "The Guinea Gulf and the Bight of Benin. There's but one comes out for three that go in." That was in the old sailing-ship and slaver days, but when you leave the coast and get up country it does not seem to be so very much better even now.

The French Association.—The British Association having arranged to visit Dover in 1899, the French Association for the Advancement of Science will meet about the same time at Calais or Boulogne in order to exchange visits. It will meet this year (1897) at St. Etienne and next year at Nantes. Besides its visits to Algiers, Oran, and Tunis—which latter protectorate, in spite of their protests about the English in Egypt, every Frenchman treats as an integral part of the domains of France the association has met on foreign soil at Bilbao.

The Telephone Company.—The National Telephone Company comes in for a fair share of blame in one way and another. Up to the present it has been mostly the company's customers and the general public that have done most of the complaining, but now a shareholder—he gives his name—has written to the *Financial News* complaining that he does not get paid enough dividend. It is, of course, difficult for the most paternal and benevolent monopoly to give to one set of persons more than their just due except at the expense of some other set of people. We can perfectly appreciate the reasons why the Board feel it expedient to keep a large reserve fund, but it is just a little disappointing to find that the dissatisfaction of the public does not appear to be compensated for by a corresponding excess of satisfaction among the shareholders. A safe 5 per cent is not so bad in these days, with at least the prospect of exchanging it for Government stock when the affair has to be bought up.

Trolley-Wire Accident.—It is stated by the *Newcastle Daily Chronicle* that the other day one of the wires by which the current for the electric tramcars between the Hartlepools is carried broke away from its support, and fell on the roadway near Dyke House Farm. Whilst the wire was lying on the roadway, a collie dog, belonging to a fishmonger, got mixed up with it. Whether the dog tried to catch the loose end of the wire with its mouth or got tangled up with it in some way does not appear, but it seems clear that it was unable to get away and was killed. It is in accordance with experience that currents at a voltage which are not seriously dangerous to human life may easily prove fatal to smaller animals. But, then, a telegraph or telephone wire may break and in falling kill a man or anything else if it happens to hit exactly in the right way. Only it is not an occurrence that is frequently recorded.

Electro-Harmonic Society.—The next smoking concert of the Electro-Harmonic Society is fixed for Friday, January 29, at the St. James's Hall Restaurant, Regent-street, W., at eight o'clock. The following will be the programme:—Part I.: overture, "Poet and Peasant," (F. von Suppé), String Orchestra; song, "Love Could I only Tell Thee" (Capel), Mr. Frank Tebbutt; piano solo, Mr. Alfred E. Izard; air, "Honour and Arms" (Handel), Mr. James Budd; ventriloquial sketch, Mr. Frederic Russell; humorous sketch, Mr. Roland Henry; selection, "Shepherd's Dance" and "Morris Dance" (E. German), String Orchestra. Part II.: serenata (Moszkowski), String Orchestra; song, "My Bark is Ready" (F. Clay), Mr. Frank Tebbutt; violin solo, "Zigeunerweisen" (Sarasate), Mr. T. E. Gatehouse; song, "Long Ago in Alcala" (Messager), Mr. James Budd; harp solo, Mr. G. T. Miles; humorous selection, Mr. Roland Henry; selection, "Lullaby' (Theo. Ward) and "March (Gamerra)" (Gung'l), String Orchestra.

Northern Electrical Engineers.—The Northern Society of Electrical Engineers will meet at the Palatine Hotel, Hunt's Bank, Manchester, on Monday, January 25, at 8 p.m., for a paper on "Alternate-Current Switch Gear," to be read by Mr. L. Andrews, of Hastings. Members desiring to take part in the discussion can have copy of the paper on application to the secretary, Mr. John Darney, at 17, St. Ann's-square, Manchester. The officers and council of the society for 1897 are as follows: president—Mr. C. M. Dorman; past-presidents—Dr. John Hopkinson, F.R.S., Mr. Henry Edmunds, and Mr. W. P. Jas. Fawcus; vice-president—Mr. S. Z. de Ferranti; members of council—Mr. C. H. Wordingham, Mr. E. Manville, Mr. C. S. Northcote, Mr. T. Browett, Mr. E. W. Cowan, Mr. G. S. Corlett, Mr. E. A. Claremont, Mr. A. B. Mountain, Mr. Jas. Taylor, Mr. S. V. Clirehugh, Mr. G. H. Nisbet, and Mr. G. W. Lowcock; hon. solicitor—Mr. John B. Parkinson; hon. treasurer—Mr. A. Eckstein; hon. secretary—Mr. John Darney; secretary—Mr. E. E. Johnson.

The Postal Telegraphs.—In the course of an article on the Post Office the *Times* says that if anyone reads an account of the improvements effected in recent years in regard to fast speed in telegraphing, "how in a few years by the greater perfection of machinery, the elimination of electromagnetic inertia, the improvement of circuits, and the use of high-speed repeaters, the words transmitted per minute have been very much increased," and then turns to the meagre record of the concessions of the Post Office in recent years both as to cost and as to convenience of telegraphing, the contrast will appear impressive. The public, therefore, is held to be right in refusing to believe that the Department has done all it could do with respect to the rates of Continental telegrams. Whether Mr. Henniker

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Heaton is right in saying that we might telegraph to any European country at a rate of one penny a word and yet the Department obtain a considerable revenue, is a question which is not discussed. But the *Times* holds definitely that the best opinion is "that the charges have not been lowered in accordance with the increased capabilities or carrying powers of wires—in other words, that the Department has not kept pace with the progress in telegraphic science."

Trades' Union Responsibility.—It is one of the faults of the "eye of the law" that its power of perception varies according to no ascertainable rule. While, instead of seeing in the case of an employer and workman two equal citizens making a free contract for the performance of certain work, it can only see a "master" having such complete control over the actions of his "man" that he must pay for every fault or mistake, it has the greatest difficulty in seeing that a trades' union ever procures anything to be done at all. It is all the single action of the workman—who does not pay damages and costs, but who gets compensation for loss of time as well as the money found for his defence out of the union funds. Under the circumstances there is no particular wonder if a union sometimes breaks the very liberal provisions of the law as to what constitutes fair picketing pretty badly. The case of Bailey *v.* Pye, which was briefly reported in our last issue, shows, however, that there is a roundabout way of opening the eye of the law on the matter—and that is by an injunction against the secretary and officials of the union. If illegalities go on happening after that, they are in contempt with the usual summary consequences.

Mortalia.—In spite of Sir Henry Mance's excellent address, the last week's meeting of the Electrical Engineers could hardly be called a cheerful one. Two obituary speeches in one evening is measure full and overflowing. First, it was the man whose work was done so long ago dying forgotten and in semi-poverty, and then it was the lad—for he was little more—whose brilliant promise will never be fulfilled. In the nature of things, Mr. Ray could have been known to few members of the profession in which, if the Fates had suffered, he was destined to take so brilliant a place, but it was only necessary to listen to the evidently heartfelt words of Prof. Ayrton's eulogy to see how those that knew him feel his loss. After the address, and when the meeting had recovered its usual tone, there was an interesting little speech from Prof. Perry. It was very short and highly condensed, but dealt with matters enough to furnish a dozen speeches. It ranged, in fact, from the excellence of oratory through a variety of subjects, including an allusion to the temperature gradient of the earth's crust, to the literature suitable for a telegraphic station on a rock in the Persian Gulf, and on the way from one to the other threw out a challenge to practical men to work out Mr. Heaviside's mathematics in copper and insulating material and see what happened.

The Birkbeck.—The Lord Chief Justice (Lord Russell of Killowen) attended the seventy-third anniversary meeting of the Birkbeck Institution last week to give away the prizes and certificates. The Lord Mayor presided, and was accompanied by the Lady Mayoress and the sheriffs. Mr. Justice Bruce and Mr. J. A. Rentoul, Q.C., M.P., were also there. The report, which was read by the secretary, stated that the work of the past year had in all respects been very satisfactory. The Lord Chief Justice, having distributed the prizes and certificates to the students successful in the past year, congratulated the prize-takers and sympathised with those who had not taken prizes, offered his congratulations to those who were responsible for the management and teaching of the institution, and said that the bare statement of the results obtained was a remarkable proof of the efficiency, zeal, and thoroughness with which it was conducted. What surprised him most about the institution was the secret of how it was carried on. It had no endowments, no great private donations, no large payments from the City companies. Its success had been secured largely by voluntary effort. There are now so many similar institutions of brand-new creation in the field that it is just as well that one that has been steadily at work since 1830 or so should not be forgotten.

Obituary.—The death has been announced of Mr. George Gorden Nicol, a director and one of the founders of the Eastern and Eastern Extension Submarine Telegraph Companies. Mr. Nicol was, however, more widely known from his connection with banking than with telegraphic interests.—The name of Mr. Agostino Gatti, who died last week, is connected in most minds rather with restaurants and theatres than with electric lighting. But Mr. Gatti and his brother (Mr. Stefano Gatti) having shown that, starting without any knowledge of the subject, they could, so far as pecuniary results were concerned, teach most theatrical managers a lesson in theatre management, were not likely to come to grief over the business part of electric lighting. As a matter of fact, they were among the early purveyors of electric lighting in London. This they organised at first for the benefit of their own establishments, but so many applications were made to them for a supply of current by hotels and theatres that their generating station adjoining the Adelphi was gradually extended until it attained large proportions. The company that has grown up as a result of this, though not a gigantic concern, from both the financial and the electrical point of view has held a record that will compare favourably with most of the London supply companies. Mr. Gatti was an Italian Swiss, having been born in the Ticino in 1841.

Meteorological Society.—The annual general meeting of the Royal Meteorological Society was held on Wednesday last at the Institution of Civil Engineers, Great George-street, Westminster, Mr. E. Mawley, F.R.H.S., president, in the chair. The secretary read the report of the council, which showed that there was an increase of 17 in the number of fellows during the year. The President then delivered an address on "Shade Temperatures," in which he stated that of all meteorological observations there were none approaching in importance those made of the temperature of the air—generally known as "shade temperature." Indeed, the first question invariably asked in regard to almost any climate was as to its temperature. Mr. Mawley traced the history of different methods of exposing thermometers, and described his own experiments at Croydon and Berkhamsted as regards the improved screen known as the Royal Meteorological Society's pattern. He showed that the only two defects which had been attributed to this form of thermometer exposure were virtually non-existent, and therefore advised its general adoption both in this country and on the Continent. Mr. Mawley had recently made observations in the Stevenson screen, and also in the screens used in France and Germany, and the conclusion he had come to was that the results obtained in the Stevenson screen were not only the nearest to the true air temperatures, but also more likely to be strictly comparable with temperatures taken in a similar screen but with different surroundings elsewhere.

Society of Arts.—Mr. Bathurst's paper on the prevention of electric fires has been fixed for February 24. Mr. Esson's paper on alternating-current power transmission is still undated. Prof. Ewing's lectures on the production of cold begin on the 28th inst. The admission to these is the same as to Cantor lectures. At the Wednesday

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night meeting Mr. Emile Gautier, of the *Figaro*, explained the Bazin roller boat. There is nothing electrical about it, and the whole lecture and discussion will be published almost immediately in the *Journal* of the society. We shall not, therefore, attempt here any description of the queer thing (Mr. Gautier himself called it whatever may be the French equivalent of uncouth). It may be said that a Bazin boat has been constructed about twice as long as a sea-going barge, is actually afloat at Rouen, and is to try to cross the Channel and come to London in about six weeks. We can do no wrong in wishing her fine weather at the start at any rate. Mr. Gautier's paper was read for him by the secretary, Sir H. Trueman Wood, but Mr. Gautier subsequently said many complimentary things about this country in general and his audience in French. There was a discussion, in which Mr. Thorneycroft made many of the obvious objections to the Bazin form of construction and omitted others. Mr. Wolff, of Harland and Wolff, prophesied unfavourably, and there were others of less account. Mr. Gautier replied in French, rebutting some of the objections and parrying others as "not affecting the principle"—*i.e.*, that of getting rid of roller friction. Sir Frederick Bramwell presided. The meetings of the society for the next week will be found in our list of "Forthcoming Events."

Rubber from Lagos.—That the enthusiasm of successful work will survive even the climate of the Gulf of Guinea is shown by the latest report of the Colonial Secretary of Lagos, which describes the growth of the rubber industry of the colony as almost incredible. On the Gold Coast the export, which in 1882 was nil, in 1893 attained an annual value of £200,000. In 1894 Lagos sent away rubber to the value of £324. 6s. 4d., and 5,867lb. in weight; in 1895 the value was £269,893, and the weight 5,069,576lb. As far back as 1882 Sir Alfred Moloney, who was the originator of the industry at the Gold Coast, suggested its introduction into Lagos, but there was no real progress until 1894, when Sir Gilbert Carter, the governor of Lagos, announced to the mercantile community that he had been able to induce a number of natives from the Gold Coast, who were experienced in rubber collecting, to visit Lagos to aid in developing the industry there. The inspection of these experts led to their reporting that certain districts were rich in rubber-producing plants; the merchants took up the idea with enthusiasm; "with startling suddenness the easy-going native awoke to the fact that wealth, easily acquired, abounded in the forests round him, and learnt for the first time that in sitting under his own fig tree he had been unconsciously reposing in the shade of the family bank." But already there is danger that reckless destruction will ruin the industry. Judicious tapping, with due regard to the life of the tree and its future usefulness, is essential; but dead trunks are said to be already too common in the forests of the productive districts. Sooner or later, says the Colonial Secretary, destruction of this kind will exhaust the richest country; adventurers will have to stray further afield. and the cost of transport will equal or exceed the value of the product.

A Tramway Man.—Mr. Mulvy Ouseley has written a sort of biography of Mr. J. Clifton Robinson in the *Senate*. There is nothing like a good beginning, and Mr. Ouseley begins: "What Edison is to the electrical world, James Clifton Robinson is to the tramways." We would not for worlds say whose fault it is, but Mr. Clifton Robinson does not as a general rule manage to get so much egregious nonsense fathered upon him as Mr. Edison does, and we believe that it is not claimed for him that he was the original inventor of everything connected with tramway work, from the primeval rail and sleeper down to the last "closed conduit." We cannot here follow further through the half-dozen columns of biographical matter which take Mr. Clifton Robinson from Highgate to California, Canada, Scotland, Ireland, and France. Mr. Clifton Robinson has tried horse, cable, and electric traction. "And," adds the *Senate*, "as already hinted, should some more potent and valuable motive power unfold itself, Mr. Clifton Robinson will bring to it, as to other methods, an ever open mind and ever exhaustless energy." With the biography is presented a portrait, with the assurance that it "is an admirable likeness of this pioneer of tramways, who was born at Birkenhead on New Year's Day, 1848." We can only hope that Mr. Clifton Robinson has not become so black as he is painted. Assuredly he was not quite a little time ago. But it appears to be our contemporary's habit to depict people very darkly. Sitters are proverbially difficult to please. It is evident that the *Senate* has the very highest opinion of Mr. Clifton Robinson, but as to what Mr. Clifton Robinson will think of the *Senate* when he comes to read it we confess we are rather in doubt.

Central African Telegraphs.—The *Daily News* says that so many important events have lately occurred in Southern Africa that the progress of Mr. Rhodes's great scheme of an African Transcontinental telegraph has been almost ignored. "Despite a temporary suspension of work owing to the Rhodesian war [and it might have been added a temporary suspension of telegraphic communication in certain parts of Rhodesia], the projected connection has so far advanced that (with the exception of a few hundred miles between Mount Darwin and Tete) communication now exists from Capetown to Zomba, in the British Central African Protectorate. This represents a total distance of nearly 2,400 miles. Material for the line is lying all along the route from Mount Darwin to Matatima, and the wire is stretched on trees as far as Tete. Zomba is only some 80 miles from Fort Johnston, and the next stage will be from Karonga (north-west of Lake Nyassa) to Kituta (south-east of Lake Tanganyika), about 230 miles. Major Forbes, who has charge of the work, thinks Salisbury and Tete will be in regular telegraphic communication by the end of July. Ere long he hopes to have London and Tanganyika, thanks to wire and steamer, less than a week apart for purposes of speech." There has been something about this before. Tete, of course, is not in the South African Protectorate at all, and Zomba (the name is also spelled in other ways, but spelling is much a matter of taste beyond the Limpopo) is only in British South Africa in the sense that it is surrounded by it. But these are mere details. What is really noteworthy is to find Bouverie-street writing of Rhodesian extension, even though it is only telegraphic extension, in such a sympathetic spirit. There is even a concluding hint that a survey for a railway from the Cape to Cairo would receive not unfavourable consideration, and a companion motto for "Trade follows the flag" is found in "The train follows the wire."

Animal Electricity.—Dr. A. D. Waller has chosen animal electricity as the subject for the Fullerian lectures on physiology, and this year's course of 12 lectures was begun at the Royal Institution on Tuesday. The subject is somewhat in a transition state, and as it is intended that the lectures shall to a large extent deal with current work absolutely up-to-date, no syllabus has been issued. It may, however, be taken that the lectures will begin by an account, with experimental illustrations, of the simpler principles of animal electricity, and be followed by an investigation of the physiological modifications effected by physical and chemical agents. While this will form the

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stem of the lectures, it will be supplemented by "explanatory digressions [there were already several of these on Tuesday] and by experimental ramifications as occasion arises." On Tuesday Dr. Waller began with the inevitable preliminary history of the subject. In this connection two thoughts immediately present themselves. One is the immense difference there is in the progress that has been made on Volta's and Galvani's sides of electrical science—*i.e.*, the knowledge and use we have of the current in the wire compared with the current in the body. In fact, the latter subject is only just beginning to shape itself in the direction of definite conclusions. The second is the extreme difficulty of putting oneself in the position of these early investigators. Imagine how one of our modern men would feel if all his instruments were taken away and he was left to work out fundamental principles with nothing better than a dead frog's leg as a substitute for a galvanometer. History left Dr. Waller little time on Tuesday to do more than start his exposition of fundamental facts and explain how the early observers were unable to separate the effects due to differential chemical action on the electrodes from the true muscular current, and to show a variety of lantern slides illustrating the effect of various anæsthetic and toxic substances in diminishing or augmenting the response of nerves to stimulation.

The Trolley in the States. — Mr. Alexander McCullum, who was commissioned by the *Glasgow Herald* to report on American tramways for the benefit of its Northern readers, appears to have become a complete "trolley man." In an article in the *Street Railway Journal* he says that he found that "everywhere the statement was made by street railway managers that nothing is to be expected from storage batteries, compressed air, or gas, and little from the conduit electric system except when the local conditions are, as in Washington, peculiarly favourable. My own similar views were confirmed. Still, I was very much struck with the beautiful smoothness of operation and perfection of every detail in the conduit system at Washington. In economy of working the thing promises well, and the climate, the streets, and the drainage are all favourable. On the financial side of trolley-wire railways I was certainly surprised. Large numbers of statements were made to me by managers who certainly can have no inducement to boom any system except for its merits, which made it plain that at length electric traction is emerging from its struggles and is getting on a sound financial basis. We were told the same story a good few years ago, but the tellers then were only what I believe I called 'the electric men,' and the street railway managers were to a large extent silent. They could show few figures then; they were experimenting, and wisely held their tongues till some definite result of experiments could be announced. Now, however, the managers are as loud in the praises of electricity as the electric men themselves, and only one conclusion can be drawn. Some managers, men who are plagued with crowded streets and a crawling pace through them, admitted to me that they did not find the operating expenses per car mile much less than with horses, but they pointed to the increased size of the cars, the very material addition to the receipts per car mile, and the great increase of the mileage run by the same number of cars. In this way even those men were able to report substantial additions to the net revenue. Their more favourably situated brethren, who had fewer crowded streets to tackle, reported the above favourable features to exist in a still greater degree and also a considerable decrease in operating expenses per mile run. Over and over again I heard the story of roads which paid no dividends under horse traction paying dividends now, and of others that paid small dividends increasing the percentage. It is thus clear that in spite of the increase of capitalisation necessitated by making the change from horses to electricity, a large proportion—and I am told the great majority—of the companies have more than recouped themselves."

University of London.—The University of London is not in the least like other universities, and it is therefore only in accordance with the fitness of things that the proceedings of its Convocations should read somewhat strangely at times. At the ordinary general meeting of Convocation on Monday, Mr. E. H. Busk presiding, business was begun with a *naive* complaint that the senate would keep using the library and laboratories for purposes quite foreign to those for which libraries and laboratories are generally supposed to be constructed. Mr. T. G. Foster presented the report of the Annual Committee, the first part of which dealt with this question. The use of the library ought to be one of the greatest privileges of members, but unfortunately it was only available for some eight or nine weeks in the year. There was no librarian and no proper reading-room, as the room so called was used for various other purposes. Many of the valuable works of reference were practically inaccessible. Nor was the condition of the laboratory more satisfactory. The report further dealt with the Board of Studies. In chemistry, physics, and other departments revision was needed. Dr. Silvanus Thompson having seconded the adoption of this report it was carried, but in order that the nail might not fail to go home for lack of hammering. Mr. Foster moved and Dr. Thompson seconded a formal resolution, "That the senate be requested to refrain from using the library as an examination hall for any of the smaller examinations." To this Mr. Harris moved an amendment expressing regret at the lack of a university hall, which compelled the senate to use the library for purposes for which it was not intended, and said there was no use in asking the senate to do the impossible, as the original resolution did. The amendment was seconded and carried, upon which Dr. Thompson said he was glad that the form of the committee's resolution had been changed. The library was virtually useless, and the valuable mathematical papers of Prof. de Morgan and the other treasures of the library were unavailable for students. Bavaria, with a population scarcely exceeding that of London, had three universities, each equipped with an admirable library far better provided for and attended to than that of the University of London. The resolution, therefore, went through in its amended form, and Mr. Foster then moved a resolution requesting the senate so to revise the regulations of the library as to make the best of a bad business. The debate frittered off into details, but in the end about half-a-dozen recommendations were carried. Convocation then fell to discussing whether obviously irrelevant notices of motion should be placed on the agenda paper. It appears that not only as things stand is there no limit to the questions which may be introduced and put on the agenda paper, but that there are some members of Convocation whose sense of the fitness of things is somewhat undeveloped. There was, for example, on one occasion a notice about the Armenian question put on the paper. Mr. K. Moore moved a resolution to stop this sort of thing, and (apparently for a change) Dr. Thompson and Mr. Foster opposed it, and Convocation went on debating this elementary matter of business organisation until the House was counted out.

Germany the Great.—Sir Philip Magnus and Messrs. G. Redgrave, Swire Smith, and William Woodall have reported to the Duke of Devonshire the result of the visit to Germany with a view of ascertaining the recent progress

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of technical education in that country, and the daily papers, where they seem to have short memories, have come out with "leaders" on the subject. The report, however, was so discounted and anticipated in public speeches by the commissioners and others that almost everything about it except the actual text was known months ago and discussed to death. We summarised other people, and ourselves had our little say on the subject at the time, and may now pass this particular report with a mere notice of its issue. When, however, there is danger of the country falling into one of its fits of unreasonable admiration of the way they are supposed to do something somewhere else, and quite misplaced attempts to imitate it, there can be no harm in seeing how the question looks to an impartial foreigner. The French do not love Germany—for good reason. But assuredly the people who call this country Carthage—with the usual prefix of *delenda*—are not to be considered as biassed in our favour. And in France, if the *Revue de Deux Mondes* is to be trusted, they are inclined to laugh at our panic. Moreover, Mr. Paul Leroy-Beaulieu, the eminent economist who has been writing on German competition with French trade, refers incidentally to the outcry in England only to show that he thinks it to be much exaggerated: "That Germany has much progressed from a commercial standpoint during a quarter of a century is universally agreed. But has she become or will she become the first commercial nation in the world?" Mr. Leroy-Beaulieu thinks not, and remarks that commerce is proportionate to population, and that Germany has 52 millions of people while France and England have only 38; but judged on a percentage standard, French trade makes a better show than German. The Germans have made great efforts, both individually and collectively, for 25 years in developing both their industry and commerce. "They have gained a high place in metallurgy, and the first place, it may be said, in chemical industries. More than any other people—more than the English, who have other qualities in a higher degree—they have solved the problem of science applied to industry, constantly remodelling it and making daily progress. Hence the leading position which they have gained, especially in that branch of industry nearest to science proper—namely, chemical products," and "if the Germans have the great merit as manufacturers of constantly appealing to science and the spirit of novelty, they have as merchants not less valuable qualities. They are insinuating, even humble, studious of minutiæ, supple, adapting themselves to all customs and all tastes, bad ones included, and to all the national prejudices of the various peoples with whom they trade." All of which would not be in the least remedied by most of the remedies which are suggested. Mr. Leroy-Beaulieu's conclusion is, that what is wanted is not more but less paternal legislation. "Paternal legislation suits only a nation of children," and we may add on our own account that a nation of children does not conquer either the commercial or the physical world. Of a truth, one has heard a little too much of the great and glorious Germany. When that country gets rid of her military system she will be really formidable. At present the trail of the (drill) sergeant is over it all. She cannot make a colony, and seems ceasing to make great chemists. The old men have many successors, but they are not great ones, and Mr. Karl Pearson is not the only man that has observed that German science is already not what it was.

Light Waves and Heavy Reading.—The purely practical man is warned off this paragraph. *Guarda e passa*, it relates entirely to the Röntgen radiations. These have been radiating in laboratories and other places now for a considerable time, and we know little more (for certain) about what they are than we did in the first month of their discovery. There have been plenty of people at work on them, and plenty of results published—in *Comptes Rendus* and other places—some of which have had to be corrected, and others, the details of the experiment not being given, remain useless for the simple reason that no one is able to say for certain that he has reproduced the exact conditions of the observation. Consequently, not only has some of the time of investigators been unduly taken up in the mere dissipation of myths, but possibly important results are passed by because there are no means of telling whether they are really reliable or not. Indeed, apart from the investigation of the effect of the radiations on the electrification of air, which at present remains entirely without any physical explanation, and the discovery, already old in this country, but which appears to be still new in Germany, that by using a Wimshurst instead of a coil, under certain conditions of circuit radiations of a much higher penetrative power can be obtained than the original Röntgen rays, there are few results of really capital importance to be chronicled in the last six months. As for theories—dismissing that numerous class of people who talk about waves and forces without any definite idea of what they mean—we have had Sir George Stokes's, which Prof. Silvanus Thompson has recently declared to be about the best. It is not altogether clear whether this is taken to be entirely satisfactory from the electrical point of view; it is still less satisfactory from the point of view of light. One must speak with considerable diffidence after a man of such eminence as Sir George Stokes, but there really seems no certainty that his solitary waves or small groups of waves, if of the same order of magnitude as light waves, would not be refracted, and all analogy is against the notion that they would never be reflected. But there is another difficulty. It is almost impossible to conceive the condition of certain light-emitting surfaces—the Violle standard, for example—to be such that a few of the molecules or atoms would not be liable to give off only small groups of waves, or even solitary waves. But if this were so, most artificial lights would, on this hypothesis, contain a small but easily separable proportion of Röntgen radiations, which is not found to be the case. On the other hand, if the waves are conceived as very small compared with light waves, it seems unnecessary to specify for "solitary" waves. They may be so, but it is not material. On the whole, the simple hypothesis that the radiations are merely waves of the same character as the ultra-violet, only very much smaller, and that they extend over a very considerable range of spectrum, perhaps several octaves, will meet the case as well or better than anything more revolutionary. That they have not yet been polarised is no real objection. One would not expect the media which polarise ordinary light to be effective on wave-lengths of a different order of magnitude. One does not polarise Hertz waves or Lebedev waves with a piece of tourmaline. Something much more like a birdcage is used in the one case, or a book or a straight-grained pie of wood in the other. As for the longitudinal vibration theory, which still finds adherents in Germany, it will be time to consider that when it has got over the difficulty presented by the theory of polarisation by reflection. That is the merest elementary matter comprehensible by such an audience as Prof. Thompson addressed at Albemarle-street. It is, however, a pity in one way that the ether is not susceptible of compression waves. If it were so, the expression X-rays would be an appropriate and expressive one. At present it is not,

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THE PRINCIPLES OF ALTERNATE-CURRENT WORKING.*

BY ALFRED HAY, B.Sc.(EDIN.), A.I.E.E.

(Continued from page 40.)

129. Ordinary alternators used as synchronous motors possess the disadvantage of not being self-starting. For starting them an auxiliary motor must be used. In cases where the alternator is excited by a small continuous-current dynamo, this dynamo may be used as a motor to start the alternator and bring it up to the speed of synchronism. For this purpose, however, a battery of secondary cells must be provided. In other cases special forms of small self-starting alternate-current motors may be used for bringing the large motor up to its speed of synchronism. From this it is evident that ordinary alternators cannot be regarded as satisfactory alternate-current motors for general purposes of power distribution. In some cases, however, they may be used with advantage, and where a constant speed is required they are especially suitable.

130. The problem of a synchronous motor is closely connected with that of the parallel working of alternators. Before considering this subject we shall briefly explain wherein the advantages of parallel working lie.

Let us suppose that a central station contains a certain number of generating units. The area of supply will require a number of feeding points where the current from the generating station enters the distributing mains. The feeders which supply the various districts may be arranged in a variety of ways at the generating station. One method (largely in vogue in America) is to divide the feeders into a number of groups, and allow each alternator to supply one group of feeders. If no arrangement is made for changing over from one alternator to another during the hours of light load, such a system is extremely wasteful, for large engines and alternators have to be kept running for many hours at a fraction of their full load. For this reason, arrangements are generally made at the station for transferring feeders from one alternator to another. Before such a transfer can be made, however, the circuit must be broken, giving rise to a momentary extinction of all the lamps supplied by the feeders which are being changed over. Such breaks in the continuity of the service are objectionable, and may be entirely avoided by running all the alternators in parallel. Again, supposing a sudden breakdown of one of the alternators to take place during the hours of heavy load, considerable delay would probably arise before the corresponding group of feeders could be switched into the circuit of a spare generator.

When the alternators are run in parallel, all the feeders may be connected to "'bus" bars, and the alternators which are in circuit may be kept running at or about their full load, thus working with maximum efficiency. As the load increases, more alternators are switched into circuit, the supply of power being always kept adjusted to the demand. If one of the alternators breaks down, it may be immediately cut out of circuit without in any way interrupting the continuity of the supply, the extra load being equally divided between all the alternators which are in circuit. As regards convenience, simplicity, and economy of working, parallel running has therefore very great advantages.

131. We have already seen that when two alternators are synchronised and the switch connecting them is closed, they will tend to run in synchronism even if one of them is loaded. When both alternators are driven by engines, we should therefore expect them to run in synchronism without much difficulty, and this is found to be the case in practice. So powerful is the synchronising action of many alternators, that in many cases an alternator which is not in step—*i.e.*, in direct opposition of phase—with the E.M.F. of supply when thrown into circuit will be pulled round so as to come into opposition of phase.† The mere synchronous running of two alternators does not, therefore, present any difficulty. But *the successful parallel working of alternators is a very different matter from mere synchronous running.* It is obvious that an alternator might be kept running in parallel with others, and not only contribute nothing towards the combined output, but actually absorb power. Successful parallel running depends on the ease with which each alternator will immediately take up its share of the load as it is switched into circuit, and with which it will keep in exact step with all the others *during the whole of a period.*

132. The parallel running of alternators may be conveniently studied in two aspects—an electrical and a mechanical one. We shall consider the electrical aspect of the problem first.

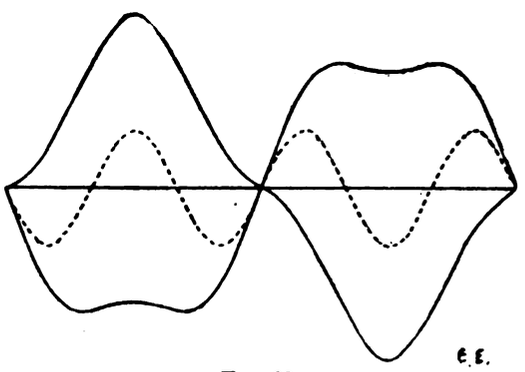

FIG. 88.

The operation of throwing an alternator into circuit has already been practically described (Art. 124). The alternator is brought into step and synchronism by means of the synchronising transformer, and the exciting current is adjusted so that the E.M.F. of the alternator on open circuit is somewhat higher than that of the station. The switch is then closed, and the steam supply to the engine is increased until the alternator ammeter indicates that the machine is taking its fair share of the load.

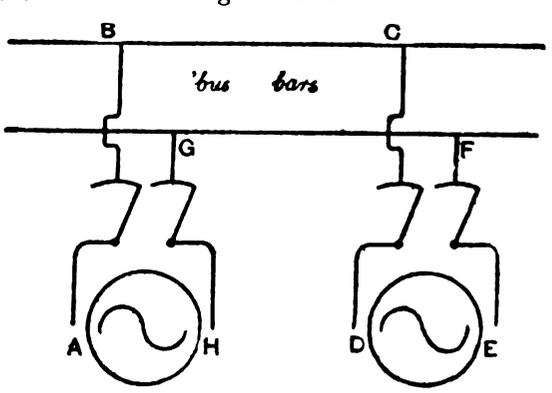

FIG. 89.

As an ideal case, suppose all the alternators to run at a perfectly constant speed, and to be in exact step with each other. If the E.M.F. waves of all the alternators are precisely alike, then it is obvious that no interchange of current will take place between any two machines. But if the E.M.F. waves of two machines are widely different, such as the peaked and flat-topped waves shown in Fig. 88, then there will be a resultant E.M.F. (shown dotted) in the local circuit, A B C D E F G H (Fig. 89), and consequently there will be a current in this circuit whose periodicity is different from that of the main current. Since this *local* current does not pass into the external circuit, it contributes nothing towards the useful output of the machines, but reduces the power factor, and lowers the efficiency on account of the additional heating of the machines with the larger current. It is thus evident that for parallel working it is desirable to use machines of the same type.*

* Based on a series of evening lectures delivered at the University College, Liverpool.

† Such a method of procedure is, however, not advisable (Art. 124, footnote), as it might result in serious damage to the alternator coils.

* This does not mean, of course, that machines giving widely different E.M.F. waves will not run in parallel; but merely that machines giving similar E.M.F. waves will work more economically (other things being equal) than those whose waves differ considerably. The exigencies arising in practice sometimes necessitate the parallel working of widely different types of machines.

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133. Perfect constancy of speed is unattainable in practice, so that we have to consider the effects produced by a slight *momentary* retardation or acceleration of one of the alternators. Let one of the machines be momentarily retarded. In Fig. 90, the middle curves show the phase relation between the E.M.F. of the mains and that of the machine under consideration when there is exact opposition of phase. A slight momentary retardation of the machine will produce a lag of its E.M.F. behind that of the mains, so that the balance of E.M.F.'s in the local circuit formed by the machines will be destroyed, and the resultant local E.M.F. (shown dotted in Fig. 90) will produce a current which is almost in quadrature with the E.M.F. of the machine. This current will exert a powerful effect on the field of the machine, for it reaches its maximum value when the alternator coils are almost facing the poles, and are thus in the best position for exerting a magnetic effect. A reference to the upper part of the diagram (Fig. 90) will readily enable the student to see that a slight *lagging* of the alternator behind the other machines results in a

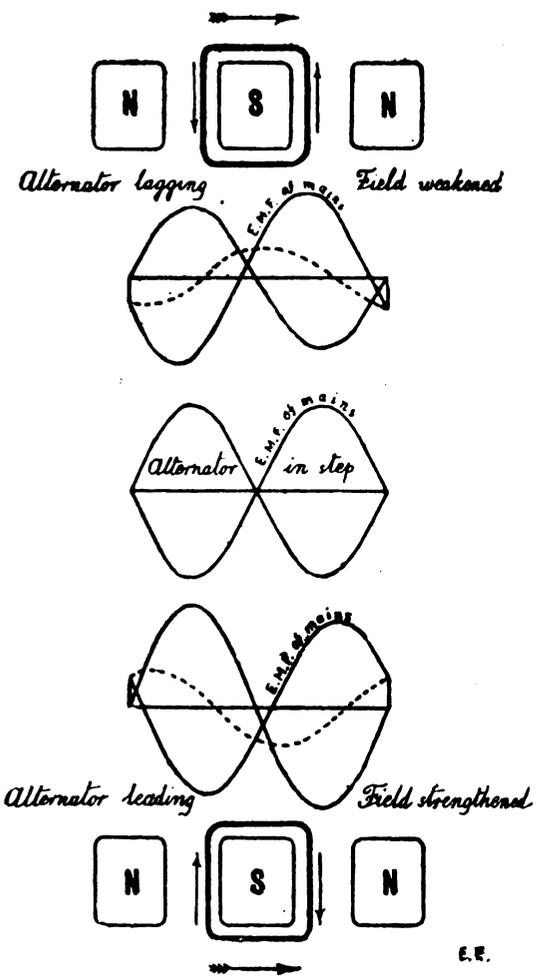

FIG. 90.

weakening of its field. Its E.M.F. will therefore be reduced, and hence also the load current which it supplies to the external circuit. The lagging alternator is thus automatically relieved of part or the whole of its load, and in extreme cases even supplied with power from the other machines.

Suppose next that the alternator is momentarily *accelerated*. Reference to the lower part of Fig. 90 shows that in this case a local current is produced which *strengthens* the field. The E.M.F. of the machine is increased, and hence also its load. Any tendency of the machine to get ahead of the others is thus checked by an immediate increase of load.

These automatic adjustments are, as we have seen, produced by a local current between the machines which controls their fields. Hence this local current is frequently termed the *controlling current*; it performs the function of maintaining the machines in synchronism.

134. So far we have merely considered the parallel running of alternators with respect to the electrical actions by which the machines are maintained in synchronism. From the explanations given above it follows that unless the momentary retardations and accelerations which are liable to occur in the case of any given machine are small, there will be a large interchange of current between the machines, which will considerably reduce the load-factor, and render parallel working unsatisfactory. But constancy of speed depends entirely on the prime mover. It is thus evident that the successful running of alternators in parallel is mainly dependent on the *prime movers* driving them. From this point of view, turbines and engines with three cranks (set 120deg. apart, so as to give the most even turning moment possible) are much more suitable for working alternators in parallel than single-crank steam-engines. Gas or oil engines working on the Otto cycle are totally unsuitable, for the torque exerted by such engines, even when fitted with heavy flywheels, fluctuates considerably during the engine cycle.

For successful parallel running, the engines driving the alternators should not be provided with independent governors. Otherwise, unless the governors are adjusted with a precision which is impossible in practice, there will be difficulty in getting each machine to take its fair share of the load, the machines which tend to run faster taking too much load, and those which tend to run slower too little. The supply of steam should be adjusted by hand until the machine is properly loaded, the governors only coming into play when owing to some accident—such as the blowing of a fuse and consequent sudden removal of the load—the engine tends to race. The governor should thus be used merely as a safety device to prevent the engine speed from rising above a safe limit, and the actual regulation of the steam supply should be done by hand.

When the problem of the parallel running of alternators first presented itself, it was supposed that whether two machines would or would not run in parallel was a question dependent entirely on the kind of alternator used (*e.g.*, on whether the alternator armature did or did not contain iron, etc.). The above explanations will, however, make clear to the student that although the controlling current (Art. 133) which passes between any two machines is to some extent determined by the types of the machines, yet the main factor determining it is not the type of alternator, but the *type of engine*. Successful parallel running is determined almost entirely by the capability of the prime mover to maintain a constant torque.

(To be continued.)

THE MECHANICAL CONSTRUCTION OF ELECTRICAL MACHINERY.

BY F. M. WEYMOUTH.

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THE DYNAMO.

(Continued from page 77.)

Bed-plates (continued).—We now come to some examples of machines having circular magnets. An advantage of these latter is that for any given length of periphery the greatest area is enclosed by the circle. Hence, for any given sectional area of magnet, the circular form will be the most economical in copper for the coils. But this is to anticipate. Figs. 24 and 25 show a bed-plate for such a machine, and, like the last discussed, it has three pedestals. This approximates a design by Messrs. J. P. Hall and Co., of Oldham; and it might have been mentioned that Figs. 18 and 19 roughly approximated forms of bed-plate made by the India Rubber, Gutta Percha, and Telegraph Works Company, Limited, Silvertown, and by the Newton Electrical Works, Taunton, and Messrs. W. H. Allen, Son, and Co., Bedford, more especially, perhaps, the last-named. In the case now under consideration we find the lower ends of the magnets are included within cast-iron caps or covers, *a a*, held by tap-bolts, *c c*. By this means a good magnetic contact between the magnets and the yoke cast within the bed-plate becomes very feasible; for the hole or socket, half in the cover and half in the bed-plate, can be bored a tight fit—too tight, in fact, to easily force the limb in

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endways. But by slacking the bolts, or removing the cover, and then inserting the magnet, the desired grip and consequent good magnetic contact is made by tightening the bolts. The pedestals receive the waste oil, which is drawn off by a tap, as at *e* in the diagram.

In Figs. 26 and 27 a bed-plate for a two-pedestal overtype machine is shown, also having circular magnets, approximated to designs by Messrs. L. Gardner and Sons, Manchester, and Mr. E. S. Hindley, Bourton, and Messrs. F. H. Royce and Co., Hulme. The sockets are bored into the bed-plate and the magnets dropped in endways; and, as shown at *d d*, may be further held by set screws outside.

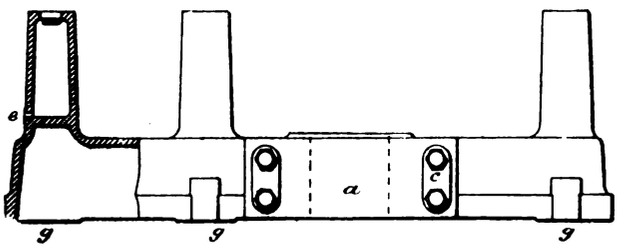


FIG. 24.

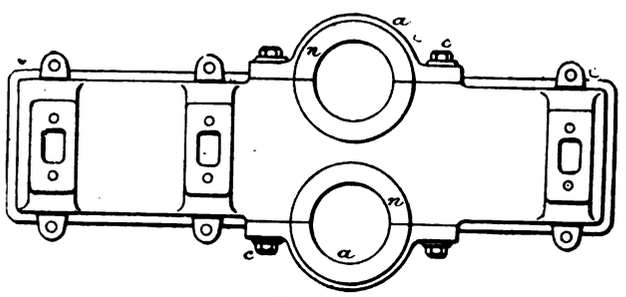


FIG. 25.

On comparing these bed-plates together, however, we note in Figs. 24 and 25 that while the magnets are circular yet the advantage is retained, as in Figs. 18 and 19, of being able, by taking off the covers, to remove the magnets without disturbing the armature; and at the same time the pedestals are low enough to enable the armature to be withdrawn endways without dismounting the magnets.

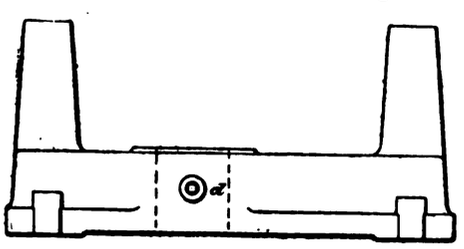


FIG. 26.

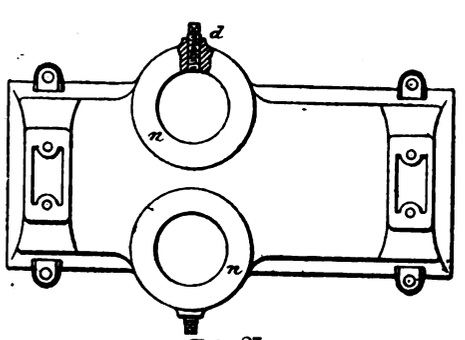


FIG. 27.

With the other bed-plate, it is necessary to withdraw the armature in order to remove the magnets, as the latter require to be lifted. Four deep bosses, one at each corner, for the holding-down bolts are also shown, as will have been noted likewise in the other bed-plates we have had under consideration.

This latter leads us to another minor point which may well receive some attention; for the proper arrangement of these bosses is by no means unimportant, especially on board ship with the vessel rolling and pitching in a heavy sea. The importance of this point, moreover, has reference not merely to the dead-weight of the dynamo, or engine and dynamo combined, in respect of the tendency of the rolling of the ship to throw it off its foundations; for another point is the gyrostatic action of the revolving armature and flywheel, especially perhaps the latter, inasmuch as this effect varies with the square of the radius of gyration of the rotating part. If, for instance, an armature and flywheel revolved on an axis athwart the ship in the direction that if dropped on to the deck they would roll forward, then on the ship rolling to starboard the revolving parts would want to turn on a *vertical axis*, so that if touching the deck they would roll away to starboard also, like a child's hoop tipped over to the right. This effect, therefore, becomes not inconsiderable with an armature weighing over a ton, and a flywheel 3ft. or so in diameter rotating between 300 and 400 revolutions per minute. A good method, in fact, of realising this peculiarity of rotating bodies is with a bicycle wheel; for let such a wheel, mounted on its bearings, be held with a hand at each end of the axle so that the latter is horizontal, and be made to rotate on its bearings. Then, on the attempt being made to raise or lower one end of the axle, it will be found that the wheel will exhibit a forcible

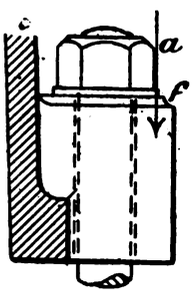


FIG. 28.

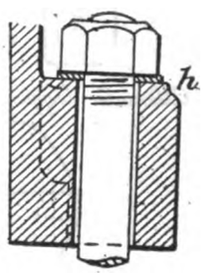
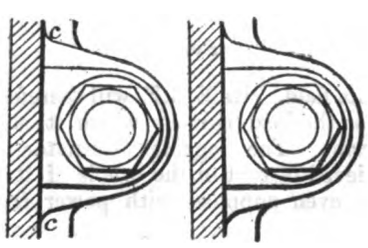


FIG. 30.

tendency to turn on a vertical axis instead. A mental comparison can thus easily be made between the effect resulting from a light bicycle wheel, and that probable from a heavy and quickly rotating armature and flywheel. Hence we find that under such circumstances the holding-down arrangements of a plant become not so entirely of minor consequence. The rotating parts, when the ship rolls, will exert a force tending to slew the whole machine or plant round so that the shaft shall become parallel to the axis on which the ship itself is rolling; and so that, as a further detail, the shaft shall also be rotating in the same sense or direction as that in which the ship is momentarily rotating, this, though a more scientific explanation, being agreeable with the allusion to the child's hoop above. "Spinning Tops," a little book by Prof. J. Perry, may further be consulted on this subject; and mathematical treatment may be found in Prof. S. P. Thompson's "Dynamo-Electric Machinery."

The case thus cited, it may be observed, is therefore one in which there is a force acting on the bearings and



FIGS. 29 AND 31.

pedestals horizontally across the upper end, throwing one side of the bearing into compression, and the other into tension. This latter, a component in the general slewing effect on the machine, will reach the holding-down boss, tending to break it off, though more especially of course when the shaft is high up and the base narrow. The strength of the boss may hence once more engage our attention.

Figs. 28 to 33 show examples of bosses in elevation and plan. A general principle involved in their design is simply that of making all parts to meet a given strain to be of the

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same strength; and so, theoretically, any mechanism being overstrained should break up all over at once without any part remaining intact. This most nearly applies when only one material is used. With variety of materials their individual reliability has to be considered as well as their mere strength. Thus cast iron is not so reliable as wrought iron or mild steel, as it is apt to have blowholes in it, or be honeycombed under the skin, and be otherwise treacherous. So an allowance is necessary for this; and, to meet a given strain, cast-iron parts must be stronger than those of mild steel or wrought iron. In the latter a factor of safety of 4 or 5 may suffice, but in the former 5 or 6. Thus the bosses must be stronger than the bolts that go through them in the proportion of at least 6 to 5. But it is necessary to provide for the worst contingency that may arise, and as the pressure of the nut might chance to come wholly, or almost so, on the outer end, as indicated by arrow, *a* (Fig. 28), the boss must be calculated accordingly. Hence, if we assume a proportionate width of base as shown, *c c*, in the diagrams, and in all cases a clearance of ½in. between the nut and side of bed-plate,

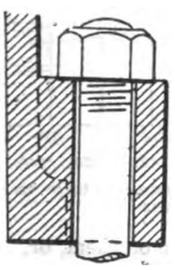

FIG. 32.

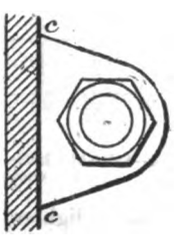

FIG. 33.

and allow a load of 3,000lb. per square inch on the cast-iron and 13,000lb. per square inch on the steel bolt, taking only the weakest section through the threads, we find the sections of bosses on *c c* for different sizes of bolts will be as follows: for a 1in. bolt, 3¼in. wide by 3½in. deep; for a 1¼in. bolt, 4½in. wide by 4in. deep; for a 1½in. bolt, 5in. wide by 4¾in. deep; for a 1¾in. bolt, 5¾in. wide by 5½in. deep; and for a 2in. bolt, 6½in. wide by 6⅝in. deep. The holes would be cored in the casting at least ⅛in. larger diameter than the bolt. In Figs. 28 and 30 washers are added, though this is perhaps not very usual in practice. Facings are also shown, finished with a single radius at *f*, but with two reverse curves forming an ogee at *h*. The latter is the better for casting, if it does not also look better, but takes more time in the patternmaking. Figs. 32 and 33 show the cheapest arrangement. In practice makers use six or eight 1½in. diameter bolts for holding down a 32-unit shiplighting set of engine and dynamo combined The bosses as illustrated are drawn to suit 1½in. diameter bolts, and reduced to scale.

(To be continued.)

THE LOCAL DISTRIBUTION OF ELECTRIC POWER IN WORKSHOPS, ETC.

BY ERNEST KILBURN SCOTT.

PART I.

(Continued from page 52.)

A system of controlling the speed of a motor without loss of power has been introduced in the United States by Mr. H. Ward Leonard. In this system, regulation is effected in the electric generator supplying the motor, and not in the motor itself. Thus, when it is desired to reverse the direction of the motor, the magnetism, and consequently the direction of current of the generator, is reversed. Similarly, when a lower pressure is desired in the motor in order to go slower, the pressure produced by the generator is reduced, instead of keeping the pressure of the generator at its full amount and reducing the pressure supplied to the motor by means of a rheostat. This system gives full torque at all speeds, and is also much more efficient, because the loss in the line is only proportional to the actual work done by the motor. It has been successfully applied to motors for driving textile machinery, etc., and the only objection to its application to lathes is that it is more costly to lay down in the first instance, each motor requiring its own generator and line circuit. The current is sometimes supplied from several continuous-current transformers, all placed on one shaft, and driven by one electric motor, but it will be seen that even this is expensive in first cost. Messrs. Sellers, of Philadelphia, are using this system for their large machine tools.

Another method has been introduced by the Miles Tool Works Company, of Hamilton, Ohio. Fig. 5 shows a 42in. electrically-driven lathe of their manufacture. The motor, which, it will be seen, forms part of the headstock, has what is termed a commutator field—a type of motor which has been tried with some success on electric tramcars in the United States. Tests have been made by Prony brake and in actual work on two lathes, a 30in. and a 42in. When running at 24 different speeds, the average combined efficiencies were 70·4

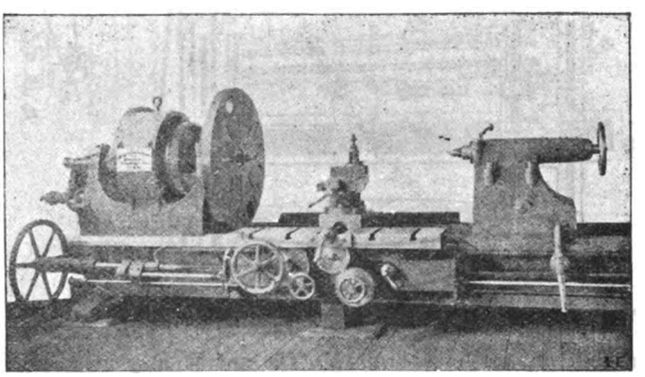

FIG. 5.—42in. Lathe, with Motor mounted directly on Headstock.

per cent. and 65·83 per cent. respectively, the larger machine showing the lower efficiency on account of the gearing and face-plate being heavier in proportion to the output. The motors were also tested for efficiency by running them loose on the spindles; they ran at speeds varying from 58 to 275 revolutions per minute, and gave a minimum of 76 and a maximum of 77·2 per cent. efficiency—the smaller motor delivering about 4½ h.p. and the larger 6½ h.p. at the face-

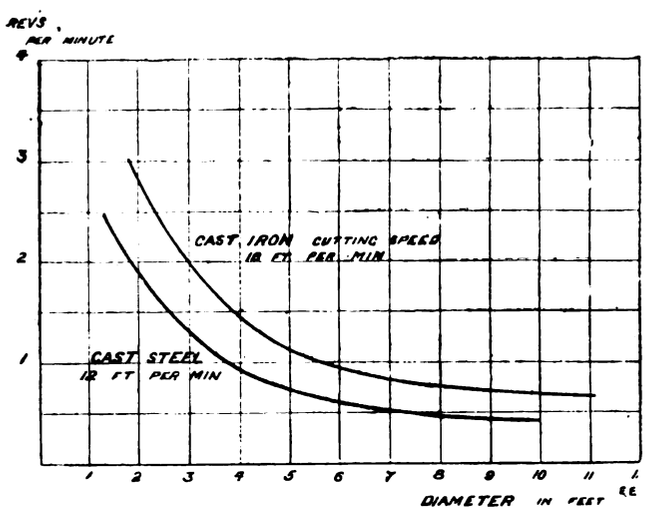

FIG. 6.—Curve showing variation of speeds of a surfacing lathe to always give about the same cutting speed.

plate. The actual tests when cutting metal were equally satisfactory, and went to show that much heavier cuts could be taken than if the tools had been belt driven in the ordinary way.

In surfacing larger areas, say up to 10ft. in diameter, in the lathe, it is necessary that the speed should be altered regularly as the tool cuts inwards from a large diameter to a smaller, or *vice versâ*. This is necessary in order to keep about the same cutting speed throughout the job. Fig. 6 gives the curves for cast iron and cast steel, showing the variation in speed from about 2ft. up to 10ft. in diameter. Take cast steel, for instance: at 10ft. diameter the face-plate of the lathe must revolve at rather less than half a revolution per minute, so as to give a cutting speed of 12ft. per minute. On the other hand, when the tool is cutting at only 2ft. in diameter, then the speed of the face-plate must

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have increased to nearly two revolutions per minute, in order to keep the same cutting speed. With large surfacing lathes of this character it is not unusual to have speed cones with seven or nine steps, and as the work proceeds the attendant must move the belt from one step to the other: and this should be done, if possible, without bringing the work to a standstill. Fig. 7 shows an arrangement, which the writer has designed, in which the step cone is dispensed with, and its place is taken by a long taper cone, A, stretching along the top of the machine, and driven by a short belt, K, from an electric motor immediately below. The motor is not visible, but it is mounted on the slides, B, which may be traversed from end to end of the

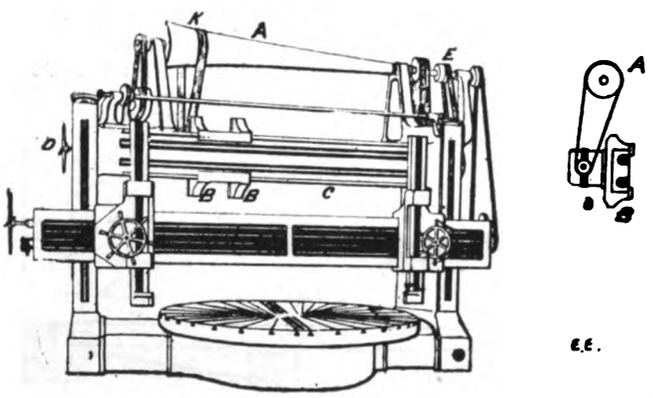

FIG. 7.—Large Lathe, with sliding motor and long cone for varying the speed.

machine on the cross-arm, C. The motor may also slide vertically for a short distance, and thus adjust itself according as to whether the belt is at the large or small end of the cone. The motor with its attachments—slides and belt — may be traversed backwards and forwards by the handwheel, D, or by the belt, E; this also applies to the tool holders, which may be traversed by another belt working over guide pulleys. In this way the machine may be made to work automatically, and will take a minimum of attendance. A belt guide, not shown, serves to keep the belt K from moving out of position, and the weight of the motor acting downwards keeps it taut wherever it

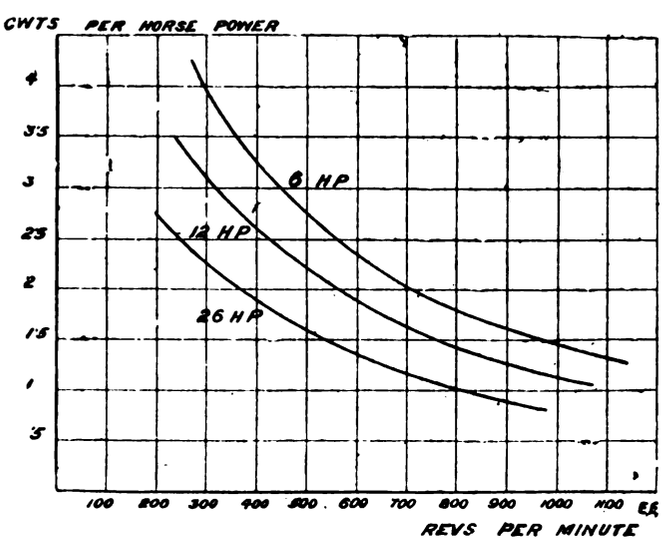

FIG. 8.—Weight per horse-power at various speeds for three sizes of continuous-current motors.

may be on the cone. Messrs. New and Mayne, Limited, of Palace-chambers, Westminster, are applying motors in this way.

The electric motor is by nature a fast-running machine, but of course it may, by simply increasing the size and weight, be designed to run at almost any speed. The standard speeds for a 6-h.p., a 12-h.p., and a 26-h.p. would be about 1,100, 1,000, and 900 revolutions per minute respectively, but as the cost of manufacturing tends to come down there will also be a tendency towards slower speeds. The writer has found the curves given in Figs. 8 and 9 useful, although naturally, they can only be approximate. Fig. 8 shows how the weight per horse-power increases (for three sizes of continuous-current motors) as the speed is decreased, and Fig. 9 gives the relative prices per horse-power at various speeds. With these curves, anyone wishing to get out a combined arrangement of a motor and, say, a slow-running machine tool, will be able to judge as to how far it will pay to dispense with gearing by reducing the speed of the motor. Owing partly to the limitations of shafting and belting, most ordinary machine tools are comparatively slow running, but it would appear that there is now a decided tendency

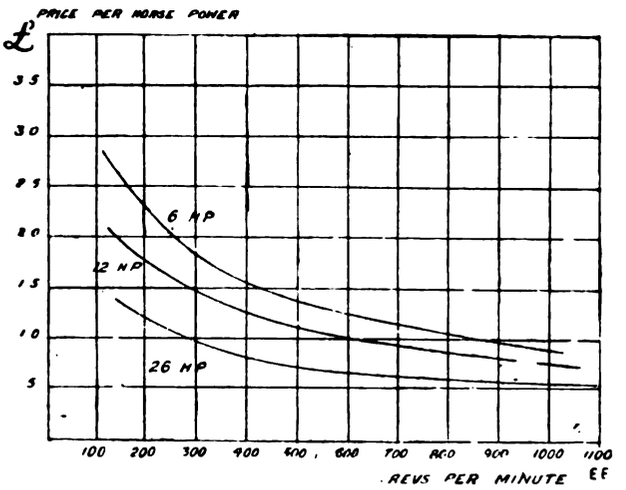

FIG. 9.—Price of a horse-power at various speeds for three izes of continuous-current motors.

towards taking lighter cuts and more of them, or, in other words, running at higher speeds.

The milling machine, for instance, is a tool designed with the idea of employing a small battalion of cutting edges, each prepared to relieve the other in rapid succession, and thus avoid the fatigue of a single cutter. The development of this idea has been so rapid that, whilst only a few years ago milling machines of two or three tons weight were considered heavy, now we hear of them weighing 15 and even 30 tons. The almost universal nature of these machines and the beautiful finish of the surfaces passed over by the milling cutter, together with the specialising of machine shop, threatens to confine the work of the fitter in the near future to the setting-out and assembling of parts. With the extension of milling cutters, the difficulty of the differences of speed between motor and tool will in time partly solve itself, and a good deal of the present speed-reduction gear will be unnecessary. The tool being essentially fitted for duplication, there will develop an infinite variety of machines, each one running at one special speed for one special purpose.

(To be continued.)

THE "KOSMO" SYSTEM OF CONCENTRIC WIRING.

The "Kosmo" concentric wiring system, briefly described below, has been devised by Mr. G. Wilkinson, the electrical engineer of the borough of Harrogate. The system is the outcome of a long period of experimental work based upon a comprehensive experience of the various methods of wiring for electric lighting and kindred purposes, while the "Kosmo" system is equally applicable to the highly-decorated hotel, mansion, or club, and the bare walls of warehouses or factories, and its absolute imperviousness to moisture renders it specially useful in exposed situations and subterranean works.

The general arrangement of the conductors on the "Kosmo" system is to lead cables from the main double-pole cut-out to distributing centres on each floor of the building. These distributing centres are double-pole switch and fuse boxes, from which the section cables radiate. Where the small branch conductors are jointed to the section cables, a single-pole switch and fuse, or a single-pole fuse, is inserted upon the joint-box and placed in the circuit of the "outer" conductor. The conductors, having a mechanical protection of solid-drawn lead tube, are laid like flexible gas-pipes, and, excepting in the largest sizes

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can be readily bent to the contour of the walls, mouldings, and angles of buildings. In practice it has been found that, where necessary, they can be perfectly secured to plaster work by means of bronzed metal saddles fixed by short round-headed screws inserted in the plaster work. This method of fixing the conductors greatly simplifies and cheapens the wiring of highly-decorated apartments, and renders the fitting-up possible without any serious defacement of walls or decorations. The lead-encased conductors can, if desired, be coloured before being fixed in position, and may be run immediately beneath the plaster mould round the apartment, no "plugging" of walls being necessary when the plaster is of ordinary good quality, as the screws get a firm hold when carefully inserted. Upon woodwork the ordinary brass saddle-pins may be used, while upon unplastered walls the common gas-pipe hooks will make good fastenings.

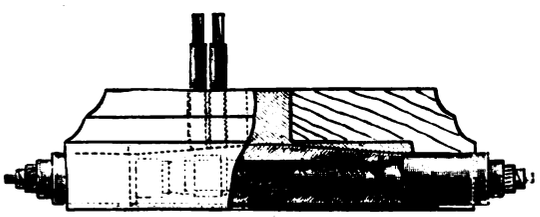

FIG. 1

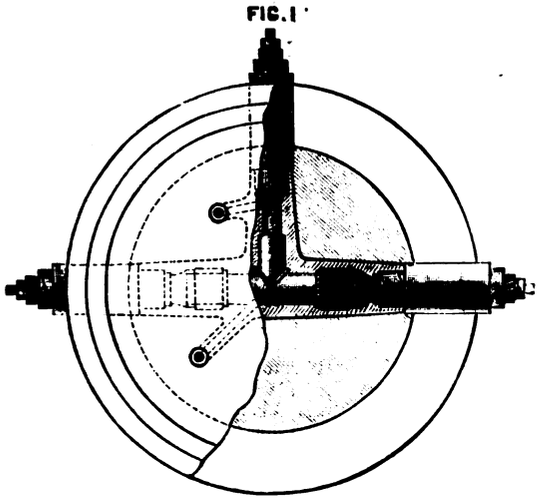

FIG. 2

Conductors.—Usually concentric cables are made with the aggregate sectional areas of the "inner" and "outer" conductors equal. The inventor of this new system claims that consequently, in the small sizes of cable, the individual sectional area of the "outer" strands of the conductors is too small to afford a practically sound jointing. He has accordingly given to his "outer" conductor in every case more than twice the area of the "inner." The conductors are of double-tinned, high-conductivity copper, the "inner" being insulated with vulcanised indiarubber and sheathed with the double-tinned copper outer conductors, which are insulated with vulcanised rubber and finally covered.

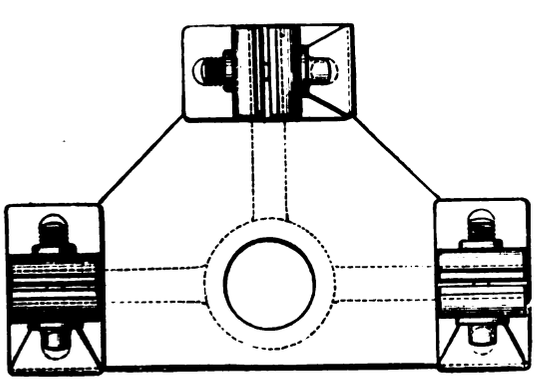

FIG. 3

Joints.—The joints in the "Kosmo" system (see Figs. 1 and 2) are made in a triple vice (Figs. 3 and 4), fixed upon a platform which is screwed to a telescopic tubular pillar attached to a heavy cast-iron base; the joint-table is thus adjustable to any convenient height. A floor base is also provided to carry the jointing-table when joints are required to be made upon conductors running beneath the floors. If an ordinary T-joint is to be made, the continuous cable is gripped by the two parallel vices and the branch cable by the central vice. A cutting tool, as shown in Figs. 5 and 6, containing a series of cutters adjusted to the necessary depths, is used to cut the lead sheathing, outer insulation, outer conductors, and inner insulation of the cables, after which they are stripped ready for jointing with an ordinary jointer's knife. The "inners" are now jointed by wrapping and soldering in the usual manner, and the insulation is made good by a serving of pure rubber strip round the soldered joint to the required thickness. A pair of "T" sockets (Fig. 7) are now taken and placed over the insulated inner joint. The "T" sockets (Fig. 7) and the other sockets of different shape for various kinds of joints (Figs. 8 and 9) are stamped out of high-conductivity copper sheet, which is covered by a coating of tin to facilitate the adherence of solder. The split T is held firmly in position by a short length of tinned copper wire whipped round at the angles of the tee (see Figs. 1 and 2), the ends of this wire being left long enough to come through a hole in the front of the joint-box and connect to one terminal of the switch fuse, which is mounted upon the face of the joint-box. The "outer" conductors of the continuous cable are now folded over the split "T," bound firmly round with a few turns of fine tinned iron wire, and soldered to the "T," as is also the copper wire previously mentioned. The "T" is now insu-

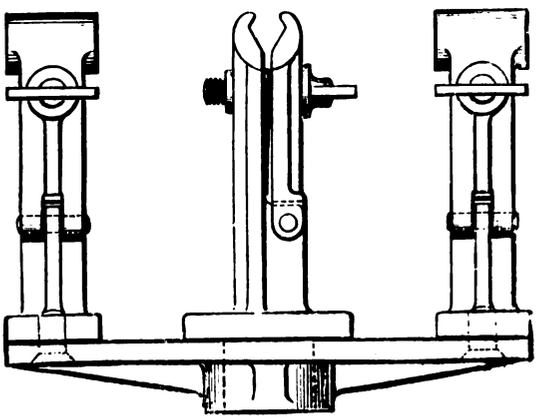

FIG. 4

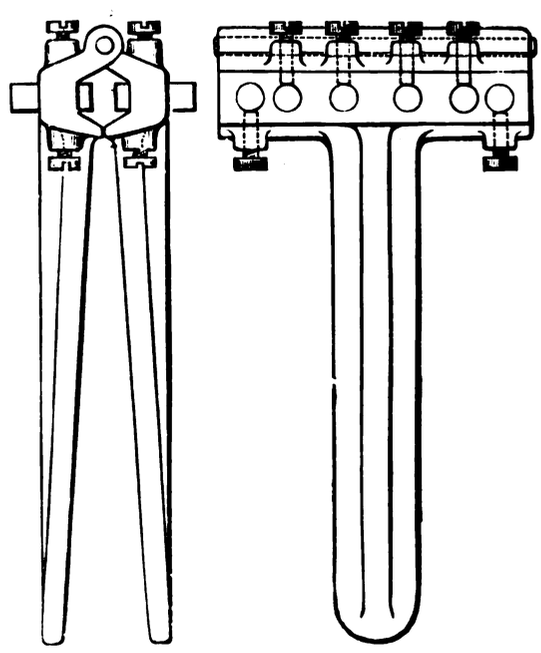

FIG. 5 FIG. 6

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lated with servings of pure rubber and black tape in the same manner as an ordinary joint, and a short length of rubber tube insulates the lead passing through the joint-box to the switch fuse. The "outer" conductors of the branch cable are twisted together, properly insulated by taping, and likewise brought through a hole in front of the joint-box in order to be connected to the other terminal of the switch fuse. Whilst the three members of the T-joint are still held in position by the vices, a recessed cover forming the joint-box is placed over the joint, and three members of the tee joint fit in slotted grooves prepared in the rim of the box, the two outer wires before mentioned being passed through holes in the front of the joint-box. A disc of stout oiled paper is then pressed upon the underside of the joint-box, and a packing block is pushed in upon the vice platform to hold the joint-box and paper disc in place. The recess is then filled through a hole in the front of the box with an insulating and waterproof compound which quickly and firmly binds the joint and joint-box together. The cable and joint box now being released from the vices is ready for fixing in position. Although, from the description, the jointing may appear to be rather a long operation, experience demonstrates that these joints are easily made by any wireman of fair intelligence, and they can be completed in a reasonable time. They also safely stand a pressure of 2,000 volts alternating current.

Joint-Boxes.—The joint-boxes for ordinary use are made of hard wood, polished, so as to form suitable bases for the fuses, or switch fuses, which are fixed upon them, but for very damp and exposed situations the boxes are to be made of metal, and the lead sheathing upon the conductors is soldered to them.

FIG.7

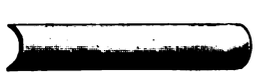

FIG.8

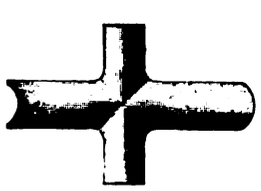

FIG.9

Switch Fuses.—Although any good make of fuse and switch may be used in conjunction with the "Kosmo" system, it is an advantage in many cases to have these accessories fixed upon the walls in the line of the conductors. In mills, warehouses, and stores this is particularly desirable, because it is less complicated and expensive than bringing the conductors down the wall to the switches, and because it removes all the electrical contacts from the reach of mischievous interference and damage. In hotels and high-class buildings an additional advantage is that all the conductors and fittings can be confined to the ceiling mouldings and dadoes, and the wall decoration is not damaged by unsightly fixtures. To meet this desideratum, small quick-break switches have been designed, which are worked by a single cord hanging down the wall to within reach of the operator, by means of which the lights are controlled. The cords and tassels are supplied in qualities and colours to harmonise with the surroundings. Large double-pole section switches and fuses in metal cases are also designed upon the same principle.

The "Kosmo" cables, accessories, and tools are manufactured by the Telegraph Manufacturing Company, of Helsby, Manchester, and London.

It will be gathered from the above details (which we have culled from information sent us by the designer of the system) that the conductors are usually to be laid on the surface of the walls. This gives a certain advantage in many places, but will not find favour in most private houses. We see no reason why the conductors should not be buried in the walls except the fact that wooden joint-boxes are used. The wooden joint-boxes form, in our opinion, the weak spot in the present arrangements.

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(Continued from page 79.)

The costly experience thus purchased was derived from the failures of a series of weak and light cables, in many of which the insulation was probably defective or insufficient from the first. Some of these cables were lost during the operation of laying. The story of the first Atlantic cable has been told by many. The experiment was a costly one, but worth the money, for it demonstrated the feasibility of safely submerging great lengths of cable in depths of over two miles. Although a commercial failure, it was a great engineering success, and during its brief existence gave a practical and striking illustration of its value. The War Department was able to countermand the movements of certain regiments, and thus avoid an expenditure of some £50,000. Some of you may remember the Indian Mutiny, and how keenly the want of telegraphic communication with India was felt. A subsidy of £30,000 per annum was granted to the Red Sea Telegraph Company, whose cables, laid in 1859, proved a deplorable failure, notwithstanding the fact that previous to their submersion upwards of 80 different cables had been laid in various parts of the world. The sections were laid too tight, the iron sheathing was insufficient, the depth and nature of the bottom had not been properly considered, and the supervision during the manufacture was probably not of that searching character which we now find to be necessary to ensure success. The record of the Malta-Tripoli-Bengasi-Alexandria cable laid in 1861 forms an agreeable contrast to the dismal failure of the Red Sea line. This cable was, I believe, the first sent to its destination in tanks, and systematically tested from the time of its manufacture up to its submersion. The costly failures previous to 1863 gave little encouragement to the British public to favour enterprises having for their object the extension of telegraphic communication to the East. At the same time it was felt that communication with India was an imperative necessity, and Colonel Patrick Stewart, R.E., was deputed by Government to arrange for the construction of a land line through Mesopotamia, and the carrying out of the cable portion of the line *vid* the Persian Gulf. A good deal of the original cable laid in 1864 is still in existence. The expedition was completely successful, and communication with India was soon after established by alternative land lines through Turkey and Persia. It was in connection with this cable that my association with submarine telegraphy commenced. Five sailing vessels were employed to convey the cable to the Persian Gulf, and as many as 12 vessels assisted during the work, which would now be easily and rapidly executed by one well-equipped telegraph steamer. Communication between the cable ship and towing steamer was constantly maintained during the operation of laying the cable by means of semaphore or signalling lamps. Six years afterwards the cables of the Eastern Telegraph Company were laid down between Suez and Bombay, and in 1871 China and Australia were brought into communication with Great Britain. The life of a submarine telegraph engineer is somewhat of a Bohemian character; half a landsman, half a sailor, sometimes working almost continuously day and night for weeks together, at other times enjoying long periods of enforced idleness. The localities chosen for cable stations are frequently isolated and uninteresting, the climate indifferent, and the life monotonous. A more desolate place than Mussendom, near the entrance of the Persian Gulf, it would be difficult to imagine: a small island in a land-locked bay, surrounded by mountainous rocks over 3,000ft. in height; not a vestige of green to relieve the wearied eye. The Persian Gulf and its vicinity is, however, rich in historic associations. Three hundred years before the birth of Christ, Nearchus, after conveying a portion of the army of Alexander the Great from the mouth of the Indus, disembarked at Bunder Abbas, near the entrance of the Gulf. The main body of the army, conducted by Alexander, made its way westward behind the range of hills which skirts the coast of Beloochistan. It is said that from time to time Alexander indicated his position to Nearchus by means of polished steel mirrors and reflected sunlight. This is the first recorded instance of visual telegraphy, and it is a singular coincidence that the experiments which mainly led to the introduction of sun signalling in the British and other armies should have been made upon the very same ground more than 2,000 years afterwards. In the Persian Gulf one occasionally witnesses natural phenomena which to the untravelled may appear incredible. In the midst of these mountains, near Mussendom, I have witnessed during a thunderstorm such displays of lightning as baffle description. I have at certain seasons of the year observed the water in the bay, which was large enough to hold all the fleets in the world, presenting exactly the appearance of blood. At such times after nightfall the silvery emerald green phosphorescent effects produced by the moving boats were indescribably beautiful. Not many miles from Mussendom I have witnessed those mysterious fire circles flitting over the surface of the sea at a speed of 100 miles an hour, a phenomenon not often witnessed and which no one has yet been able to explain. While steaming along the coast of Beloochistan I have been called from my cabin at night to

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witness the more common phenomenon of a milky sea, the water for miles around being singularly white and luminous. In the same locality I have observed the sea to be for short periods as if putrid, the fish being destroyed in myriads, so that to prevent a pestilence measures had to be taken to bury those cast up on the beach. This phenomenon was doubtless due to the outbreak of a submarine volcano and the liberation of sulphuretted hydrogen. In these waters jelly fish are as large as footballs, and sea snakes of brilliant hue are met with in great numbers. On one occasion a swarm of sea snakes forced their way up one of the creeks in Karachi Harbour, apparently for the purpose of having a battle royal, for the ground between high and low water mark was thickly covered with their bodies, in positions which betokened a deadly struggle. I have seen such a flight of locusts on the coast of Beloochistan that with every swish of a stick two or three locusts would be brought to the ground. The column extended for miles, yet it had all disappeared by the following day, most probably into the adjacent ocean, towards which they proceeded under the influence of the north-west wind then prevailing. From Jask, on the coast of Beloochistan, I have in the hot season observed the most perfect mirage effects. An exact image of a steamer then entering the bay has appeared inverted in the sky, and, still more wonderful, the image of a steamer has been observed over the mountain inland, when the nearest vessel could not have been less than 120 miles away.

Submarine Telegraphy in 1897.—There are to-day more than 1 300 submarine cables in existence, the aggregate length of which cannot be less than 162,000 nautical miles. They vary in length from a quarter of a mile to, say, 2,600 nautical miles, and may be roughly classified as follows :

Cables under	5	miles	in length		.....	761
Exceeding	5	,,	and under	50	.....	223
,,	50	,,	,,	100	.....	65
,,	100	,,	,,	500	.....	155
,,	500	,,	,,	1,000	.....	54
,,	1,000	,,	,,	2,000	.....	29
,,	2,000	,,			.....	8
						1,305

Of these cables, about 18,000 knots belong to the various governments, while the balance of 144,000 knots, mostly composed of long sections, have been laid by private companies. They represent a total expenditure of about 40 millions sterling, of which probably 75 per cent. has been contributed by English capital. Up to quite recently nearly every telegraph cable of importance has been manufactured in this country; but England can no longer boast of a monopoly in this business. The development of French submarine telegraph enterprises is no doubt the direct outcome of the liberality with which the French Government has in recent years subsidised submarine communications. There are now established well-equipped cable works at Calais, and a smaller establishment at St. Tropez, on the shores of the Mediterranean. In addition to these, there are the Government works at La Seyne, near Toulon. The Italians have cable works at Spezzia. Germany has recently subsidised a direct cable from Emden to Vigo. Our telegraph supremacy may be considered by some as ranking next in importance to the supremacy of our navy. This natural rivalry is not without its significance, and shows that foreign governments are fully alive to the importance of fostering submarine telegraphy. The sounding apparatus of Lord Kelvin has added immensely to the possibilities of ocean telegraphy. A sounding which in the old days would have taken two or three hours, and the value of which even then would have been doubtful, can now be ascertained in 20 minutes and be considered reliable. Notwithstanding the heavy weights employed, hemp lines could not be relied upon. In the Gulf Stream it was found almost impossible to get bottom with them. The use of ordinary pianoforte wire has proved a great success. With a breaking strain of 270lb. it offers an extremely small resistance to the water, and gives accurate results in the strongest currents. Some 2,000 fathoms could be wound in less than half an hour, even when the ship is steaming slowly ahead. A knowledge of the contour and nature of the bottom of the ocean is of the utmost value to the cable engineer. He does his best to protect the sheathing of a cable from corrosion ; but so far as my experience goes, 2in. of good substantial mud is the best preservative for a submarine cable. I have on many occasions recovered cable which had evidently been resting in grey mud for nearly 20 years, and I have found it in as good condition as the day it left the factory. Deep-sea cables, when well away from shore, have this advantage : they generally rest on a fairly level and uniform bottom, an advantage not enjoyed by shallow-water lines laid near the coast. Prof. Geikie, writing on the subject of ocean depths, remarks : "To be told that mud gathers on the floor of these abysses at an extremely slow rate conveys but a vague notion of the tardiness of the process ; but to be told that it gathers so slowly that the very star dust from outer space forms an appreciable part of it, brings home to us, as nothing else could do, the idea of undisturbed and excessively slow accumulation." For all practical purposes, the telegraphic engineer may regard the oozy bottom of the sea in mid-ocean as in a state of eternal rest ; the deeper the water the better the bottom, the safer the cable. In shallow water, however, the bottom, being subject to the action of current tides and waves, is frequently irregular ; we cannot ensure that the cable will rest fairly on the ground throughout its whole length. It is certain that there will be undulations and depressions, even though the bottom may be formed of hard mud ; the cable rests on the ridges of these undulations, and is suspended in a series of long or short spans. In the course of years the cable becomes encrusted at intervals with shell fish and marine life. It sways gently with every turn of the tide. Marine monsters, such as sawfish, consider it their larder, and, while raking off the marine life, either rupture the cable or penetrate the core with one of their formidable teeth. In any case sooner or later the sheathing corrodes, and the cable parts altogether, or as the outer wires give way one by one the cable elongates, the core stretches, until the copper conductor breaks, the ends being frequently kept insulated by the dielectric until the cable is lifted for repairs. Some of the faults that occur in submarine cables are of the most extraordinary character. Lightning, earthquake, landslips, submarine vulcanoes have all to be reckoned with ; and the leviathan of the deep has more than once been responsible for an interruption. This sounds incredible, but it is nevertheless true. But probably the most dangerous enemy is the teredo. To ward off the attacks of the latter, the plan is resorted to of covering the core with a thin taping of brass. Submarine cliffs, where the soundings rapidly vary from, say, 50 to 500 fathoms, should be especially avoided, as if the cable is not taken well inside or outside of the line of soundings indicated on the chart, but rest near the edge of the cliff, long spans will be inevitable. The deep channels at the mouths of rivers have to be negotiated very carefully, or the cable is pretty sure to be fractured sooner or later by submarine landslips. One of the most curious faults I have met with was that caused by the cable rolling down a submarine slope. In one direction for a considerable distance the iron guards straightened themselves out, while in the other direction the length of the lay had been reduced one-half, and the cable had twisted itself into the most fantastic shapes. In order to effect the repairs which are necessary, a fleet of 41 telegraph ships is maintained, the gross tonnage of the telegraph marine being nearly 60,000 tons. The vessels are stationed in all parts of the world, and are fully equipped with the usual machinery for grappling, picking up, and relaying. This machinery is substantially very similar in design to what it was 30 years ago. The type of cable now generally adopted for deep water is a great improvement on that used in the earlier deep-sea cables. Five-and-twenty years ago the best wire used for cables had a breaking strain of, say, 50 tons per square inch. To-day, wire is easily obtainable having a breaking strain of 90 tons per square inch. The application of a preservative tape and compound to each of the wires forming the sheathing—a plan, I believe, originally adopted at the Silvertown works—must tend to prevent or retard corrosion. As compared with a cable in which the iron guards rest one against the other, there is a saving in weight, in cost of materials, and although the breaking strain may be slightly reduced, the cable will bear as great a length of itself in water as an apparently stronger type. The deep-sea portion of the latest Anglo-American cable and of the South American cable are made of this type ; and I consider the design an important improvement upon the old plan, where, to lessen the specific gravity, the sheathing wires were separated by intermediate yarns. The cost of repairs is a most serious item in the accounts of a telegraph company, but there is a great element of luck in cable maintenance, and fortunately with deep-sea cables there is comparative freedom from interruption, though when breaks do occur in great depths the cost of re-establishing communication is likely to be very considerable. Repairing one of the Anglo-American cables is said to have cost on one occasion £95,000. This is probably the most expensive repair on record. The following brief notes regarding the amount of spare cable which may be necessary to effect repairs during the life of a cable laid in comparatively shallow water may be useful. You will, of course, understand that such a return can only be approximate, as much depends upon the type of cable and the care with which it was laid. My experience shows that during the first five years of the life of a shallow-water cable, it is prudent to allow for ½ per cent. per annum of its total length to provide for repairs.

From the 6th to 10th year, say,				¾	per cent.
,,	11th ,, 16th	,,		1	,,
,,	17th year	,,		1¼	,,
,,	18th ,,	,,		1½	,,
,,	19th ,,	,,		2½	,,
,,	20th ,,	,,		2¾	,,
,,	21st ,,	,,		3	,,

In addition to this expenditure of fresh cable, we have also to consider the cost of the engineering staff and the maintenance

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of the repairing steamer should an independent vessel be employed. Three per cent. on the total length of the cable per annum after 21 years does not at first sight appear to be considerable for a shallow-water cable; but there comes a time when in consequence of the great public inconvenience, loss of revenue, and cost of repairs it is cheaper either to make extensive renewals or to lay a new cable. Assuming the cable to be 1,000 miles in length, and that the beforegoing estimate is approximately correct, then 30 miles of cable would be expended annually. This would probably mean 10 or 12 interruptions. As a matter of fact, 16 interruptions was the actual number that occurred in the Persian Gulf cable of 1,740 knots during the twenty-first year. The inconvenience of such frequent repairs was felt to be so great that the alternative of picking up, stripping, and resheathing nearly the whole of the section at the Government cable factory at Karachi was resorted to with most advantageous results. Many years ago (in the seventies) I had the privilege of being allowed to inspect the working on the Atlantic cables at Valentia. For several days I watched the signalling conducted by operators who were splendid "mirror" readers. The syphon recorder had not then come into general use. A rate over 20 words, or 100 letters, was obtainable during a trial; but I noticed the speed obtained in practice, when messages containing a fair proportion of foreign and code words were being transmitted, was 15 and 16 five-letter words per minute. At this rate 50 or 60 10-word tariffs were transmitted within the hour. This included preambles, collations, and repetitions, the latter being extremely rare. By abbreviating the preamble and collations in accordance with modern practice, greater commercial efficiency is obtained, and the proportion of words paid for becomes greater. As an instance of how the commercial efficiency can be worked up under pressure, I may mention that during an occasion when the whole of the traffic to and from the East was thrown on the Persian Gulf line, the number of telegrams passed through the cable during the 24 hours was rapidly increased from about 650 to nearly 1,000 daily. Great Britain supplies the majority and the best of our telegraphists for long submarine cables; in reading the mirror, recorder, and manipulative skill, they far surpass the operators of any other nation. In working land-line Morse circuits by "sounder," the Americans are the only people who can compare in rapidity with our countrymen. It is to be regretted we do not see more of our telegraph friends at the meetings of this Institution. Telegraph administrations especially should, I think, encourage their employés, especially those that are to serve at foreign stations, to take every opportunity to render themselves thoroughly proficient not only in a knowledge of the apparatus in daily use, but also in a knowledge of testing. A clerk is none the worse operator because he happens to be an intelligent electrician. The life at isolated cable stations must often be a dull one, and if the employé can be encouraged to devote his spare time to improving his mind by the study of a most fascinating and interesting subject, the result, I am convinced, would be beneficial in many ways, not only to the man, but the company he serves. In connection with testing I may be permitted to give a word of advice to young beginners: use few formulæ, the fewer the better, but apply them with judgment. Test as soon as you can after the occurrence of a fault, see that your plugs and contacts are clean, and if you are in a cable ship keep your head cool. The average distance between the assumed and actual position of faults in the Persian Gulf cable, where the sections vary from 150 to 500 miles in length, is, I find from a recent report for that department, less than one-third of a knot, so that the electrician can localise the breaks closer than the captain can navigate his vessel. Thirty words per minute is a high speed for a writer, and no average signaller could maintain a greater speed with the mirror key for any length of time. The results obtained from the cables last laid by the Commercial and Anglo-American Telegraph Companies show that it is possible to transmit nearly 50 words of five letters each per minute. This, of course, has to be effected by means of an automatic transmitter. The introduction and universal adoption of this adjunct will no doubt considerably increase the carrying capacity of our cables. An ordinary automatic transmitter may not appreciably increase the speed of working on very long cables, but by the use of the automatic curb transmitter with an adjustable curb commutator, the speed of working has, I understand, been increased on some of the Eastern Telegraph Company's cables at least 30 or 35 per cent. The invention of the telegraph and its subsequent development is closely associated with the reign of her Most Gracious Majesty. But the work of the telegraph engineer is in one respect incomplete. It still remains for him to establish a girdle round the earth. The question of a Pacific cable has again come to the front. A committee has been sitting at the Colonial Office for the purpose of considering the matter. The points which suggest themselves for consideration are: Is the Pacific cable desirable for strategic reasons? Is the scheme feasible? To these questions any statesman or telegraph engineer would, I think, unhesitatingly answer in the affirmative. It would be difficult to over-estimate the strategic value of the Pacific line. At the same time I do not attach too much importance to the much-talked-of telegraphic isolation of England which is feared immediately we are involved in warfare with any great European Power. This is held up to us as a sort of "bogey." If our fleet does its duty—and it generally does its duty—any cable-cutting craft which may adventure into the shallow waters near our shores, or near those of our Colonies, may be expected to meet with an unpleasant reception. On the other hand, the wholesale destruction of cables in deep water will not prove an easy task to the comparative amateur. It takes a certain amount of time to grapple a cable in deep water, even when the exact position is known. The popular imagination pictures the work of destruction as being carried out by 20-knot cruisers in something like the twinkling of an eye. Cable-catching is not to be learned in a day. I do not think the malicious damage to cables in deep water need be greatly feared, and it may be taken for granted that our cable ships would quickly repair the damage inflicted in shallow water unless the enemy held command of the sea. Nevertheless, the more telegraphic routes we have to our Colonies the less the probability of their being isolated in the event of war, and the less the chance of panic in time of peace. Nothing more disheartening for the would-be destroyer of cables can be imagined than the knowledge that there are so many routes available for sending messages, so that the destruction of any one cable would hardly be worth the risk. When our network of telegraphs is complete with cable ships judiciously placed for repairing purposes, and fast cruisers to watch the more exposed portions of the route, there ought to be little risk of Great Britain being isolated from her Colonies in time of war.

Telephone and Fast-Speed Cables.—We may reasonably hope that we are on the eve of substantial developments in connection with the methods of submarine electrical communications. I am not now speaking so much of improvements such as the duplex or the high-speed automatic curb transmitter, but of fundamental alterations in the structure of cables which we may anticipate will result from the consideration the subject is receiving from our highest authorities. I do not suppose that we shall see an ideal cable manufactured straight off the reel or that cable companies will be too ready to incur the risk of acting on the suggestions of inventors. Of course, mistakes will be made, but I look with confidence to the day when these efforts shall bear fruit. A day may come when our electricians will design and our engineers construct a cable which will enable us to hold converse by telephone with our Transatlantic brethren. In Mr. Preece's proposed cable, designed for telephone work, and described in a paper read before the British Association, there are two conductors, semi-circular in section, in each core, thus providing a complete metallic circuit. The conductors are first separately insulated with brown paper, then arranged with the flat sides pressing closely against each other, with only the brown paper between them. The twin conductor thus formed is insulated with guttapercha in the usual way. It is claimed that as the conductors are made to approach each other, the electromagnetic induction increases at a greater rate than that of the electrostatic induction, until at a certain point the one will neutralise the other. Prof. Silvanus Thompson aims at increasing the speed of working on long ocean cables by using a double core, forming a complete metallic circuit, and establishing at intervals permanent inductive leaks or bridges of very high resistance between the two wires. These intermediaries are well insulated, and may be 50 or 100 miles in length; they would be laid in with the double core and connected at their extremities, so as to form a by-pass between the two conductors. In an Atlantic cable three or four of these derived circuits would probably be required. The advantage of introducing leaks at intervals, where practicable, on a long cable is well understood; I have used them with advantage myself where we had intermediate stations available, so that ordinary resistance coils could be used to connect the cable with earth. Prof. Thompson anticipates that with a cable of this type, with several leaks, he would be able to transmit signals across the Atlantic at six or eight times the speed at present obtainable. It must, however, be remembered that in increasing the number of cores we should considerably increase the cost of the cable; as a matter of fact we should be putting, say, two eggs into one basket. The cost and telegraphic capacity would, therefore, have to be compared with that of two good modern single-core Atlantic cables. A third system has been suggested to me by Messrs. Phillips and Barr. They propose to employ what is practically a double conductor, but the return circuit for each wire, or group of wires, would be the earth. It is intended that the insulation between the two conductors, or groups of conductors, should be comparatively low, so that an appreciable amount of leakage would occur from one circuit to the other. By means of a suitable key, one conductor would be simultaneously charged with a similar current as the other is discharged; and it is claimed that the fall of energy on the one circuit, as it is disconnected from the battery and put to earth, would be balanced by the rise of potential on the other, so that the retarding effects of static induction would be reduced to a minimum.

In quitting the subject of submarine telegraphy for this

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evening, I would remark that it has not been my intention to give you a paper embracing the history up to date of this important branch of electrical science. I have, on the contrary, endeavoured to keep off the beaten track, my aim, I confess, being to interest rather than to instruct. In lighting, traction, and transmission of power over short distances electricity has to encounter formidable rivals. Perhaps it is as well that it should be so, as wherever two branches of science still in the stage of vigorous growth meet there may we look for striking developments, and all the more so when the two sciences in question have met with important industrial applications. The use of electricity in connection with the various processes pertaining to electro-chemistry has made satisfactory progress during the past year. The results already obtained and the wide field that presents itself for further operations suggest that chemistry will in future be one of the most important studies for the student who wishes to advance to the front rank of the electrical profession. The ease and accuracy with which electrical action can be regulated under its extensive utilisation in chemical and metallurgical processes suggest great possibilities in the immediate future. The processes for the most part are electrolytic, but most important work is being done by utilising the intense heat of the electric arc. The production of alkali and chlorine by the decomposition of salt naturally first engages our attention. Large works are being erected near Widnes for the purpose of carrying out the Castner-Kellner process for the production of caustic soda and chlorine. The Holland process for a similar object is being developed by the Electro-Chemical Company at St. Helens, where, I understand, 4,000 h.p. will shortly be at work. One of the most successful processes in which electricity is employed is the production of aluminium; this is in operation on a large scale at Pittsburgh, the Falls of Niagara, and also at Foyers in Scotland. Large works are in operation in Sweden, Switzerland, and France for the production of chlorate of potash, and further installations are contemplated for the United States. The decomposition of gold from cyanide solutions is being successfully carried out on an increasing scale in South Africa by the Siemens-Halske process; and this firm has also developed a process for the deposition of zinc from zinc ores, which is likely to come into extensive use. The researches of Monsieur Moissan have given a great stimulus to the methods which rely on the use of an electric furnace. The processes involve for the most part the formation of new combinations—such, for example, as carborundum, a carbide of silicum, which can be used in place of emery powder. One thousand horse-power is employed in producing this material at Niagara. Other carbides have been produced on a large scale, more especially carbide of calcium, which by the action of water yields acetylene gas. Phosphorus is also now manufactured on a commercial scale by means of the electric furnace. Serious attention has been given by chemists to the fascinating problem of obtaining electrical energy direct from carbon. To Prof. Ostwald must be given the credit of having, at a meeting of German electrical engineers, in Leipzig, during 1894, stimulated the activity of the genuine electro-chemist. As a result we have had the Borcher cell, in which it was thought at first that the electrical energy obtained was derived from the combination of carbon monoxide and oxygen, cuprous chloride acting as the intermediary. Then came the Coehn cell, with an apparently soluble anode of carbon, a cathode of lead peroxide, and sulphuric acid as the electrolyte. A primary battery claiming to produce electrical energy direct from carbon must, like Cæsar's wife, be above suspicion. Although the elements of practical success are wanting in the instances I have mentioned, it is pleasant to bear testimony to the *bonâ fide* attempts made to solve this great problem, and it is a matter of congratulation that the investigations are being conducted by men of scientific repute.

In my address this evening I have chiefly dealt with facts which are beyond question. In my concluding remarks, which I promise you shall be brief, I may touch on topics regarding which there is a divergence of opinion. You will understand, therefore, that I am speaking on my own responsibility. We are all agreed it is imperatively necessary that as an Institution we should keep in the front rank, but to ensure this result we must stand shoulder to shoulder, and do what we can to retain the sympathy of all sections of our members, and keep in touch with every branch of our profession. If it is inevitable that from time to time there should spring into existence offshoots from the parent society, or associations with similar objects, they should, if possible, be brought to act as buttresses, and not partake of the nature of rifts in the foundations of the Institution. I feel sure your council would be glad to see their way to gratify as far as possible the natural aspirations of any section of the society, and meet the reasonable requirements of all. Possibly, as the basis of the Institution broadens (and I do not see any finality to our sphere of usefulness), the solution of the question will eventually be the formation of local committees and the simultaneous reading of papers, the various discussions on which could afterwards be printed in the *Journal* of the Institution.

In making a forecast as to our future, I may be permitted to refer to one item in the accounts recently presented at our general meeting—namely, the amount standing to the credit of the building fund. Whatever divergence of opinion may exist as to the advisability of taking early action in the matter, there can, I think, be no question that the provision of a building for the purposes of the Institution is a matter of paramount importance. It is our duty to seriously consider whether the interests of the society are not prejudicially affected by our inability to offer to our members, or any subsidiary associations which may be affiliated with us, the convenience of a central place of meeting and research. We have at present a name, but not a habitation of our own. No one appreciates more than myself the generous treatment we have received from the Institution of Civil Engineers or the advantages of this magnificent place of meeting; but the time may come, and it assuredly will come, when our frequent occupancy of this hall may not be convenient, and it behoves us as business men, remembering that Rome was not built in a day, to endeavour to make timely provision for such a contingency. We must not shut our eyes to the fact that, notwithstanding our growing importance, we have fewer meetings now than we had eight years ago. If this Institution is to continue to lead the way in electrical science it must be fed by contributions in the way of papers from its members, and to do justice to these contributions it is equally obvious that we must have more meetings at which to discuss them.

Let us look for a moment at the immediate future. First, there is the Pacific cable—the dream of telegraph engineers, who desire to share in the honour of completing the girdle round the earth. Next there is the establishment of telephonic communication through long submarine lines, and its corollary, fundamental alterations in the form of our future cable. Turning to another branch of the electrical industry, we have two important underground electrical railways in course of construction in the Metropolis, and several others, the Bills for which will be presented to Parliament during the coming session. London will be pre-eminent throughout the world in regard to electric railways, as she is in every other respect. The new applications of electricity in connection with electro-chemistry and electro-metallurgy are most important. Who can prophesy as to the next position from which electric science and enterprise will exercise its beneficent influence? The chemist, the electrician, the engineer, ever seeking, ever striving to discover new natural agents, and to apply them to practical use. To me it seems the outlook is full of promise. The prospect of continued activity in connection with electric lighting, electric traction, and mining machinery is most satisfactory. Electric light mains, lamps, and storage batteries will assuredly receive continued attention. The telephone business is steadily increasing, and the service improving by the adoption of the complete metallic circuit. The developments of the last 15 years are only an earnest of what is to come. Under these circumstances, I think we may enter our second quarter of a century with feelings of hope and confidence; and there is some justification in congratulating the junior members of this Institution upon their choice of a profession which is not only growing and progressive, but full of interest. The boy is father to the man, the student of to-day is the raw (sometimes very raw) material from which we are manufacturing the electrical engineer of the future. It is to them the fortunes of this Institution will be entrusted; it is not in our power to give the clear head, cool judgment, steady nerve, and the faculty of acting promptly in cases of emergency, which is so invaluable to those who are placed in responsible positions; but it is quite within our province—indeed, it is our duty—to make any suggestion which may be of service to those who intend to adopt electrical engineering as a profession. I do not know whether my experience is similar to that of others, but I have frequently found it as difficult to find the right man for the appointment as to find vacancies for the applicants. Students now command far greater facilities for acquiring a knowledge of their profession than were available 20 years ago, but they should remember that much more is expected from them. The standard of excellence is rising, the training must be both theoretical and practical; and it is not until some practical experience has been acquired that the young engineer becomes of real value to his employers.

In conclusion, I would remind you that your duty towards the Institution does not altogether cease with the payment of the yearly subscription. Surely few of us have gone through life without learning something in connection with our profession the knowledge of which would be useful to our members, and which might be imparted either in the form of a paper or communicated during the discussions which follow the papers of others. Throw diffidence overboard; the proper place for silent members is over the way—in the House of Commons. Try, if you can, to contribute one little pearl of truth to the common stock of knowledge; for if by the proper use of the talents entrusted to you, you are able to leave the world a little better, a little wiser, than you found it, believe me, gentlemen, you will not have lived in vain.

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THE

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TO CORRESPONDENTS.

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All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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CITY AND GUILDS OF LONDON INSTITUTE.

There is an old and wise saw which suggests non-interference in quarrels between man and wife. The party who interferes is pretty certain to get kicks from both sides and no thanks. The advocates of technical education and the various technical institutions may be looked upon as analogous to man and wife, and while both agree that one may quarrel with the other, woe be to the third party interfering. The Central Institute of the City and Guilds of London has been attacked in an un-English manner—that is, the attack has been more or less anonymous, but none the less spiteful; and it behoves all advocates of technical education to hasten to repel such assaults. As stated in our last issue, a report of a special committee was presented to the governors of the institute last week. This report is the outcome of a resolution of the Court of Assistants of the Mercers' Company, a resolution no doubt brought about by the anonymous attacks previously referred to. It will be best to give the text of the resolution: "That this Court is of opinion that a full enquiry should be made into the expenditure of the Central College of the City and Guilds of London Institute for the Advancement of Technical Education, especially as compared with results, and requests the governors to appoint a committee to report on the whole matter."

In accordance with the resolution, the governors appointed a strong committee, which again appointed two sub-committees—one to deal with the financial and administrative part of the question, the other to deal with the educational part. Each sub-committee examined and reported, and the whole committee adopted these reports, and with few further remarks presented them as their report to the governors. We can but briefly discuss the subject; but we must enter a most emphatic protest against anonymous, biassed, and untrue statements being put forward to do harm to an institution of this character. The institution was founded for three objects: to give instruction to (1) "people who are training to become technical teachers; (2) persons not under sixteen years of age who had passed a matriculation examination and followed a prescribed course of instruction; (3) persons attending special courses, *not required to matriculate*, and interested in particular industries." To carry out these objects in the best possible manner, suitable buildings suitably, equipped, are required and the best professorial staff obtainable. In the case of the Central Institution we have the necessary combination. It would be difficult to nominate a better professorial staff, while the buildings and equipment are in accord with the most modern views of the subject. No buildings will accommodate an unlimited number of students. The Central Institution was designed for two hundred. It has for some years had to accommodate more than this number, and it must be remembered that a student, whether he takes a three years', three months', or three days' course, will occupy one students' place while he is taking that course. We will restrict our further comments to what we conceive should be

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the principal of the three objects—the training of technical teachers. The value of a number of good technical teachers scattered and working throughout the country is not calculable. The great question is not, does the institute turn out good men at a cost of so much per head, but does it turn out good men at all? The critics seem to think able men should be turned out like brass castings at Birmingham, at so much the "gross." This may be a sign of the "nation of shopkeepers"; but it may also be the wrong way of looking at the balance-sheet. We shall not even question that the institute is turning out good men—both good teachers and good professional men—because we do not believe there is any doubt in the matter. It is a fact that cannot be disputed by any man who knows anything of the matter. The training of these men is not to be valued at so much per head, but rather as a good result at any cost. If, then, to even the business minds of men who look upon everything from a balance-sheet point of view it is shown that the institute is doing this work at no greater cost than somewhat similar institutions at other places, the verdict must be absolutely in favour of the organisation of the institute. The report shows that from the £ s. d. point of view the men are turned out at a less cost than the originally estimated cost, and at a less cost than in most other colleges of a similar kind. Suppose, however, the figures of the report had been otherwise, we again ask, what is the money value of a continued stream of good teachers? Anyone may suggest improvements in certain details of any institution, but resolutions of the kind of that of the Mercers' Company—a company which is doing, and has done, so much for education—should not be lightly passed. They strike at the very root of the organisation, they raise a doubt as to future continuity, and tend to keep students away. The idea of placing a money value per head of students turned out instead of attempting to gauge the value of the instruction given to the students, and indirectly to the technical operatives of the country, is a step backward rather than forward, and one we trust will never be repeated.

TRAMWAYS.

A return ordered by the House of Commons has just been issued, giving a good many details as to tramways and their working. This return gives a total of 153 undertakings, 37 of which belong to local authorities. The total authorised capital is £18,039,704, and there has been paid up £14,157,354, while £15,195,993 has been expended. The length of line open for traffic is 1,009 miles, worked by 35,621 horses and 568 locomotives, with 4,663 cars. The number of passengers carried in 1896 was 759,466,047, giving gross receipts £4,152,016. The working expenses came to £3,105,511, leaving as net receipts £1,046,505. These figures are for the United Kingdom. However, it may be well to say that of the miles opened, 792 are in England and Wales, 96 in Scotland, and 121 miles in Ireland.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

A REJOINDER.

SIR,—Certain statements made in your review of "Alternating Currents and Alternate-Current Machinery," which appeared in the *Electrical Engineer* for November 27, 1896, are of a nature which seems to call for a rejoinder.

Less than one-half of the types of alternators referred to in the first two chapters of the book are of English design. Many are obsolete, it is true, the reference to the types being made for the purpose of illustrating certain methods which have been used or suggested by reputable designers for the purpose of obtaining certain results. These results may have in the end proved desirable or undesirable, but that has nothing to do with the illustrations of the methods by means of which the results have been obtained. Again, it is hardly fair to say that "the hints on the measurements of both self-induction and capacity are also taken from English sources." Four well-known books—Maxwell's "Electricity and Magnetism," Gray's "Absolute Measurements," Gerard's "Leçons sur l'Electricité," and Hospitalier's "Energie Electrique"—together with the technical journals and *Transactions* of the technical societies, are the sources specially referred to in "Alternating Currents," though other sources might be mentioned. Any person born to the English tongue may well be proud of the part played by the English island in the development of our methods of electrical measurements, but it is wise to remember that much important work has also been done elsewhere.

Your reviewer is in error when he asserts that the rectifier used on American alternators is not described. This is such a simple device—it consists simply of a commutator of the proper number of segments, alternate segments being connected together in a single-phaser—that it does not need much description. It is described, however, on page 259, and a special figure given (an index reference shows this plainly), while the usual connections of American machines with rectifying commutators are illustrated and described on pages 251, *et seq.* The Ganz rectifying commutator is described to show the pains taken to avoid sparking, which pains are entirely omitted in the usual American construction, as the book plainly shows.

Neither does the book leave one to be "casually informed that an engine running with an irregular angular velocity does not assist" parallel running of alternators, but an entire section is given up to a statement of the fact (an index reference might again have served your reviewer). I think, upon the whole, that the conclusions arrived at in the book in regard to parallel operation are fully borne out by experience. The point of view taken by the reviewer is somewhat the same as that taken by some of our engineers interested in power transmission, but is scarcely tenable in great electric light plants.

I cannot let pass the statement regarding the 150 pages of matter relating to alternating-current motors. It may be reasonably said that the treatment is unusually full, excepting in descriptions of the motors of various inventors or manufacturers other than typical machines; nor does the treatment consist of "standard abstracts," a considerable part of the matter coming from original experiments, and the method of design being directly related to the methods of transformer design. At this point I may point out that the bulk of the volume does not consist of abstracts, as asserted by the reviewer, though I am entirely willing and glad to acknowledge the indebtedness of the work to technical articles and treatises of many great designers, experimenters, and scientists.

Finally, let me say that "active" pressure, as used in the book, when multiplied by current gives power, or "active" current when multiplied by impressed pressure gives power. This, by the way, is somewhat analogous to the use of the word *actif* in a generally approved French work on alternating currents.—Yours, etc.,

D. C. JACKSON.

Madison, Wis., January 1, 1897.

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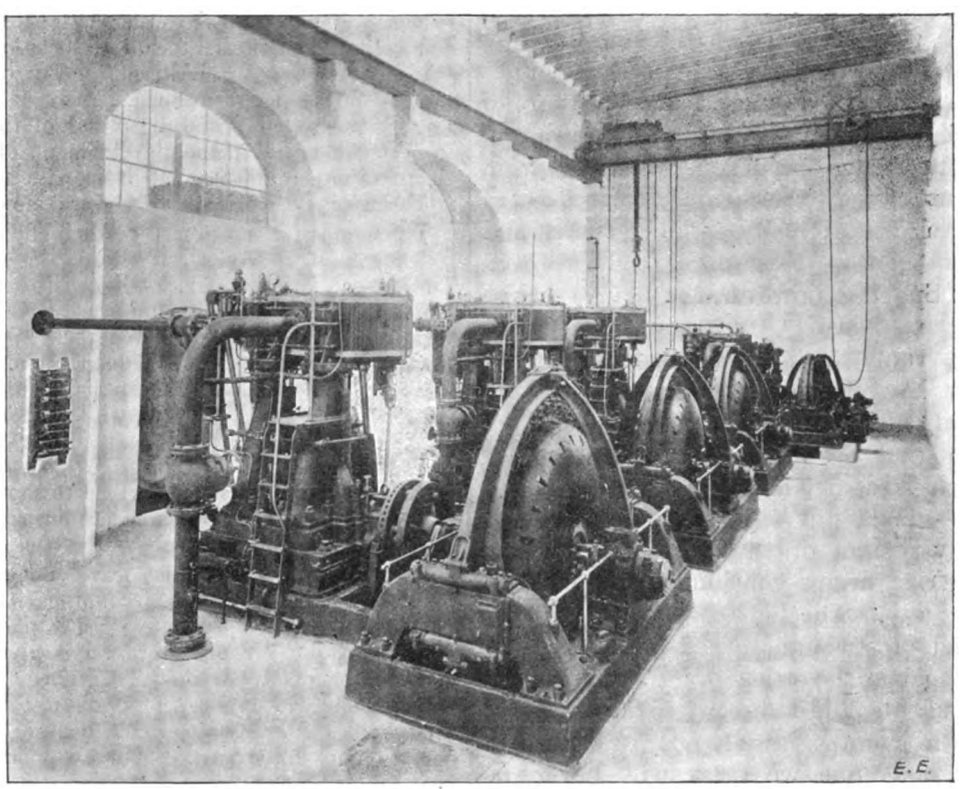
REVIEWS.

Electric Tramways and Light Railways, Popularly Explained. By H. SCHOLEY. London: Alabaster, Gatehouse, and Co.

The author in a brief preface claims for this little book no higher function than the putting before the public in popular language the latest developments of electric traction, coupled with a hope that it may help to dissipate some erroneous notions concerning the appearance of overhead wires. The captious critic (it is a mere courtesy prefix the same, as all readers are "intelligent" as of right) is therefore deprived of his last resource—namely, to quarrel with the book because it is not something which it never pretended to be. The history of electric locomotion is brief, and so, therefore, is the first chapter which deals with it. Then we have a short reference to the principles at the base of the dynamo, motor, and transmission line. This is little more than formal, but will serve to remind the general reader that electric trains or tramcars do not go of themselves, and that somewhere, hidden out of sight in a power-house, there is a steam-engine burning coal after the manner of steam-engines whether locomotive or stationary. Then we get to the business of the book. Two questions the townsman who is frightened at the introduction of electric trams may reasonably want answered: Will they go? and, How do they look? As to the first, he can get abundant testimony from printed descriptions. For the second, unless he is going to make a considerable tour, he must depend on pictures. Mr. Scholey supplies quite a quantity of these, evidently in most cases process reproductions from photographs, and therefore free from the bias of the artist. Nor has he picked only the favourable examples. The network of span wires, for instance, seen in perspective in Fig. 29 (Hamburg) might be taken as an example of what might by other arrangements be avoided. Besides the English and Irish lines, the illustrations include French, German, and Italian practice. There is one very pretty picture of the cathedral front at Milan, with a couple of tiny tramcars in the corner, and another of the Lugano tramcar, with the double trolley necessitated by the three-phase current system. The concluding chapters deal with open and closed conduit systems and electric railway work, and there is a brief section on the subject of cost.

MALTA ELECTRICITY WORKS.

In our issue for December 25, 1896, we gave a description of the electricity works at Malta, which were designed by Mr. A. H. Preece. We are now able, through the courtesy of the contractors (the Brush Electrical Engineering Company), to publish the general view of the engine-room. The details of the arrangements can be very well seen from it. The hinges for swinging back the greater sections of the stationary armatures of the alternators show prominently in the machine in the foreground. The alternator in question has an output of 100 kilowatts.



General View of the Engine Room of the Malta Electricity Works.

INSTITUTION OF ELECTRICAL ENGINEERS.

At last week's meeting the retiring president, **Dr. John Hopkinson**, took the chair, and, before calling on the new president, Sir Henry Mance, to deliver his inaugural address, said that it was his painful duty to announce to the Institution the death of Mr. Jacob Brett, who was one of the first founders of a great industry which more than any other industry had been in the direction of the advancement of the civilisation of the world. Mr. Brett was a gentleman whom the Institution had been proud to number among its honorary members. Dr. Hopkinson then formally moved a resolution of regret from the President, Council, members, and associate members of the Institution, and that the resolution should be communicated to the Rev. Mr. Brett, the surviving brother of the deceased.

Mr. Latimer Clark seconded the resolution. Mr. Brett had been for a long time a friend of his own; not, perhaps, in the days when Mr. Brett performed his greatest achievements, but for many years afterwards, and he had just had the melancholy honour of following their President at Mr. Brett's funeral. Mr. Latimer Clark then briefly referred to the course of Mr. Brett's life. [Most of the facts have already appeared in our obituary notice, and therefore need not be repeated here.] The deceased had been one of the great benefactors of mankind. There could be no manner of doubt that the Brett brothers were the originators and first performers of the feat of telegraphically uniting nations across the sea. When J. W. Brett died, Jacob Brett inherited most of his brother's wealth, and he lived for some time in Paris in considerable style, but got away just in time to escape the siege. He was not, however, like his brother, a good man of business, and he managed to lose all his money in Turkish bonds and in other ways. The result was that during the last eight or nine years he had nothing to live upon but a Civil List pension of £100 a year. Efforts, as they knew, had been made to get this increased, and it had been supplemented to some extent privately; and though Brett had died before their efforts were successful, it had been a comfort to him to know that help, if he needed it, was coming. He (Mr. Latimer Clark)

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must, however, express the thought that though Brett was never in a state of absolute destitution, that he should have been left to live out the last years of his life in a state of semi-poverty was not very creditable to the great and wealthy country which had benefited so much by his work.

Dr. Hopkinson then presented the annual premiums awarded for the papers read during the session 1895-96—namely, the Institution premium to the paper on "Experimental Tests, etc.," by Messrs. Stanley Beeton and C. P. Taylor (students), and J. Barr. For papers read at the students' meetings the Council decided to present two premiums, one of these to Messrs. Ray and V. Watlington for their paper on "Underground Conductors," and the other to Mr. E. B Wedmore for his paper on "A Simple Method of Analysing Harmonic Curves." The Salomons scholarship was given to Mr. E W. Marchent, a student of the Central Technical College, Dr. Hopkinson remarking that it would be a satisfaction to Prof. Ayrton that the first cheque he drew as treasurer of the Institute was in favour of a student of the Central Technical College. Dr. Hopkinson also alluded to the unfortunate death of Mr. Ray, which had taken place since the premium had been awarded him.

Prof. Ayrton said that before proceeding with the business of the evening he would like to take the opportunity of referring to the bright promise of a career which had been cut short only the week before by the death from typhoid fever of Mr. Ray at the early age of 20. Poor Ray had been one of the ablest and brightest students that had ever come to the Central Technical College, and not only was his ability very marked, but the sweet charm of manner which endeared Ray to himself (Prof. Ayrton) and to everyone else with whom he came in contact was equally striking. After enumerating a list of honours and prizes taken by Mr. Ray, ending with the Institution premium, Prof. Ayrton said that it was hardly possible for anyone who had not come in contact with him to realise the intellectual power he showed, but he might be allowed to express a hope that the blow of his sudden loss would be somewhat lessened when his parents realised that, young as their son was, his merits had been recognised by the Institution, as well as by his friends and fellow-students.

Dr. Hopkinson then vacated the chair in favour of the incoming president, Sir Henry Mance.

Major-General Webber moved the vote of thanks to the retiring president for his services during his term of office, and briefly alluded to the fact that, in spite of the claims of his profession, Dr. Hopkinson devoted a large amount of time and energy to independent research. It was also at Dr. Hopkinson's suggestion that when it appeared that this country was likely to be involved in war, the services of the electrical engineers were offered to the Government.

Mr. Alexander Siemens seconded the vote.

Dr. Hopkinson briefly acknowledged the resolution of thanks, and **Sir Henry Mance** then proceeded to deliver his presidential address. A portion of this was given in our last issue, and the remaining portion of it will found elsewhere.

At the conclusion of the address, **Mr. R E. B. Crompton** proposed the vote of thanks to the President. It was a fact to be regretted that they heard so little from telegraphic engineers in that Institution. He considered that the presence of Sir Henry Mance in the chair might be taken as an earnest of better things for the future in respect of a branch of engineering as to which Englishmen had a real right to be proud, and in which almost up to the present time they had held a monopoly against all the world

Prof. Perry, in seconding the vote, said he had begun to think at their technical colleges they ought, in addition to their other subjects, to teach students the importance of learning to speak so that they could take part afterwards in the discussions. Leaving that subject, Prof. Perry referred to the information gained for science from the work done for submarine telegraphy. Had it not been for that, there would have been very little information obtained as to deep-sea soundings and the condition of the ocean bottoms. Just at present it seemed about the most important thing men could do was to get accurate information as to this globe of ours, as to which most of our knowledge was at present confined to a skin of about half a mile in thickness. Again, all real development of mathematics had been in answer to the demand of some physical problem. There was one most important branch the successful development of which had been almost entirely the result of the problems presented by submarine cables. There was a man down in Devon-hire who would be exceedingly glad to recognise that his notion of the deep-sea cable was being recognised by so many inventors that there was a probability of its being carried out. The requirements were now so known that it ought to be easy for the constructive genius of this country to get them carried out. Referring to a portion of the address, Prof. Perry expressed the fear that if it had been his lot to be stationed on telegraphic work in one of the places in the Persian Gulf described by Sir Henry Mance he might not perhaps spend all his spare time in the study of electricity, but might be tempted to order a big box from Mudie's.

Sir Henry Mance briefly acknowledged the vote.

The next meeting is on the 28th; the paper to be taken will be one on "Electrical Interlocking the Block and Mechanical Signals on Railways," by Mr. F. T. Hollins.

Colwyn Bay.—At a meeting of the Colwyn Bay and Colwyn Urban District Council, the Clerk read a report on the scheme of Messrs. Dickenson and Co., Birmingham, for constructing an electric tramway from Colwyn Bay to Llandudno, which was adopted.

FORTHCOMING EVENTS

The following are some of the announcements for the week.

TO-DAY (FRIDAY).—Physical Society (Mr. Baly, on "Conduction in Gases"), Burlington House, 5 p.m.—Royal Institution (Prof. Dewar, on "Properties of Liquid Oxygen"), 9 p.m.—Junior Engineers (Prof. Barr), Westminster Palace Hotel, 8 p.m.—French Civil Engineers, at Paris.

TO-MORROW (SATURDAY).—Royal Institution (Mr. Carl Ambruster's lectures on "Neglected Italian and French Composers"), 3 p.m.—Junior Engineers' Dinner, Westminster Palace Hotel, 6 30 p.m.—Midland Engineers at Sheffield (Mr. J. Piggford, on "Electric Haulage").

MONDAY, JANUARY 25.—Society of Arts Cantor Lecture (Mr. Burton on "Pottery"), John street, Adelphi, 8 p.m.—Northern Electrical Engineers, at Manchester (Mr. Andrews on "Alternate-Current Switch Gear), 8 p.m.

TUESDAY, JANUARY 26.—Royal Institution (Dr. Waller's second lecture on "Animal Electricity"), 3 p.m.—Direct United States Cable Company's meeting, Winchester House.—London Chamber of Commerce examinations prize distribution by the Lord Mayor at the Mansion House, 2.30 p.m.—Institution of Civil Engineers ("Diversion of the Periyar").—Society of Arts (Mr St. John Hope on "Heraldry"), 8 p.m.—Scottish Engineers and Shipbuilders' meeting at Glasgow.

WEDNESDAY, JANUARY 27.—Society of Arts (Mr. Nicholl on "Voice Production"), 8 p.m.—The Faraday House Dinner, Imperial Institute, 7.30.

THURSDAY, JANUARY 28.—Institution of Electrical Engineers (Mr. Hollins on "Electrical Interlocking of Railway Signals") at the Civil Engineers', at 8 p.m.—Municipal Electrical Association ("Fire Risks at Electricity Works") Westminster Palace Hotel, 10.30 a.m.—Royal Institution (Prof Miers on "Crystals"), 3—City and South London Railway Company's meeting, Winchester House, 12.—Society of Arts Howard lecture (Prof. Ewing on "The Production of Cold") John-street, 8 p.m.; also the Indian Section (Mr. W. Lee Warner on "Indian Advance") Imperial Institute, 4 30 p.m.—The Lord Chancellor distributes the prizes of the City and Guilds of London Institute at Carpenters' Hall: the Lord Mayor presides. Also dinner of Liverpool Engineering Society, Adelphi Hotel, Liverpool.

FRIDAY, JANUARY 29.—Royal Institution (Prof. J. C. Bose on "The Polarisation of the Electric Ray"), 9.

SATURDAY, JANUARY 30.—Royal Institution (Mr. Carl Ambruster, second lecture), 3 p.m.

FOREIGN IMPORT DUTIES ON ELECTRIC PLANT.

The *Board of Trade Journal* publishes the following statement showing the rates of import duty leviable on dynamo-electric machinery and electric lamps in the principal European countries and India, which statement has recently been prepared by the Board of Trade:

Countries and tariff classification.	Rates of duties.		English equivalents.	
Austria-Hungary:		Fl. kr.		£ s. d.
Dynamo-electric machines ...	100 kilos	5 00	Cwt.	0 5 1
Electric lamps	,,	50 00	,,	2 10 10
Belgium:				
Dynamo-electric machinery ...				
The duties are assimilated to those on machinery of all kinds which are—		Fr. ct.		
Machinery of cast iron ...	100 kilos	2 00	Cwt.	0 0 9¾
Machinery of wrought iron or steel	,,	4 00	,,	0 1 7½
Machinery of copper or other metal	,,	12 00	,,	0 4 10½
Electric lamps	10% *ad val.*		10% *ad val.*	
Bulgaria	10½% *ad val.*		10½% *ad val.*	
Denmark:		Kron. ore.		
Dynamo-electric machines ..	Pund*	0 02½	Cwt.	0 2 4
Electric lamps	According to material of which composed.			
France:				
Dynamo-electric machines weighing 5,000 kilos and more, containing at least 50 per cent. of cast iron ...	100 kilos	Fr. ct. 12 00	,,	0 4 10½
5,000 kilos and more, containing less than 50 per cent. of cast iron.....	,,	20 00	,,	0 8 2
From 2,000 to 5,000 kilos, containing at least 50 per cent. of cast iron	,,	18 00	,,	0 7 4
From 2,000 to 5,000 kilos, containing less than 50 per cent. of cast iron	,,	20 00	,,	0 8 2
From 1,000 to 2,000 kilos.....	,,	20 00	,,	0 8 2
From 50 to 1,000 kilos	,,	30 00	,,	0 12 2
From 10 to 50 kilos	,,	80 00	,,	1 12 6

* Or 10 per cent. *ad val.* at option of importer.

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Countries and tariff classification.	Rates of duties.		English equivalents.	
Conductors for dynamo-electric machines and detached pieces, such as metal coils, surrounded by insulated copper, worked parts of copper weighing less than 1 kilo, numbered and marked, fitted together or not for electric machines weighing—		Fr. ct.		
More than 2,000 kilos	,,	35 00	,,	0 14 3
From 1,000 to 2,000 kilos.	,,	40 00	,,	0 16 3
From 200 to 1,000 kilos...	,,	45 00	,,	0 18 3
From 1 to 200 kilos..	,,	60 00	,,	1 4 5
Less than 1 kilo...	,,	75 00	,,	1 10 6
Electric lamps—				
Incandescent lamps of glass—				
With their mountings	100 kilos	350 00	Cwt.	7 2 3
Not with mountings	,,	700 00	,,	14 4 6
Arc lamps (regulators)	,,	60 00	,,	1 4 5
Germany :				
Dynamo-electric machines (so far as they cannot be described as "Locomotiven" or "Lokomobilen")—				
Preponderating material being		Mk. pfg.		
of cast iron	,,	3 00	,,	0 1 6¼
Ditto, ditto wrought iron	,,	5 00	,,	0 2 6½
Ditto, ditto of other common metal	,,	8 00	,,	0 4 0¾
Electric lamps—Incandescent (Gluh) lamps of glass in conjunction with other materials so far as the same cannot be classed as hardwares, etc., with the exception of case in which platinum wire is used	,,	24 00	,,	0 12 2
Electric arc ("Bogen") lamps and other electric lamps ...	According to material of which composed.			
Greece :				
Dynamo-electric machines ...	Free.		Free.	
Electric lamps—		Dr. l.		
If of glass	Oke	1 00	Cwt.	1 12 0
If of plain porcelain	100 okes.	50 00	,,	0 16 0
If of porcelain, inlaid, coloured, or gilt	,,	200 00	,,	3 4 0
All others	According to material of which made.			
Holland :				
Dynamo-electric machinery ..	Free.		Free.	
Electric lamps and appliances for electric lighting not forming part of the machinery	5 % *ad val.*		5 % *ad val.*	
Italy :				
Dynamo-electric machines—		Lire cts.		
Weighing up to 1,000 kilos.	100 kilos	25 00	Cwt.	0 10 2
,, more than 1,000 kilos.	,,	16 00	,,	0 6 6
Detached parts of dynamo-electric machines.....	,,	25 00	,,	0 10 2
Electric lamps of bronze, brass, steel, or iron.....	,,	30 00	,,	0 12 2
Electric lamps of other materials	According to material of which made.			
Norway :				
Dynamo-electric machinery ...	Free.		Free.	
Electric lamps	According to material of which chiefly made.			
Portugal :				
Electric apparatus and machinery for whatever purpose..	30 % *ad val.*		30 % *ad val.*	
Electric lamps	According to material of which made.			
Roumania :		Lei. b.		
Dynamo electric machines ..	Free.		Free.	
Electric lamps	100 kilos.	50 00	Cwt.	1 0 4
Russia :				
Dynamo-electric machines of		Rbls. cop.		
all kinds.....	Poud	1 40	,,	0 13 9
Electric lamps	,,	6 00	,,	2 19 1
Spain :		Pes. cts.		£ s. d
Dynamo-electric machines ...	100 kilos.	18 50	Cwt.	0 7 6
Electric lamps : chargeable as ordinary lamps according to material of which composed, as follows :				
Of copper	,,	125 00	,,	2 10 0
,, cast iron	,,	8 50 to 17 50	,,	0 3 5½ to 0 7 1¼
,, wrought iron	,,	25 00 to 36 00	,,	0 10 2 to 0 14 8
,, tin-plate	,,	50 00	,,	1 0 4
,, other common metals	,,	37 50 to 45 00	,,	0 15 3 to 0 18 3
,, glass and crystal	,,	50 00 to 110 00	,,	1 0 4 to 2 4 9

Countries and tariff classification.	Rates of duties.		English equivalents.	
		Pes. cts.		£ s. d.
,, earthenware	,,	37 50 to 120 00	,,	0 15 3 to 2 8 9
,, porcelain.....	,,	52 50 to 120 00	,,	1 1 4 to 2 8 9
Sweden :		Kron. öre.		
Dynamo-electric machinery ...	10 % *ad val.*		10 % *ad val.*	
Electric lamps	Kilog.	1 50	Cwt.	4 4 8
Switzerland :		Fr. ct.		
Dynamo-electric machines ...	100 kilos	4 00	,,	0 1 7½
Electric lamps.....	,,	6 00	,,	0 2 5¼
Turkey	8 % *ad val.*		8 % *ad val.*	
United States :				
Dynamo-electric machines.....	35 % *ad val.*		35 % *ad val.*	
Electric lamps, of metal	35 % *ad val.*		35 % *ad val.*	
,, ,, of glass..... ...	35 % *ad val.*		35 % *ad val.*	

INDIA.

All the following are admitted free of duty: machinery—namely, prime movers and component parts thereof—including boilers and component parts thereof; also including locomotive and portable engines, steam-rollers, fire-engines, and other machines in which the prime mover is not separable from the operative parts. Machinery (and component parts thereof), meaning machines or sets of machines to be worked by electric, steam, water, fire, or other power not being manual or animal labour, or which before being brought into use require to be fixed with reference to other moving parts, and which are intended for (*a*) the preparing, ginning, pressing, spinning, weaving, sewing, knitting, bleaching, and dyeing of cotton, jute, hemp, silk, wool, or other fibres, and any other process intervening between the raw material and the finished product as packed ready for the market; (*b*) the smelting and milling of iron and other metallic ores and the manufacture of iron, steel, and other metals; (*c*) the manufacture of leather, sugar, indigo, silk, paper, soap, gas, oil, flour, cordage, rope, and twine; (*d*) the milling of rice; (*e*) the manufacture of tea in all its stages, from the drying of the leaf to its packing for the market, inclusive; (*f*) the pulping of coffee; (*g*) printing presses; (*h*) foundries and workshops of iron and other metals; (*i*) railway workshops; (*j*) the refining of petroleum, and the manufacture of vegetable oils; (*k*) the crushing of bones and bricks; (*l*) the manufacture of lac; (*m*) potteries; (*n*) sawmills; (*o*) agriculture, navigation, dredging, and pumping; (*p*) such other manufactures and industries as the Governor-General in Council may from time to time specify; provided that the term does not include tools and implements to be worked by manual or animal labour, and provided also that only such articles shall be admitted as component parts of machinery as are indispensable for the working of the machinery, and are, owing to their shape or to other special quality, not adapted for any other purpose. *Note.*—Machinery and component parts thereof made of substances other than metal are included in this entry.

Machinery and component parts thereof not included in the foregoing exemptions are charged at the rate of 5 per cent. *ad valorem.*

RADIATION.*

BY C. M. DORMAN.

Radiation is the result of waves produced by vibrations in an elastic medium. It will be better for a start to dismiss the popular conception of waves altogether, and to concentrate our thoughts on vibrations only (Fig. 1). Imagine a point, 1, in

2 1 3

FIG. 1.

any medium originally in stable equilibrium moved a certain distance to another position, 2. If in this new position a force is found tending to move it back again, we say that the region possesses elasticity. On the cessation of the original stress, the point will immediately move back to its original position. Further, suppose a certain minute volume, say of spherical form surrounding that point as centre, possesses the quality known to physicists as mass, and consequently inertia. When at rest in its second position the elasticity of the medium endows it with potential energy, and this starts it on its journey back to its original position, but on its arrival its kinetic energy prevents its coming to rest there, and causes it to overshoot the mark and be carried with constantly decreasing velocity until it comes to rest in a third position, 3, opposite from 2, and under ideal conditions equidistant from 1. At 3 the energy of the mass is entirely potential again, and starts it back on its journey to 1, where the energy, now kinetic, again carries it to 2. A vibration, in fact, is set up in the medium. The time occupied by a single vibration depends on two factors, the elasticity of the medium and its mass. If the elasticity be increased, the displaced medium will have a greater anxiety to regain its original position, and will consequently hurry home the quicker.

* Presidential address, delivered January 11, 1897, before the Northern Society of Electrical Engineers.

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The possession of mass will, however, retard its homeward passage, and on its arrival will carry it away from home again in the other direction. The greater the elasticity the greater the speed of vibration, or, what comes to the same, the less the time taken for a complete swing. The greater the mass or density the less the speed and the longer the time occupied by a complete vibration. The periodicity or number of vibrations (per second, say) varies, of course, inversely as the time taken for a complete vibration. If there are a hundred vibrations in a second, each vibration naturally occupies a hundredth of a second.

It will be convenient at the outset to consider some points connected with the presence of vibrations in elastic solids. Elasticity in the sense used here is perhaps better expressed by the word resilience. It must not be confounded with the amount of distortion a material will bear without experiencing a permanent set. An indiarubber band can be stretched very considerably without being permanently strained, but from our point of view is not particularly elastic. Elasticity must be looked upon as the anxiety possessed by a body to preserve its original geometrical form when distorted. This distortion must always be imagined so small that no permanent change of form takes place after the straining stress has been removed. The ratio of the stress to the strain it produces is the coefficient of elasticity or resilience. In the case of liquids and gases it is the quotient of the pressure by the compression it produces. In solids, say of rods of the same cross-section, it is the force required to stretch them a given percentage of their original length. To cause the same elongation in bars of steel, wrought iron, teak, lead, and cedar, the necessary forces would be 420, 280, 24, 7, and 4 respectively. These numbers, which represent the repugnance to straining, are called by engineers the moduli of elasticity. Of course, if the cross-section of the rod is doubled, double the force must be applied to produce the same extension. A fairly clear conception of most of the conditions under which vibratory waves are produced in elastic solids can be obtained from a critical examination of a stretched indiarubber tube. If a tube, say, ¼in. diameter, suspended from a hook on the ceiling, being held and stretched by one hand, is subjected by the other to a sharp knock administered near to the held end, the depression caused by the knock will be found to travel up the tube, and on reaching its upper fixed end will be reflected and descend as an elevation. The speed with which the depression travels up the tube is the same whether a gentle tap or a sharp rap is given, and is quite independent of the depth of the depression, or, in other words, to the amplitude of vibration. If the stretch on the tube be increased, it is found that the wave travels up the tube with increased velocity. This increased velocity is due to two governing factors. For a given displacement or amplitude of vibration the anxiety displayed by any displaced point to return to its original undisturbed position is measured by the stretch on the rubber or the elasticity of the medium. The thickness of the tube, or, more accurately, its weight per unit length or mass, is the factor that checks this anxiety, and prevents the infinite speed with which the tube would straighten had the medium no mass and, consequently, no inertia. The increased stretch has in this case increased the elasticity, and at the same diminished the mass. To separately examine the effects of elasticity and mass on the speed of wave propagation, two simple cases may be examined. Take two indiarubber tubes of the same total weight, but let one be four times the length of the other, and consequently have only a quarter of the cross-section. Let these be stretched side by side until they are of the same length. They will then have the same mass or weight per unit length, but the more-stretched one will have four times the elasticity, and it will be found that if a simultaneous tap be given to both, the depression will travel up the more-stretched tube at twice the velocity, and that the reflected elevation will arrive at the lower support at the same instant as the depression in the less-stretched tube has only just reached the upper support. It appears, then, that for the same mass the speed of wave propagation in an elastic medium varies as the square root of its elasticity. Now, take two identical tubes, equally stretched, but let one be filled with sand or other substance possessing mass, but no appreciable elasticity, and choose the internal diameters of the tubes so that the one filled with sand has four times the mass or weight per unit length. On again performing our experiment, we shall find that the depression has only reached the upper support of the sanded tube at the same instant as the reflected elevation has completed its upward and downward journey in the empty tube. From this we learn that for the same elasticity the speed of wave propagation varies inversely as the square root of the medium's mass or density. Compounding these two results we may write—

$$\text{Velocity} = \sqrt{\frac{\text{Elasticity}}{\text{Density}}}.$$

As this equation lies at the bottom of all elastic wave calculations, one more simple example may be examined to impress it on our memories. Take a stretched tube as before, but let only its upper half be filled with sand, a piece of string being tied round the tube to prevent the sand falling into its lower half. The depression caused by a sharp rap will travel up the tube, and on its arrival at the junction will be partly reflected as an elevation which will travel back again down the empty part and partly transmitted up the sanded part as a wave of decreased amplitude and velocity. The transmitted wave will in due course reach the top support and be there reflected, and returning reversed will on its downward journey sweep into the empty half tube with increased amplitude and velocity.

To facilitate expression, we have talked of a single depression passing up the tubes and a single elevation reflected downwards. Of course it is impossible for such conditions to obtain in practice. The depression caused by the rap, A (Fig. 2), will, as before explained, in attempting to straighten itself overshoot the mark and become an elevation, B, and this elevation will in its turn commence to straighten, and being once more carried across the centre line finds itself a depression again, C. In the meantime the original depression has travelled a certain distance up the tube, and is separated from the secondary depression which now appears at the source by an elevation. This distance, measured from the lowest point of the two depressions, is the wave-length. It is thus seen that in an elastic medium a transverse wave travels its own length during the time occupied by one complete transverse vibration. But the number of complete vibrations per second is the periodicity of the vibration, consequently periodicity × wave-length = velocity, or the distance travelled by the wave in a second. This is always true, and as we have seen that the velocity of a wave in any medium is dependent solely on that medium's elasticity and density, it follows that in

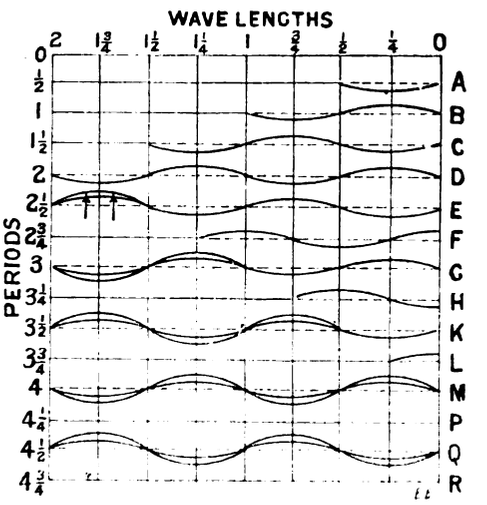

FIG. 2.

any given medium the wave-length is solely governed by the periodicity, or *vice versâ*. You now see on the screen a working model of a travelling transverse wave. The projection of the pin points represent molecules of a homogeneous elastic medium. These molecules before agitation all lay in a straight line whose direction is the direction of propagation of the wave or ray. The elastic cohesion of the medium causes the up and down motion of the molecule situate at the source of the ray to be communicated to the one next in advance. The greater the elasticity the closer will the motion of the second molecule follow that of the first. Its lag—if we may use such an expression—is due to its mass, which demands a certain period of time in which to acquire the velocity of vibration of its agitator. This second molecule moves the third after a similar interval of time, and so the motion of vibration is transmitted along the ray. It may be here observed that were the medium absolutely devoid of mass there would be no lag, consequently all the molecules situate in the direction of the ray would move simultaneously, and infinite velocity of propagation would be the result. It need hardly be pointed out that a wave of this description is merely the translation of a disturbance, and that it is unaccompanied by the transfer of matter in the direction of its propagation.

Harking back to our stretched tubes, we find that when the original depression has reached its fixed support, D (Fig. 2), it is reflected back again as an elevation, E. At the instant depicted at E—that is, 2½ periods from the commencement of the wave—there are in the space between one and a half and two wave-lengths measured from the source, two half wave-lengths, one travelling to the left and the other to the right, and the forces acting on the molecules in this region are all upwards. The combined effect produces an elevation of double the amplitude (as shown above the two arrows). Following the reflected ray on its downward course, we find a quarter of a period later, F, the big loop flattened out, and in another quarter period it is carried over, making a depression, the elevation having now travelled

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down, and meeting one at 1¼ wave-lengths from the source of the same phase, an elevation of double amplitude is caused, as shown at G. The course of the reflected wave, and the manner in which it affects the original wave, can be followed from the figures until we find it reaching the bottom support at M. A quarter period later the tube is quite straight, and at Q the loops are reversed. At distances measured by 0, ½, 1, 1½, and 2 wave-lengths from the source, the forces occasioned by the advancing and receding wave are always equal and opposite, consequently no motion takes place of the molecules situate in these localities, which are called nodes. At distances of ¼, ¾, 1¼, and 1¾ from the source, the forces are sometimes in conjunction, forming a loop of double amplitude on one side of the centre line or the other, sometimes in opposition when the tube is straightened out. These localities are called vertical segments. We will now reproduce this on the screen. Suppose the top skeleton wave to be moving to the left and the solid wave to the right. At the moment of representation the elevations or crests of the skeleton wave are immediately over the depressions or troughs of the solid one. The two waves are now completely out of phase, the forces acting on the top wave being equal and opposite to those acting on the bottom one. We will now combine them, and you see the crests of one fill up the troughs of the other, and a straight line is the result. We will now move the bottom solid wave until its crests and troughs come under the crests and troughs of the upper wave, with the result as predicted—a combined wave of double amplitude. Continuing to cause a relative opposite movement between the two waves, there is seen to be constant rest at the nodes and an up and down vibrating action in the vertical segments, but no apparent longitudinal movement. In this respect a reflected stationary wave differs from a travelling one. The clearness of our conception of the interference occasioned by the passage through any part of a medium of two or more waves, whether travelling in the same or different directions, will be much simplified if we are careful to bear in mind that the actual strain at any instant is that due to the combined action of every individual acting stress. If the stresses are in the same or similar directions the strain will be increased, if in contrary directions, diminished. Their combined algebraic sum resolved in the given direction tells us what is going on at that point.

Now for a little elementary electricity. We were taught at school that a force of one dyne exists between two electrostatic units of electricity separated by a distance of one centimetre in air. It is pretty certain that this statement gave us no very clear idea of what was taking place in the air to cause this stress. It is also improbable that our later contemplation of the phenomenon has materially improved the clearness of our perception. But at any rate our teachers might have pointed out more definitely that this force was dependent not only on their charge and their distance apart, but also on a quality of the dielectric medium called its specific inductive capacity. It would surely be better if more emphasis were laid on the fact that if the medium in which the experiment is conducted were capable of being suddenly changed from air to, say, paraffin or glass, the force of one dyne (which is practically equal, by the way, to one-eighteenth of the weight of a postage stamp) would be reduced to half a dyne where paraffin was the medium, and one-sixth of a dyne in the case of glass. Now suppose the two bodies to be both charged positively. The force between them will be repulsion. Whether we choose to picture this repulsion as caused by a tendency of the lines of force between these two bodies and the negative boundary of the field to shorten, or prefer to picture the lines of force between the two bodies as repelling one another, or, what is more probably correct, to imagine both states of thing occurring, the fact remains that a repulsion exists between them. Now let us push these two bodies together until they are only half a centimetre apart. Push is the right word, because work must be done on them to move them together. This is evident from the fact that the force of repulsion between them is now four dynes in the case where air is the medium, two dynes in paraffin, and two-thirds of a dyne in glass. In these days, when no sane individual admits the possibility of action at a distance, we must look to the medium between the bodies, or, to be more accurate, in the present instance, perhaps, also to the medium existing as far as the negative boundary of the electric field, for the cause of repulsion between them. It would be idle to pretend to describe the physical state of the region under discussion, but this much is certain—the quality which we call its specific inductive capacity, K, is the factor which governs the repulsion, and that when K is large the small resilience of the medium shows that what may be called its modulus of electrical elasticity is small. Elasticity then, used in an electrical sense as applied to a dielectric medium, is the antithesis or reciprocal of its specific inductive capacity, and is consequently denoted by $\frac{1}{K}$.

So much for electrical elasticity; but as we are to-night discussing vibrations and waves, it will be necessary, before we can form any conception of an electric wave, to find some electrical quality corresponding with density or mass in gross matter. Now inductance, or self-induction, is that quality which prevents a finite and steady E.M.F. from at once generating in an electrical circuit the full current due to its resistance, and which prevents the complete cessation of the current until some time after the E.M.F. has been withdrawn. Self-induction, then, seems to bear, in the case of variations in the strength of flow of an electric current, a strong analogy to mass in the case of matter changing in linear velocity, or to moment of inertia in angular velocity. But what do we, as electricians, understand by inductance? We know that electricity in motion is always accompanied by what we call a magnetic field. Whether the current causes the field or the field the current we need not enquire here. As practical men we know that one cannot exist without the other, and, in fact, we are in the habit of indicating and even measuring the flow of a current by observing the nature of the magnetic field in its vicinity. We read in text-books that when a current of unit strength flows round a circle of unit radius it produces at the centre of that circle a magnetic field of unit intensity. If the radius be doubled while the current remains constant the field of intensity is halved, because, although the magnetising force is doubled, the area it has to magnetise is quadrupled. In conventional language, double the number of lines of magnetic force occupy four times the area, and are consequently only half as dense. It is generally left to the intelligence of the reader to discover in some other chapter of the book that such elementary calculations refer to a medium surrounding the circular conductor, such as air or a vacuum. As a matter of fact, the result happens to be the same for most non-magnetic media, but this is taken for granted, and not properly pointed out. If the medium surrounding the circular conductor were iron the field intensity would be enormously increased, perhaps a thousand-fold. This quality in a medium which governs the intensity of magnetic field due to a given circuit conveying an electric current is known to electricians as permeability. Now, the energy expended in calling into existence an electric current is that necessary to produce the magnetic field linked by it, and this we see depends on the permeability of the medium of the field. As soon as the field has been produced, no more energy is needed to maintain it than that necessary to force the steady current producing it against the resistance of the circuit. To increase the strength of current flowing, an amount of extra energy must be expended corresponding to the extra field intensity due to the stronger current, and to maintain this stronger current against the constant resistance its flow will, of course, require a corresponding greater E.M.F. The energy necessary to produce the field cannot, we know, be lost, and will show itself after the cessation of the E.M.F. which maintains the steady current is withdrawn. This manifestation takes the form of what practical men call the extra current at break. In figurative language this is due to the closing up and disappearance of the lines of force surrounding the conductor, and which were linked with it. The number of these we have seen depend on the permeability of the field, and therefore we may look on permeability as the governing factor of inductance or self-induction.

Summing up then, we find that the impression of an E.M.F. on a circuit produces what we call a current as soon as its magnetic field has been established, and this field after the E.M.F. has ceased causes a maintenance of current during its disappearance. The size of this reservoir of energy, known as inductance, depends not only on the geometrical dimensions of the circuit, but also on the physical quality known as permeability. Permeability then seems to be the electrical analogue to density or mass in gross matter, just as we have assumed that specific inductive capacity is the electrical analogue for pliability or want of elasticity. To show that this is really true it is only necessary to consider the phenomena accompanying the charge and discharge of an ordinary electrical condenser. In charging a condenser to a given potential difference between its boundaries, a quantity of electricity must be displaced. The amount of this displacement depends on the capacity of the condenser, and the capacity depends not only on its size, but also on the specific inductive capacity of its dielectric. If the capacity is great, a considerable electrical displacement is necessary to obtain a given reaction or potential difference. A condenser of large capacity is like a long thin lath held in a vice, which requires considerably more displacement or bending strain to call forth a given back pressure than a shorter or thicker lath, which may be compared with a condenser of small capacity. In the case of two flat metal plates parallel to one another, the capacity varies as the area of the plates, and inversely as their distance apart, just as the conductivity of the space between them varies as the area of the plates, and inversely as their distance apart. These geometrical considerations are always true, but before we can specify the actual capacity we require to know the specific inductive capacity, just as the specific conductivity must be known to arrive at the actual conductivity of the space.

(To be continued.)

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LEGAL INTELLIGENCE.

CLAIM FOR ELECTRICAL WORK.

In the Westminster County Court, on Wednesday, before his Honour Judge Lumley Smith, Q.C., the case of Howard *v.* Scott was heard. The plaintiff is an electrical engineer, of Charing Cross road, and he sued the defendant, a gentleman residing at Victoria street, Westminster, to recover the sum of £5. 15s. in respect to electrical fittings supplied and work done.

The **Defendant** admitted liability for the fittings to the extent of £1. 10s., but said they were rendered quite useless in consequence of the defective character of the plaintiff's work, all of which had had to be done over again by another firm.

After going into the evidence, his **Honour** found that the work was done over a year ago, and that no complaint was made until payment was pressed for, and consequently he gave judgment for the plaintiff for the amount claimed, with costs.

CLAIM FOR ELECTRIC LAMPS.

In the Westminster County Court, on Wednesday, his Honour Judge Lumley Smith, Q C., had before him the case of Holman *v.* White, in which the plaintiff, an agent for the sale of electrical appliances, sued the defendant, of Ashley-gardens, Victoria-street, to recover payment in respect of electrical fittings supplied to his order.

The **Defendant** admitted having ordered the goods, but said he did so on the footing that his landlord was to pay.

His **Honour** gave judgment for the amount claimed.

THE MOTOR CAR SYNDICATE.

In the High Court, on January 15, before Mr. Justice North, Mr. Moulton, Q.C., appeared on behalf of the plaintiffs in the case of the British Motor Car Syndicate, Limited, *v.* Rolls.

Learned **Counsel** said that this was an action for infringement of patent. The defendant being an infant, he now appeared by guardian, and the latter, on his behalf, had consented to a perpetual injunction, the motion being treated as the trial of the action. The plaintiffs proposed to allow the defendant the use of his motorcar on paying a royalty of £15.

His **Lordship** made the order accordingly.

A TELEPHONIC CASE.

In the High Courts of Justice on Tuesday, before Mr. Justice Charles, the hearing was commenced of an action in which Julius Edward Wedekind, an electrician, sought to restrain the General Electric Company, Limited, Queen Victoria-street, from infringing his copyright in a registered design for an improvement in telephone receivers and transmitters, and for damages, or an account of profits and costs.

Mr. Lewis Edmonds, Q C., and Mr. Walter H. Moresby appeared for the plaintiff, and Mr. McCall, Q C., and Mr. Chas. C. Scott for the defendants.

The result of the case had not transpired at the time of going to press.

ELLIOTT BROS. v. SULLIVAN.

In the Court of Appeal, before Lord Justice Lindley, Lord Justice A. L. Smith, and Lord Justice Rigby, the above case came on for hearing on Tuesday and Wednesday last. The appeal arose out of an action brought by the plaintiffs in June last to establish their claim as the sole licensees for the manufacture of the "Sullivan" Universal galvanometer. Mr. Justice Kekewich then gave judgment that no such license existed, and that Messrs. Elliott Bros. must not go on manufacturing the instruments in question. The appeal to set aside this decision has failed, as the three judges above mentioned decided against the plaintiffs. Their judgment clearly sets forth their reasons for the decision, and restrains the plaintiffs from manufacturing the Sullivan instruments during the continuance of the respective letters patent.

A QUESTION OF LIABILITY.

In the High Court on January 15, before Mr. Justice Mathew and a special jury, the case of Taylor and Son *v.* the London and South-Western Railway Company was heard.

In this case the plaintiffs, who were a firm of electric launch and boat builders at Chertsey, claimed £130 damages for injuries alleged to have been sustained by an electric launch in course of transit between Chertsey Station, on the defendants' railway, and Manchester. The defence set up by the railway company was that any injuries that might have happened to the launch were caused by the improper packing in the launch of some accumulators containing a mixture of sulphuric acid and water. The company relied on two conditions in the consignment note, which was signed by the plaintiffs. These conditions were as follows: "The company will not be liable for any loss or damage or delay to goods resulting from their not being properly protected by packing." "In respect of goods consigned to places beyond the limits of the company's free delivery, the responsibility of the company will cease when such goods have been delivered over to another carrier in the usual course for delivery." The company contend that under this latter clause they were absolved from liability, because they had handed over the launch to the Midland Railway Company in good condition at Brent Station. The company also pleaded that the mixture of sulphuric acid and water was "dangerous" goods within Section 105 of the Railway Clauses Act, 1845, and the nature of the liquid not having been marked on the outside of the vessels, and notice in writing not having been given to the company, the contract of carriage was rendered void.

Mr Atherley-Jones, Q.C, and Mr. Boydell Houghton appeared for the plaintiffs; Mr. Bucknill, Q.C, and Mr. Acland for the railway company.

His **Lordship**, in summing up said if it was true, as the plaintiff alleged, that the planks of the launch had been stove in, then there was no doubt that it must have been roughly handled, and the first and most important question was as to the truth of that allegation. On the one hand, there was the uncorroborated evidence of the plaintiff and his son; on the other, four witnesses were called, who said they had carefully examined the launch and had found no trace of broken planks. In deciding between these two conflicting stories it was most important to consider the circumstantial evidence It was a most significant fact that there was no mention of the broken planks in the plaintiff's first letters to the company. His complaint, then, was that the planks had been damaged by the spilt acid. His Lordship having referred in detail to the evidence on the other points in the case. left the following questions to the jury: (1) Were the planks broken when the launch was on the defendant company's railway? (2) Was the liquid from the accumulators dangerous? (3) If so, was the station master informed as to the nature of the liquid, and did he consider it not dangerous? (4) Was the damage caused by insufficient packing of the accumulators?

The jury answered the first question in the negative; the second in the affirmative; the third in the negative, adding that the station master considered the liquid not dangerous; the fourth in the affirmative.

On these answers his **Lordship** gave judgment for the railway company.

COMPANIES' MEETINGS AND REPORTS.

CITY AND SOUTH LONDON RAILWAY COMPANY.

Directors: Charles Grey Mott, Esq. (chairman), Harrow Weald, Middlesex; Charles Seymour Grenfell, Esq, Elibank, Taplow; Sampson Hanbury, Esq., Wyvenhoe Park, near Colchester; S. Barclay Heward, Esq., 96 Ashley-gardens, Westminster; Edwin Tate, Esq, 21, Mincing-lane, London, E C.

Report of the directors, with statement of accounts, for the half-year ending December 31, 1896 to be submitted to the twenty-fifth ordinary general meeting of the Company, to be held at Winchester House, Old Broad-street, E.C, on Thursday, January 28, 1897, at 12 noon:

The receipts from all sources for the past half-year have amounted to £26,282 4s. 6d., and the cost of working has been £14,930. 1s. 11d., leaving a profit of £11,352. 2s. 7d. Inclusive of the balance brought forward from June 30 last, the net revenue account shows an aggregate total of £12,559. 9s. 1d. After making provision for the debenture and debenture stock interest, a balance remains available for dividend of £8 930 16s. 6d. Out of this sum your directors recommend that the full dividend of 5 per cent. per annum be paid on the preference shares, and that a dividend at the rate of 1¾ per cent. per annum be paid upon the consolidated ordinary stock, leaving a balance of £1,313. 11s. 6d. to be carried forward to the next account. The following table shows the number of passengers, exclusive of season-ticket holds, carried since the opening of the railway in each half-year:

Half-year ended	Number of passengers (exclusive of season-ticket holders)	Receipts (including season tickets).
Dec. 31, 1890 (11 days)	165,000	£1 568 3 9
June 30, 1891	2 412,343	19,403 6 9
Dec. 31, 1891	2,749,055	19,798 16 6
June 30, 1892	2 813,162	20,931 4 2
Dec. 31, 1892	3 117,602	22,002 17 5
June 30, 1893	3,146,656	22 458 6 9
Dec. 31, 1893	3 093,351	22,067 14 10
June 30, 1894	3 383,154	23,564 10 6
Dec. 31, 1894	3,275,649	23,540 12 4
June 30, 1895	3,113,199	23,711 5 8
Dec. 31, 1895	3,172,438	23 780 3 7
June 30, 1896	3,192,672	24,021 13 0
Dec. 31, 1896	3,368,480	25,567 7 6
Total since the opening of the line	37,002,761	£272,416 2 9

The new condensing plant is completed, and working satisfactorily. The further sum of £6,900 has been paid off the 5 per cent. terminable mortgage debenture bonds during the past six months. The Bill for the extension of time for the construction of the line to Islington gave rise to much discussion and difference of opinion between the two Houses of Parliament in reference to the removal, or otherwise, of St. Mary Woolnoth Church. Eventually the Bill was passed retaining the clauses inserted by the House of Commons, the general effect of which was to give power to construct a station on the site outside and underneath the church, provided the fabric of the church itself was preserved. Plans for carrying out the works under these altered conditions have been prepared and are now under discussion with the authorities. The sites for the stations at London Bridge and Finsbury-pavement have both been acquired, and at the former the works are now in progress. The

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tender of Messrs. J. Mowlem and Co. for the construction of the tunnels and stations has been accepted, and they have commenced work. Your directors have to record with great regret the death of Mr. J. H Greathead, who has been the engineer of this Company from its commencement, and under whose supervision the construction of the line was so ably and successfully carried out. In consequence of Mr. Greathead's death it was necessary to appoint another engineer to carry out the works now in progress, and your directors have great satisfaction in being able to report that Sir Benjamin Baker has consented to undertake the work. In the year 1890 an Act was obtained for the extension of the railway from Stockwell to the Plough at Clapham. Since that date Parliament has twice extended the time limited by the Act, on the Company representing that it was useless to bring a large accession of traffic on to the existing line until provision had been made for dealing with it by the construction of the extension through the City. As the latter works are now in progress it is undesirable to ask Parliament for a further extension of time. The period for the compulsory acquisition of the land for stations expires in August next, and your directors therefore propose to take steps to acquire the land required for the two stations contemplated, and to have the plans prepared and arrangements made for carrying out the works with a view to their completion soon after the City extension has been opened for traffic. With that view they ask the shareholders' sanction to issue when required the 5,000 5 per cent. preference shares, the balance of the preference capital already created on June 30, 1891, and also to create the small amount of additional ordinary share and loan capital authorised by the Act of 1895. The directors retiring by rotation are Messrs. Sampson Hanbury and Spencer Barclay Heward, who, being eligible, offer themselves for re-election. Messrs. Turquand, Youngs, Bishop, and Clarke are the auditors to retire on this occasion, and are eligible for re-election.

Dr. REVENUE ACCOUNT.	£	s.	d.
Maintenance of way, works, and stations	655	6	1
Locomotive and generating power	5,444	13	4
Carriage repairs	533	10	7
Traffic expenses	5,813	0	5
General expenses	1,702	7	0
Law charges	3	13	6
Rates and taxes	725	17	1
Passenger duty	52	13	11
	14,930	1	11
Balance carried to net revenue account	11.352	2	7
	£26,282	4	6
Cr.	£	s.	d.
Passengers (3,368 480)	24,356	19	0
Season tickets (565)	1,099	7	9
	25,456	6	9
Parcels, etc.	111	0	9
	25,567	7	6
Transfer fees	28	10	0
Rent of property	674	3	6
Sundry receipts	12	3	6
	£26,282	4	6

Dr. GENERAL BALANCE SHEET.	£	s.	d.
Balance from net revenue account	8,930	16	6
Unclaimed interest	70	9	0
Interest payable or accruing and provided for	1 155	10	2
Sundry outstanding accounts	4,861	4	11
Balance from capital account	179,262	11	10
	£194,280	12	5
Cr.	£	s.	d.
Cash at bankers on deposit, at interest	25,000	0	0
,, ,, current accounts	5,387	1	9
	30,387	1	9
,, on hand	726	10	2
	31,113	11	11
General stores	3,734	16	0
Sundry outstanding accounts	604	8	10
Investments—at cost £151,228 15 0			
Less proportion of interest received applied in reduction of premiums 500 0 0			
	150,728	15	0
Interest on calls paid in advance 9,000 0 0			
Less balance investment and bank interest received 900 19 4			
	8,099	0	8
	£194,280	12	5

CAMBRIDGE ELECTRIC SUPPLY COMPANY, LIMITED.

Directors: D. Munsey, Esq., chairman, Edenfield, Cambridge; the Hon. C. A. Parsons, managing director, Holeyn Hall, Wylam-on-Tyne; Sir B. C. Browne, D.C.L., Westacres, Benwell, Newcastle-on-Tyne; Wm. C. Hall, Esq., J.P., Elmhurst, Cambridge; P. W. Latham, Esq., M.D., Trumpington-street, Cambridge; John B. Simpson, Esq., Bradley Hall, Wylam-on-Tyne. John H. Barker, general manager and secretary.

Report of the directors to be submitted to the shareholders at the fifth annual general meeting to be held at the Company's offices at Cambridge on Friday January 29, at 12 noon:

Your directors have pleasure in reporting that the prospects of the Company continue to be satisfactory. During the year 1896 there has been added to the Company's mains the equivalent of 3,973 8-c.p. lamps, making the total 18,633. The number of units supplied has been 197,615, against 150.510, an increase of 47.105, or 31 per cent. The total cost of coal has been diminished by 6¾ per cent. Forty new consumers have been added, making the total 287. The capital expenditure for the past year has been £2,584. 2s. 9d., against £5,690. 2s. 6d. for 1895; the number of lamps, however, connected during 1896 is in excess of 1895. The Company has very largely benefited by the new machinery and sub-stations which were added 14 months ago. The 220 yards laid down in the year brings the total of main conduit pipe and cable to 13,271 yards. The conversion of the high-tension house-to-house supply to low tension (three wires at 210 volts) has been steadily proceeded with. A new public sub-station at the theatre has been constructed and the capacity of the existing ones largely increased; of the total demand, 53 per cent. is now supplied through sub-stations, and thereby a considerable saving is effected. The Company has made a profit on the year's working of £2,492. 16s 9d., which, added to £63. 4s. brought forward from last year, makes £2,556. 0s. 9d.; and after paying £112. 15s. 2d. interest on debenture capital there remains a balance of £2,443 5s. 7d. Your directors therefore advise the payment of a dividend of 5 per cent., of which £654. 16s. 1d. has already been paid as an interim dividend, absorbing £1,738. 17s. 11d., leaving £704. 7s. 8d. for depreciation, directors' fees, and carrying forward. Sir B. C. Browne and Dr. Latham retire by rotation; both are eligible, and offer themselves for re-election. The auditor, Mr. Arthur Rutter, also offers himself for re-election.

Dr. BALANCE-SHEET, DECEMBER 31, 1896.		£	s.	d.
Capital—5,000 shares at £10 each		50,000	0	0
4,925 shares issued, £8 called up		39,400	0	0
Debentures, £750 at 4 per cent.		750	0	0
Creditors		368	2	2
Profit and loss account—Profit for year ending December 31, 1896, as per statement	£2,380 1 7			
Less interim dividend	654 16 1			
		1,725	5	6
Balance from last year	1,460 15 1			
Less depreciation, dividend, and income tax	1,397 11 1			
		63	4	0
		£42,306	11	8
Cr.		£	s.	d.
Amount expended to date on land, buildings, plant, pipes, cables, meters, transformers, electrical instruments, public lamps, etc.	£37,032 4 4			
Less depreciation fund	200 0 0			
		36 832	4	4
Provisional order		1,017	13	2
Preliminary expenses	1,752 14 8			
Less amount written off	377 14 8			
		1,375	0	0
Stock of stores, etc.		166	10	5
Sundry debtors		2,728	13	0
Cash at bankers		184	10	10
Cash in hand		1	19	11
		£42,306	11	8

PROFIT AND LOSS ACCOUNT, YEAR ENDING DEC. 31, 1896.

Dr.	£	s.	d.
Directors' fees	147	0	0
Wages, salaries, rents, rates, and taxes	1,252	2	6
Stores, fuel, and water	1,281	4	2
Repairs and renewals	219	5	5
Stationery and general expenses	226	16	2
Balance carried down	2,492	16	9
	£5,619	5	0
Cr.	£	s.	d.
Electric energy supplied less discounts	5,354	13	4
Meter rents	264	11	8
	£5,619	5	0
Interest on debentures and loans	£112	15	2
Balance carried to balance-sheet	2,380	1	7
	£2,492	16	9
Balance brought down	£2,492	16	9
	£2,492	16	9

EASTERN TELEGRAPH COMPANY, LIMITED.

The forty-ninth half-yearly general meeting of this Company was held yesterday (Thursday, 21st inst.) at Winchester House, the Marquis of Tweeddale in the chair.

The report showed that the revenue for the period amounted to £435,464. 15s. 5d., from which are deducted £102,376. 1s. 1d. for the ordinary expenses and £22,121. 9s. 6d. for expendi-

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ture relating to repairs and renewals of cables, etc., during the half-year. After providing £5,111. 14s. 9d. for depreciation of spare cable, £297. 17s. 5d. due to revaluation of currency assets, and £5,817. 2s. 9d. for income tax, there remains a balance of £299 740 9s. 11d., to which is added £7,151. 17s 9d. brought from the preceding half-year, making a total available balance of £306,892. 7s. 8d. From this balance there have been paid—interest on debentures and debenture stock, £29 629. 7s. 9d.; dividend on preference shares, £20,296. 3s.; and two interim dividends of 2s 6d. per share each on the ordinary shares. £100 000; making a total of £149 925. 10s. 9d. After carrying £10,000 to the reserve fund for maintenance ships, £75,000 to the general reserve fund, £20,000 to the fire insurance fund, and £10 000 to the land and buildings depreciation fund, there remains a balance of £41,966. 16s. 11d., which is carried forward to the next account. The revenue includes £23,186. 4s. 10d., dividends for the half-year upon the Company's shares in other telegraph companies. The cable of the Deutsche See-Telegraphen-Gesellschaft between Emden in Germany and Vigo was opened for traffic on December 25. The Eastern Telegraph Company, in conjunction with the Brazilian Submarine Telegraph Company, is largely interested in this company, and it is hoped that this line will be a new feeder to the Eastern Company's system for all classes of traffic. At the International Telegraph Conference, held in the summer of this year at Budapest, certain reductions were agreed to in the tariffs for messages passing over this Company's cables. Some of these reductions came into operation on 1st inst., the remainder will be brought into force in July next. The directors have appointed Francis Alexander Johnston, Esq., to a seat at the Board.

The **Chairman**, in moving the adoption of the report, referred to the death of Mr. G. Nicol, one of the original directors of the Company. He stated that there was a great increase in receipts for all the lines except that to India, which had altered but very slightly. He also said that an automatic system of signalling was being introduced, which would greatly assist the transmission of messages. It had been decided to subscribe £1,000 to the Pender memorial, and it was also agreed to give £500 to the Indian famine fund.

Mr. J. D. Pender seconded the adoption of the report, which was carried.

Mr. F. A. Johnston and Mr. C. W. Strong, C.B., were re-elected, and the auditors, Messrs. Deloitte, Dever, Griffiths, and Co., and Messrs. Welton, Jones, and Co. were also re-elected.

YORKSHIRE HOUSE-TO-HOUSE ELECTRICITY COMPANY, LIMITED.

Directors: Grosvenor Talbot, Southfield, Burley, Leeds (chairman); George Henry Crowther, civil engineer, Huddersfield; Robert William Eddison (John Fowler and Co. (Leeds), Limited), engineer, Leeds; Robert Hudson, engineer, Gildersome Foundry, near Leeds; Samuel Ingham (Illingworth, Ingham, and Co.), timber merchant, Leeds; Arthur Greenhow Lupton (William Lupton and Co.), cloth manufacturer, Leeds; John Thomas Pearson, The Hall, Melmerby, S.O., Yorkshire. Consulting electrical engineer: Robert Hammond, M.I.E.E., Ormond House, Great Trinity-lane, London, E.C. Engineer: Harold Dickinson. Secretary: Wm. T. Green.

Report of the directors to be presented to the ordinary general meeting of the Company, to be held at the Great Northern Hotel, Wellington-street, Leeds, on Tuesday, February 2, 1897, at 2.30 p.m.:

The directors submit herewith a statement of the income and expenditure for the past year, and the balance-sheet showing the assets and liabilities of the Company made up to December 31 last. The profit for the year, after transferring £3,000 to the depreciation fund account, amounts to £6,960. 0s. 5d., to which is to be added the sum of £517. 16s. 4d. brought forward from the previous year, making a total of £7,477. 16s 9d., which the directors propose shall be appropriated as follows: to reserve fund account, £2,500; to payment of interim dividend at the rate of 5 per cent. per annum upon the ordinary shares of the Company, made for the half-year ending June 30, 1896, £1,652. 14s. 9d.; to payment of a dividend at the rate of 7 per cent. on the same shares for the half-year ending Dectmber 31, 1896, on the amount called and paid up thereon, making 6 per cent. for the year, £2,932. 9s. 10d.; to balance to carry forward to next account, £392. 12s. 2d.; total, £7,477. 16s. 9d. The Company's works and plant have been maintained in a thoroughly efficient state of repair. The number of lamps connected to the mains which on December 31, 1895, was equivalent to 32,539 35-watt lamps, had increased by December 31, 1896, to 39,396 such lamps. Contracts were made in the early part of the year for the erection of extensive additions to the Company's buildings, and for the supply of engines, boilers, and other plant, representing an increase of 1,000 i.h.p. (or 600 kilowatts) in the capacity of the works, and involving an expenditure of upwards of £35,000. It was expected that the new plant would be running in time to meet the present winter's demand, but the recent strike in the building trade, extending over 20 weeks, rendered this impossible. Owing to this delay the directors have been compelled to refuse the applications of many intending consumers, otherwise the increase in number of lamps connected and in sales of current would have been larger. As reported verbally at the last general meeting, the Company has purchased the Britannia Mills estate, comprising 5,700 square yards, immediately adjoining the present works. In the event of further extensions being necessary this purchase will prove very advantageous, and in the meantime the bulk of the property is let. The mortgage for £6,000 on the land and buildings occupied by the Company has been paid off. The contracts and purchase above mentioned necessitate a further increase of capital, and as all the Company's present authorised capital is issued with the exception of 1 052 shares, the shareholders are asked to increase the capital of the Company by the creation of an additional 20,000 ordinary shares, bringing the capital up to £200,000. Immediately upon this authority being given the directors propose to offer at par to the shareholders whose names may be on the register at the date of the general meeting an equal number of shares to those held by them respectively at that date. As will be seen from the notice accompanying this report, the register of transfers will be closed from the 27th inst. to February 2 inclusive The retiring directors, Mr. Samuel Ingham and Mr. George Henry Crowther, being eligible, offer themselves for re-election. Mr. John Gordon, jun., offers himself for re election as auditor.

Dr. Revenue Account, Year ending Dec. 31, 1896.	£	s.	d.
Coal, including carriage, etc.	849	8	3
Oil, waste, water, and engine-room stores	211	4	3
Salaries and wages of engineers and workmen	1,926	13	5
Repairs and maintenance	651	15	8
Rents, rates, and taxes	246	12	7
Directors' remuneration	500	0	0
Salaries of secretary and clerks, stationery and printing, law expenses, and general charges	613	13	10
Insurances	76	3	9
Total expenditure	5,075	11	9
Amount carried to depreciation fund account	3,000	0	0
Balance carried to net revenue account	7,475	4	4
	£15,550	16	1
Cr.	£	s.	d.
Sale of current, rental of meters and other apparatus, etc., after providing for discounts and bad and doubtful debts	14,728	4	4
Rents receivable	793	14	3
Transfer fees	3	17	6
Students' instruction	25	0	0
	£15,550	16	1

General Balance-Sheet.

Dr. Capital and Liabilities.	£	s.	d.
Capital account—Amount received as per last account	76,020	0	0
Received during the year	18,600	0	0
Total amount received	94,620	0	0
Amount due to bankers (Wm. Wms Brown and Co.) (As security for this they hold a mortgage debenture for £10,000 upon the Company's undertaking.)	6,792	16	4
Sundry creditors	4,971	8	11
Net revenue account—Balance brought forward from last year £517 16 4			
Profit for the year 6,960 0 5			
7,479 16 9			
Less interim dividend paid July 10, 1896 1,652 14 9			
	5,825	2	0
Reserve fund account—Balance at credit thereof	2,500	0	0
Depreciation fund account— ,, ,,	4,300	0	0
	£119,009	7	3
Cr. Property and Assets.	£	s.	d.
Capital account—Amount expended for works as per last account	76 536	16	9
Expended during the year	28,850	6	4
Total capital expenditure	105,377	3	1
Stores on hand—coal, £24. 9s.; oils, waste, etc., £72. 17s. 8d.; general, £274. 18s. 7d.	372	5	3
Sundry debtors for amounts paid on account of contracts in course of completion	5,929	15	10
Sundry debtors for current supplied, £6,347. 11s.; less reserved for discounts, etc., £450	5,897	11	0
Other debtors	851	19	8
Deposit with Leeds Corporation and interest	505	0	0
Cash in hand	75	12	5
	£119,009	7	3

DIRECT UNITED STATES CABLE COMPANY.

The report of the directors of the Direct United States Cable Company, Limited, for the six months ended December 31, to be presented at the general meeting to be held at Winchester House on Tuesday next, states that the revenue, after deducting out-payments, amounted to £47,601, as compared with £43,938 for the corresponding period of 1895, showing a difference of £3,663 in favour of the half-year under review. The working and other expenses for the same period, including income tax, but exclusive of cost of repairs of cables, amounted to £19,816, leaving a balance of £27,785 as the net profit, making, with £4,236 brought forward from the previous half-year, a total of £32,021. For the corresponding period of 1895, the working expenses and other payments amounted to £19,058. Interim dividends of 2s. 6d. per share for the quarter ended September 30 last, and of 2s. 6d. per share for

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the quarter ended December 31, together amounting to £15,177, have been declared, and after setting aside £12,000 to the reserve fund, the balance of £4,843 on the revenue account has been carried forward. The general improvement in business has made itself felt in Atlantic telegraphy, while the outlay for repairs during the past half-year has been small—namely, £529, which has been debited to the reserve fund as heretofore. After crediting this account with interest, realised profit, and the amount set aside from revenue account, and charging it with £3,000 written off the Ballinskelligs buildings account, the balance amounts to £327,801.

BURNLEY TRAMWAYS COMPANY.

The half-yearly meeting of this Company was held on Saturday last.

Alderman Greenwood, who moved the adoption of the report, said 925 786 passengers had been carried, the receipts amounting to £8,035. There had been an increased expenditure of £414, but there was a balance equal to £2 242.

A dividend of 5 per cent. was declared, and Alderman Greenwood was re-elected director.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Visé (Belgium).—The authorities (l'administration communale) of the town of Visé desire propositions from companies and others for town electric lighting. The proposal is an open one, both as to method and date, and offers or enquiries should be made to the Collège echevinal, Visé.

Hanover.—Tenders are wanted by the Prussian State Railways for 32,600 telegraph insulators, with and without screwed attachments; 260 tons of wire (not line wire), 2¼ tons of insulated wire, and 1¼ ton of wire rope. Particulars for one mark from the Railway Authorities (Königliche Eisenbahn Direktion), Hanover, Joachimstrasse 7.

Hull.—The Corporation invite tenders for a lease of the tramways authorised to be constructed by the Tramways Orders Confirmation (No. 1) Act, 1896. Tenders to be delivered by February 1, endorsed "Tramway Tender," at the office of Mr. R. Hill Dawe, town clerk, Town Hall, Hull, from whom all particulars and conditions of tender may be obtained.

Hastings.—The Corporation require tenders for alterations and additions to an engine and boiler house in Waterworks-road. Drawings may be seen and forms of tender and specifications obtained at the office of Mr. Philip H. Palmer, A.M.I.C.E., borough engineer, Town Hall, Hastings, between 10 a.m. and 5 p.m. Tenders, under cover, endorsed "Tenders for Electric Lighting Engine-House," must be delivered at the office of Mr. Ben. F. Meadows, town clerk, Town Hall, Hastings, by 12 noon on February 3.

Harrogate.—Tenders are invited for wiring the Queen Hotel, Harrogate, and for electrical fittings for same. Specifications and forms of tender can be obtained from the Electrical Engineer, 12, Dragon-view, Harrogate, on deposit of £2. 2s., which deposit will be returned on receipt of a bona fide tender. The hotel can be inspected on application to the manager. Tenders, sealed, and marked "Tender for Electric Lighting," must be addressed to Mr. Geo. Wilkinson, M.I.E.E., consulting engineer, and delivered by February 3.

Edinburgh.—Tenders are required for the complete wiring of the Royal Infirmary. Specifications and drawings can be inspected at the office of Mr. William S. Caw, treasurer and clerk, or at that of the consulting engineer to the infirmary, Prof. Kennedy, 17, Victoria-street, Westminster, S.W. Firms desirous of tendering can have copies of the specification and drawings on making a deposit of £5. 5s., which will be returned on receipt of a proper tender. Tenders must be received by the Clerk, in sealed envelopes, marked "Tenders for Electric Lighting," by 10 a.m. on 28th inst.

London, N.W.—The Vestry of St. Pancras invite tenders for supplying and laying earthenware conduits, lead-covered armoured cables, and bare copper strip conductors in culverts. Copies of specification, conditions of contract, quantities, and form of tender in duplicate to be obtained upon application to the Electricity Department Offices, 57, Pratt street, N.W., on payment of a deposit of £1, which will be returnable on receipt of a bona fide tender and specification. Tenders to be sent to Mr. C. H. F. Barrett, vestry clerk, Vestry Hall, Pancras-road, London, N.W., endorsed "Tender for Earthenware Conduits, Lead-Covered Armoured Cables, etc.," by 12 noon on 26th inst.

Wallasey.—The Urban District Council are prepared to receive tenders for the supply and erection of a 200-kilowatt alternator, with engine combined, and for the requisite switchboard extensions. Copies of the specification may be obtained on application to the engineer, Mr. J. H. Crowther, at his office at the Great Float, near Birkenhead, on payment of the sum of £2. 2s., which be returned on receipt of a bona fide tender. Sealed tenders, on the form provided for the purpose, addressed to the Chairman of the Gas and Water Committee, and endorsed "Tender for Steam Alternator, etc.," to be delivered to Mr. W. Danger, clerk to the Council, Public Offices, Egremont, Cheshire, not later than 4 o'clock in the afternoon of Thursday, February 18, 1897. The contractor will be required to enter into a bond with approved sureties for the due performance of the contract.

RESULTS OF TENDERS.

Bury (Lancs.).—The Corporation have received tenders from the following firms for the wiring of the municipal offices, Bank-street and Parson's-lane:—H. H. Woods and Co., 77, Northgate, Blackburn (accepted); Marr Electric Company, Manchester; F. Saunders and Co, Holborn, W.C.; Coates Bros., Nelson; J. Downham, Bury; T. Cornall, Bury; Paterson and Cooper, Manchester; Electrical Installation Company, Manchester; E. M. Evans Manchester; S. H. Heywood, Manchester; Welch and Co., Manchester; Shaw and Co., Stockport; Birmingham Installation Company.

BUSINESS NOTES.

Carlisle.—A proposal is on foot to light the Citadel railway station with electric light.

Western and Brazilian Telegraph Company.—For the past week the receipts were £2 856.

Hyde.—The Town Council have decided not to consider the question of obtaining electric lighting powers at present.

Blackburn.—The controversy is still going on as to the advantages and disadvantages of the overhead system for the tramways.

America.—The rumours of litigation between the American Bell Telephone Company and the Western Union Telegraph have been officially denied.

Removal.—The Stewart Electrical Syndicate, Limited, inform us that they have removed to 5, New Compton-street, Charing Cross-road, London, W.C.

The Cost of Royal Commissions.—From a parliamentary return which has just been issued we learn that the Royal Commission on Communication with Lighthouses and Light-Vessels cost £2,409.

Oria Syndicate, Limited.—This syndicate, which has just been registered with a capital of £50,000 in £1 shares, to work mines for mineral and precious stones, also take power to construct electric works, etc.

Morecambe.—At the District Council meeting several property owners sent in objections to the proposed site of the electric lighting works, but the question is still under the consideration of the Board of Trade.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended January 17 amounted to £1,278, as compared with £1,172 in the corresponding week of the previous year, being an increase of £106.

Dublin.—An exhibition of cycles, tyres, and motorcars was opened on Saturday on the premises of the Royal Dublin Society at Ballsbridge. The place has been fitted up with a complete installation of the electric light.

Bristol Tramways and Carriage Company, Limited.—The traffic returns for the week ended January 15 were £1,913. 14s. 2d., compared with £1,725. 19s. 5d. for the corresponding period of last year, being an increase of £187. 14s. 9d.

Glasgow.—The third lecture of the winter course on "Electric Traction" was delivered on Monday in one of the city halls by Mr. T Crichton Fulton before a large audience. The lecturer took for his subject "The Car and its Equipment."

International Copper Corporation, Limited.—This Company, which was recently registered with a capital of £1,000,000 in £1 shares, takes power to construct and maintain electric power lighting works, telegraph and telephone systems, etc.

Ipswich.—The provisional order in connection with the Ipswich Electric Lighting Bill came before the Examiners of Private Bills on Monday, and was ordered to be reported to the House of Commons as having complied with the Standing Orders.

St. James's and Pall Mall Electric Light Company.—The directors recommend a dividend for the half-year ended December 31, of 8s. per share on the ordinary shares, making, with the interim dividend, 10½ per cent. for the year 1896.

British Motor Syndicate.—The *Financial Times* state with regard to the British Motor Syndicate that organised action is being taken with the object of securing a return of money subscribed, and that proceedings have already been commenced.

Bradford.—At the meeting of the Scientific Association, at the Church Institute, Mr. Alfred H. Gibbings, A.I.E.E., the borough electrical engineer, gave an interesting lecture on "The Fundamental Principles of Electrical Apparatus" before a crowded audience.

Electric Lamps in Collieries.—For the Ocean Colliery Company, one of the largest in South Wales, 10,000 electric lamps have just been received for use in the pits. The Ferndale and other large collieries in the district are about to adopt the same kind of lights.

Berlin.—A Dalziel's telegram from Berlin says that the Government has approved of the construction of a telephone between Berlin and Brussels, but the work will not be begun until the credit is voted by the Reichstag. Berlin is already connected by telephone with Amsterdam.

Llandrindod Wells.—At the District Council meeting the provisions inserted in the order of the Llandrindod Wells Electric Light and Power Company were considered, and it was resolved to lodge objections as a matter of form, so as to secure a *locus standi* to secure certain clauses.

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City and South London Railway.—The returns for the week ended January 17 were £1,085, compared with £1,004 for the corresponding period of last year, being an increase of £81. The total receipts for the half-year 1897 were £3,273, compared with £3,041 last year, being an increase of £232.

Cresswell's Asbestos Company, Limited.—This Company has been registered, with a capital of £20,000 in £1 shares, to acquire and carry on the business of an asbestos spinner, manufacturer, and merchant, carried on at Wellington Mills, Laisterdyke, Bradford, Yorkshire, as Cresswell and Sons.

Liverpool.—A meeting of the Liverpool branch of the Self-Propelled Traffic Association was held on Tuesday, under the presidency of Mr. Alfred Holt, at which Mr. Worby Beaumont, M.I.C.E. (London), delivered an address on the subject of "Mechanical Haulage on Common Roads.

Motor-Car Components Company, Limited.—This Company has been registered, with a capital of £7, in £1 shares, to manufacture, repair, sell, and deal in motorcars, light locomotives, autocars, velocipedes, cycles, and other carriages, and all adjuncts, parts, components, and accessories of the same.

Stockingford.—The Pooley Hall Colliery Company are about to increase their existing electrical plant by putting down three large motors and a 20-unit dynamo now being made by Messrs. Easton, Anderson, and Goolden, Limited, of Erith. The electric pumping plant at this pit was supplied in 1895 by this firm.

Islington. — In connection with the electric lighting in Islington, Mr. Lambert reports that the profit on the revenue account for the last quarter amounts to £1,503. 19s. 11d. Instalments of loan and interest were paid, amounting to £682. 8s. 2d., leaving a net profit for the quarter of £818. 17s. 9d.

London Chamber of Commerce.—In view of the prospect of some amendment of the Factory and Workshops, 1878 to 1895, during the ensuing session of Parliament, members of the Chamber are invited to communicate with the secretary as to any grievances within their experience which call for legislative remedy.

Birmingham.—The Public Works Committee of the Corporation have had a conference with the promoters of the new tramways scheme to discuss the arrangements for traction and other details of the scheme. The main lines of the Bill to be promoted in Parliament have already been agreed to by the committee.

Hampstead.—By an error in copying (not our own) the name of the gentleman who signed the tender for the exciter for the Hampstead Vestry was given last week in our results instead of the tendering firm. Mr. Antill, of course, is one of the heads of department at Messrs. Siemens Bros., the firm to whom the contract goes.

Electric Power on Railways.—The Paris correspondent of the *Daily Telegraph* says a new electric locomotive of large dimensions (the "Heilmann"), calculated, it is said, to draw trains double the weight of those attached to the ordinary steam-engines at the rate of 100 kilometres, or 62 miles, an hour, has been tried with success on the Western of France line.

Practical Primary Electric Battery Syndicate, Limited.—This Company has been registered, with a capital of £8,000 in £10 shares, to manufacture, sell, and deal in primary and secondary electric batteries, electric and other lamps, electric motors, and all machinery, implements, utensils, apparatus, and appliances used in connection with the same.

Mutual Electric Trust, Limited —This Company has been registered, with a capital of £10,000 in £1 shares, to acquire certain letters patent, inventions, and rights relating to the distribution, measurement, and utilisation of electrical energy, and to carry on the business of electricians, engineers, suppliers of electricity, and electrical apparatus manufacturers. Registered office: 111, Gloucester-road, Brighton.

Clontarf.—Mr. Graham suggested at the meeting of the Commissioners that the secretary be asked to enquire what would be the cost of lighting the township by electricity. He thought that the manure works at Ballybough Bridge would give the steam power, and that the matter could be done very cheaply. The Secretary said that he would make enquiries on the subject.

Birkdale.—A public meeting has been held to consider the question of gas supply, and a resolution was passed approving of the action of the Urban District Council with reference to the question, and requesting them to use their utmost endeavours to obtain a provisional order, independent of Southport, authorising them to supply gas and electric light to Birkdale consumers

Personal.—Mr. Geo. T. Pardoe, of Littlehampton, Sussex, has been appointed electrical, etc, engineer to the Frontino and Bolivia Gold Mining Company, Limited, 184, Gresham House, Old Broad-street E C, at their mines in Colombia (New Grenada).—Mr. J. C. Lamb, C.B., C.M.G, has been appointed second secretary of the Post Office, and Mr. John Ardron has been appointed an assistant secretary.

Fire.—An outbreak of fire occurred last week upon the premises of the Crystal Palace District Electric Supply Company in Beardell-street, Norwood. The insulation of the wires in the engine-room running to the armature had become ignited, and the whole of the motor transformer was involved. Fortunately the mischief was rapidly overcome, but much damage was caused in the engine-room.

Westminster Engineering Company, Limited.—This Company has been registered, with a capital of £20,000 in £1 shares (12 500 ordinary, 7,000 preference, and 500 founders'), to carry on the business of electrical and mechanical engineers manufacturers, of and dealers in electric, galvanic, magnetic, telephonic, and other appliances, as ironmongers, electric bell manufacturers and fitters, iron merchants, etc.

Telegraph Messengers' Institute.—At the Eastern Central Postal District Telegraph Messengers' Institute last week a lecture was delivered by Mr. T. Briggs, vice-president of the institute, and assistant sub-controller of the circulation office, on "Past and Recent Arctic Exploration." The chairman, Mr. F. Bray, afterwards distributed a number of prizes to the successful candidates in the drill competitions.

Nuneaton Electric Company, Limited.—This Company has been registered, with a capital of £10,000 in £1 shares, to form centres in Nuneaton or elsewhere at which electric power may be generated, accumulated, or conveyed; to enter into contracts for the supply of electric light or force, and to manufacture, sell, and deal in lightning conductors, electrical generators or accumulators, lamps, fittings, engines, turbines, etc.

Bolton.—At the meeting of the Gas and Electricity Committee a letter was read from Mr. J. F. Elliston, managing director of the Bolton Theatre and Entertainments Company, making a proposal with regard to the supply of electricity to the Theatre Royal and Grand and Victoria Theatres. The proposal was agreed to, subject to certain alterations suggested to the engineer being made, the arrangement to be during the pleasure of the Council

Canterbury.—At the Town Council meeting Councillor Dean asked the town clerk, if the loan of £23,000 was sanctioned, whether the purchase of the site for the electric lighting works was included in that sum. The Town Clerk replied that it was an addition. Councillor Dean said that would be £23,000 for the electric light station, the cost of the site and the cost of the road. He pointed out there was no margin allowed for any extra expenses in the £23,000.

Ayr.—The Convener stated at the Town Council meeting last week that the police reports showed that the extinction of public lamps had all but completely ceased within the last three weeks. The following note of revenue and expenditure for the month of December was submitted by Mr. Pink—namely: expenditure (total working), £142. 9s. 10d.; estimated revenue—streets £41. 13s. 4d., private £337. 10s —£379. 3s. 4d.; balance for interest and sinking fund, £236. 13s. 6d.

Sheffield.—At a special meeting of the City Council approval was given to the promotion of a Bill in Parliament to extend the tramway system of the city. The system is to be extended in several directions, and the cost is estimated at £800,000. The deputation which visited the Continent to discover the best method of traction has not yet reported, but will do so in two or three weeks. It is, however, understood that the overhead electric system will be recommended.

Wardle.—The minutes of the General Purposes Committee, read at the District Council meeting, stated that a letter had been received from the Bury, Rochdale, and Oldham Tramway Company, asking the Council to receive a deputation from the company in reference to an application they proposed to make to use electrical traction on the Littleborough section of their lines. It was resolved that a meeting of the General Purposes Committee be held on January 21 for the purpose of meeting the deputation. This minute was approved.

Swansea.—The Corporation have passed the statutory resolution necessary for proceeding in Parliament for powers to municipalise the tramways, etc., otherwise known as the "triple scheme." Mr. George Hopkins has, at the request of the Corporation, visited Swansea for the purpose of reporting on the agreement entered into between the Council and the tramway company. As the result of an exhaustive investigation, he has arrived at the conclusion that the Council has for the burgesses made an excellent bargain with the tramway company.

Worcester.—A letter was read at the Watch Committee meeting from the city electrical engineer (Mr. Ruthven Murray) with reference to the complaints made of the electric lamps. He pointed out that there were now 54 lamps in use, as against 27 last year, and although more were reported, the percentage was not so large. The lamps were seldom out for any length of time. The engineer stated that he had had a watchman whose sole duty it was to inspect the lamps found to be faulty. He had been engaged up till midnight, but he proposed now that another should be engaged until the lamps were extinguished.

Ashton.—At the Town Council meeting the Electric Lighting Committee reported that Mr. Clirehugh had presented a plan showing suggested sites for about 66 arc lamps The plan was fully considered, and the number of sites was increased to 70. The plan was adopted. Mr. Clirehugh also presented designs of pillars for arc lamps, and one was adopted. Councillor Kelsall, in moving the minutes, said that the committee, after careful consideration, had decided that 70 lamps for the illumination of the town would be as many as their finances would justify at present. Councillor Cooke seconded the motion, and it was passed.

Employes' Annual Dinner.—The employés of Messrs. Rosling and Appleby, Trafalgar Works, Bradford, held their fifth annual dinner recently. After the dinner a smoking concert was held. Mr. Joseph Overend, the works manager, took the chair, and after the usual toasts were drunk, the evening was enlivened with humorous and sentimental songs by the following gentlemen: Messrs. Milnes and Lofthouse, accompanists; and Messrs. Moody, Hughes, Atkinson, Busfield, Cork, Brown, Lord, and Barry. The success of the arrangements was due to the stewards, Mr. J. Wraith and Mr. Wm. Wainwright.

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Ealing.—At the District Council meeting Mr. Kasner called attention to the inadequate lighting of Drayton Green-road, which, he said, was used by an enormous number of people going to Castle-hill Station. The electric mains ran up the road, and he thought it should be lit by arc lamps. The Surveyor said he had recently made a survey of the road at night, and he agreed that the lighting was not adequate to the traffic. The matter was referred to the Works and Electric Lighting Committee.

Cardiff.—At the meeting of the Board of Guardians it was agreed, on the recommendation of the Building Committee, to call in an expert to advise as to the feasibility and cost of lighting the workhouse with electric light, produced by means of surplus steam power on the premises. An important report of the electrical engineer (Mr. Applebee) will be submitted to the Corporation immediately. A large amount of extra plant is being laid at the electric lighting station, and this, Mr. Applebee states, will not be sufficient—when it is ready in 12 months' time—if the demand goes on at anything like the present rate.

Stirling.—Prof. Kennedy's report on the electric lighting was submitted to the meeting of the Police Commissioners. It recommended the adoption of the continuous-current three-wire system with 200-volt lamps, the estimated cost being £16,000 for the compulsory area, and £20,000 for an extended area, including the residential part of the town. The Lighting Committee recommended the adoption of the report, and a remit to the committee to carry out the work to the whole extent therein indicated. Provost Kinross suggested that the matter should be postponed for a week for fuller consideration of the report, and this was agreed to.

Appointment Vacant.—The Commissioners of Public Baths and Wash-houses, parish of St. Paul, Deptford, invite applications for the appointment of engineer to take charge of the engines, boilers, pumps, and all other machinery connected with the public baths and wash-houses. The person appointed must be able to execute general repairs to the machinery, and must have a thorough knowledge of electric lighting. Age not to be less than 25 years and not to exceed 45 years. The remuneration will be £2. 10s. per week, rising to £3 per week. Applications should be sent to Mr. Arthur Huntley. clerk, Vestry Offices, 20, Tanners-hill, Deptford, by 12 noon on 25th inst.

Cleethorpes.—The District Council have consented to the Great Grimsby Street Tramways Company extending their lines in Cleethorpes, subject to certain conditions, which include the alteration of the gradient of Isaacs-hill, the full width, including the footpaths, and the lowering of the fence on the west side, entirely at the cost of the company; the construction of a double line throughout; the full width of the road at certain points to be pitched with granite setts from channel to channel; and also that, providing the overhead system of electrical motive power be used, the approval of the District Council shall be obtained as to the kind of standards to be erected, but in no case shall wood standards be allowed.

Calcutta.—At a recent meeting of the Municipality, Mr. Apcar's amendment postponing the decision on the electric tramways question was carried with practically no opposition. He considered that it is inadvisable to sanction electric tramway service in Calcutta before the Corporation are furnished with information on the following points: (1) cost of electricity to run 1,878,529 car miles (being the distance run by the present tramway company for the year 1895); (2) cost of maintenance of cars, lighting, water, rent, and taxes; (3) depreciation of electric plant (including that on cars); (4) maintenance and renewal of line; (5) repairs to buildings, machinery, and plant; (6) traffic expenses; (7) office establishment; and (8) income tax.

Portsmouth.—Alderman Ellis stated at the Town Council meeting that the sinking fund in connection with the electric lighting accounts for the 12 months was £4 545. and deducting this from the gross profit, £3,690. 6s. 3d. would be left at the disposal of the Council on March 31 next. The works were started two and a half years ago, and before another couple of years elapsed they would want more boiler room. The committee had been able to secure two houses next the electric light station for £700. Other sums of £5,000 for accumulators and three motor generators, £3,000 for two additional feeder mains, to give double mains in Portsea, Landport, and Southsea, were required, together with further amounts of £300 and £800 for other items, bringing the total up to £10,000.

Commercial Cable Company of New York.—This Company, which has a paid-up share capital of 10,000,000dol., announces an issue of £400,000 sterling 4 per cent. 500-year debenture stock, being part of an issue of 20,000,000dol., or the sterling equivalent £4,120,000, represented by bonds or debenture stock ranking *pari pa su* and secured by a mortgage in favour of the Farmers' Loan and Trust Company of New York as trustee. Baring Bros. and Co., Limited, are prepared to receive applications for £400,000 of this debenture stock at 94 per cent. The stock will carry the quarterly interest due April 1 next, and the failure to pay any instalment when due renders all previous payments liable to forfeiture. It is stated by the president (Mr. Mackay) that for 1895 the net earnings were 1,833,260dol.

"Blot" Electric Accumulator, Limited.—This Company has been registered, with a capital of £160,000 in £1 shares, to acquire the benefit of certain existing inventions and also the factory and other premises at Boves and Paris, and the business of an electrical engineer and manufacturer there carried on by G. R. Blot, and to develop, deal with, work, and turn to account the same in such manner as the Company shall see fit; and further to carry on in all or any of their respective branches the businesses of electricians, mechanical and chemical engineers; to produce, store, accumulate, and supply electricity and electric motive power; to light cities, towns, docks, markets, theatres, buildings, etc.; to construct. lay down, establish, fix, and carry out all necessary cables, wires, lines, accumulators, and works.

Stafford.—The Congregational church is going to be lighted with electricity. The Corporation have made a short extension of the cable in Eastgate-street to supply Messrs. Cooke and Co.'s factory with current to work a new motor to drive their machinery. The firm were the pioneers of the movement in the town. The accounts in the electricity department for the past quarter are very satisfactory. The rental was 11,778 units at 8d, which is equal to £360. 14s. 3d., and 6,182 units at 4d. which is equal to £103. 0s. 8d. The meter rents and fittings bring up the receipts to £565. 17s. The total for current and meter rents was £478. 2s 5d., as compared with £221. 17s. 3d. in the corresponding quarter of last year, and this sum would have been considerably larger but for the recent reduction in the price charged for the current.

Dundee.—At a meeting of the Gas Committee of the Town Council Mr. Tittensor. the electrical engineer, reported that the directors of the North British Railway had decided to light the Tay Bridge Station and offices by electricity. The meeting remitted the matter to a sub-committee to take into consideration the question and report. Some time ago the question of electric lighting area of the city was discussed and several suggestions made. The matter has again been before the Gas Committee, when new plans showing the proposed extensions were submitted. The area now proposed is somewhat larger than at first suggested. A total of 60 lamps are set down in the plan, and these, it was reported, would replace 248 gas jets. After consideration of the matter, the meeting delayed taking any decided action at present.

North Uist.—At a meeting of the North Uist District Committee of the Inverness County Council, the extension of the inland telegraph f om Locheport to Bayhead and Tigharry was considered, and a request from the Postal Telegraph Department for a seven-year guarantee of £48 per annum for the extension to Tigharry, or £61 per annum for the combined extension to Bayhead and Tigharry, was refused. The committee were unanimously of opinion that a guarantee could not reasonably be given in view of the already heavy taxation in the district and the agricultural depression prevalent, the population being largely agricultural. It was agreed to press the claims of the district to a free extension of the telegraph upon the attention of her Majesty's Government.

Brush Electrical Engineering Company, Limited.—We are informed of the following changes in the management of the Brush Electrical Engineering Company: "Mr. J. S. Raworth, whose time is now almost entirely devoted to the development of the Universal steam-engine, has resigned his position as joint manager and chief engineer, and has been appointed consulting engineer and elected a director of the Company. Mr. W. M. Mordey, who for many years has been chief electrician, will in future act as consulting electrician to the Company, and will be free to undertake other work; the Company, however, retaining his advice and assistance with regard to the articles of his design and invention which it manufactures. Mr. Percy Sellon, lately joint manager with Mr. J. S. Raworth, has been appointed general manager of the Company, and Mr. C. E. Hodgkin works manager at the Loughborough works."

Leeds.—The Leeds Corporation Improvement Bill, which includes powers for the extension of the tramways, has passed the Standing Orders stage without opposition. It has also met with the approval of the property owners and ratepayers of the city. At a meeting of the Highways Committee, the decision of the Tramways Committee to request the Council to permit the relaying of the lines on the Headingley, Chapeltown, and Hunslet sections in such a manner as shall be suitable for an electrical system of haulage was confirmed. The committee also agreed to the recommendation to order 3,000 tons of rails. It is said that the order for these rails is to be offered to the Leeds Steelworks, who received the contract to supply the rails required on the Roundhay and Kirkstall sections. In the event of the terms stipulated by the committee not being accepted by the steelworks company the work will be advertised and tenders invited.

Dewsbury.—At the meeting of the Board of Guardians attention was called by the workhouse master to the necessity which exists for something being done to the electric battery, owing to its incapacity to serve light throughout the night. Mr. Joseph Brown said it seemed that owing to more work having been put upon the battery than it was designed to do, it was practically collapsing. Unless something was done to it at once, their engine would have to be run day and night in order to supply the light. He was of opinion that the battery would have to be enlarged, and suggested that power be given to a committee to deal with the matter without waiting for the formal action of the Board. He observed that the battery had had put upon it one-third more work than was contemplated being done by it, and moved that the committee have full power to take such action in repairing or replacing it as they may deem fit. Mr. Hepworth seconded, and the motion was carried.

Hove.—A circular letter was read at the Urban District Council meeting from the Hove Electric Lighting Company, Limited, intimating that on and after the 1st inst. an important reduction would be made in the charge for current by reducing the time per day for the charge at 8d. per unit to one hour in lieu of two hours as at present. The effect of the new arrangement would be that after the consumer had used sufficient electrical energy to supply the maximum number of lights switched on at any one time for

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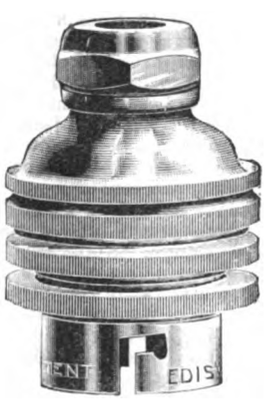
one hour per day, all energy consumed by him subsequently would be at the rate of 4d. per unit. The charge on and after the above date for electrical energy for motive power would be at the rate of 3d. per Board of Trade unit. It was resolved to call the attention of the company to the way in which the pavements were left unfinished after they had been opened for the construction of culverts, and the surveyor was instructed to insist that the pavement be relaid complete within a reasonable time after the works were commenced.

Crompton and Co., Limited.—Messrs. Crompton and Co., Limited, give notice that, having disposed of the lease of their premises at 1, Lillie-road, London, they are transferring the manufacture of electrical cooking and heating apparatus heretofore carried on there to their new works at Chelmsford, and they have decided to cease taking orders for wiring houses in the London district. Accordingly they have disposed of the house-wiring business to Messrs. Warburg, Dymond, and Co., who have engaged to complete the orders now in hand to the satisfaction of the customers of the Company, and will in future act entirely on their own account as wiring contractors. Messrs. Warburg, Dymond, and Co. will for a short time have their offices at the above address, 1, Lillie-road, London, S.W. Messrs. Crompton and Co. draw attention to the fact that while the office and showroom for general enquiries and orders for cooking and heating apparatus remains as heretofore at 35, Queen Victoria street, London, goods or communications relating solely to the manufacture should be sent, after March 15 next, to the new Arc Works, Chelmsford.

Victorian Era Exhibition—The official programme of this exhibition has now been issued by the directors of the London Exhibitions, Limited, from the Exhibition Buildings, Earl's Court. Particular attention will be devoted on the scientific side to the many discoveries of these 60 years, and their developments and application to purposes of general public utility. In order to make the commercial and industrial section at once national, representative, and of the highest interest, free space will be granted (under certain conditions) to approved exhibits of purely British industries showing the present condition of manufacture contrasted with that prevailing at the beginning of the reign, or at the time when the particular industry was first opened up. The directors do not propose to admit to the exhibition any industrial exhibits other than those emanating from within the United Kingdom. The Duke of Cambridge, as president of the honorary committee of advice, is supported by the Marquis of Lorne, the Lord Mayor, and Sir Edward Poynter, P.R.A., as vice-presidents, with a long list of men eminent in various professions as members of the committee.

Waterproof Holder.—The Ediswan Company have brought out an improved waterproof holder. This holder is designed for outside use, for mines, collieries, etc., and for all damp places, and the accompanying illustration represents the 1897 pattern. The top part is now cast in one piece, which does away with a slight objection to the old pattern—namely, that there was a possibility of water making its way through the thread. This, of course, is now quite impossible, and to further secure that it shall be absolutely waterproof a rubber washer is clamped against the flexible cord by means of a screw-nut.



Grimsby.—An adjourned meeting of the Town Council has been held to consider the alterations which the tramway company are proposing to make in their system. The Corporation at a previous meeting objected to the overhead mode of electric traction which the company wished to adopt, and they also wanted the line to be extended from Hainton-street to the Wheat Sheaf, but this the company did not wish to do. It was now decided to formally affix the seal of the borough to the notice of objection. The Chairman said that since the last meeting another question had cropped up. According to the terms of the Act the Corporation would have power to compulsorily take over the tramways in about five years' time, and if these improvements were carried out, they as a Corporation, if they bought the tramways would have to purchase all the machinery and pay for all expenditure that would be involved in any improvement. The deputy town clerk (Dr. Grange) read the clause in the lease referring to this matter, and the Town Clerk recommended that as the Corporation did not wish to be involved in any such expenditure they should mention this clause as an additional objection. This course was unanimously agreed to.

Hanley.—The Electric Lighting Committee recommended at the Town Council meeting that application be made to the Local Government Board for sanction to borrow £15,000, required on account of extensions to the electricity works, repayable within 25 years. Alderman Hammersley, in moving that the recommendation be confirmed, gave statistics to show the advantages conferred upon the town by the adoption of electric lighting. The committee wished to be empowered to raise during the next two years £15,000 as it was found necessary to expend it. In the first year of their working they asked the Local Government Board to sanction the borrowing of about £24,000. That was found not to be sufficient, and they asked for a further sum which made up a total of £46,110. Out of this the committee had expended on capital account £42,145. With regard to the increase of engine power and the extension of the system, he said that in 1895 they sold 180,469 units at 6d. per unit, while last year they sold 247 881 units at 5d. per unit. The revenue last year from electricity supply was £4,192, and the receipts from meter rents were £106, being half as much again as in 1895. Mr. H. Coates seconded the motion, which was agreed to.

Coventry.—Last week about 100 shareholders in the Motor-Car Syndicate inspected the works at Coventry, as well as the Daimler works, and those of the Humber and New Beeston Cycle Companies. In the evening a general meeting was held. Mr. N. L. Lawson presided, and spoke of the satisfactory progress that had already been made. The fact, he said, that the directors were holding on to their scrip was a great element of strength. Already many people had felt compelled to apply for their licenses. Mr. T. Lawson and Mr. Van Praagh also spoke hopefully of the company's prospects, and a resolution was passed expressing gratification at the progress shown, and confidence in the directors, and the future success of the syndicate. The annual report of this company shows that in the first year of working of the electric trams, in the year ended December 3 last, the results were very satisfactory. In the period the cars ran 215,416 miles, and carried 1,196,939 passengers. The profit of the year has been £2,584. 3s. In addition to paying dividends on the preference shares of £885, there is an 8 per cent. dividend on the ordinary, absorbing £786. 13s. 4d., and leaving a balance of £912. 9s. 8d. to be carried forward. The capital of the company amounts to £25 000, and there is £25,000 in debentures. The assets of the company on December 3 amounted to £42,396. 14s. 10d.

Fulham—At a meeting of the Electric Lighting and Dust Destructor Committee of the Vestry considerable time was occupied in dealing with a letter received from Mr. Medhurst, the electrical expert, on the question of payment to him, in which he said that "unless my scheme is adopted by the Vestry, in that case I should expect to be retained as consulting engineer." Mr. Medhurst subsequently attended, and, in answer to the Chairman, said if the Vestry decided to adopt his scheme, he should expect to be engaged; it was only right if his ideas were being worked out. Mr. Stuart-Barker took it that until such time as the Vestry adopted his scheme or a modification of it he had no charge against them. Mr. Medhurst replied that he agreed with that exactly. Mr. Stuart-Barker remarked that it was the Hackney case which caused them to ask the question. Mr. Medhurst: They have passed a resolution, and you have not. In answer to other questions, Mr. Medhurst said he did not consider the Vestry bound to him until they had specifically engaged him. A report was submitted of a deputation of 10 members who inspected the dust destructor at Leyton, accompanied by the medical officer and the surveyor. They recommended that the deputation should be empowered to inspect other dust destructors in operation, and that some of the Vestry's dust should be sent for destruction whilst they were present. The report was agreed to.

Southampton.—At the Town Council meeting, the following resolution, passed on December 9, was confirmed: "A Bill to authorise the acquisition by the Corporation, by agreement or arbitration, of the undertaking of the Southampton Street Tramways Company; transference of powers of said company to Corporation; winding-up and dissolution of the said company; power to borrow; power to Corporation to work tramways and to use thereon mechanical power, including electricity, steam, cables, and other power; and to provide apparatus, engines, buildings, etc., therefor; power to make agreements; amendment and repeal of Acts; and that the costs and expenses of promoting the said Bills respectively be charged on the borough fund, borough rate, district fund, general district rate, or some or one of them, or out of moneys borrowed under the powers of the Acts respectively, and shall be debited to such accounts and in such proportions as the Corporation shall think equitable." It was understood that there would be a full discussion of the matter before a committee of the whole Council. The Estates Committee reported that the sub-committee considered designs for the various departments of the Municipal Offices and Guildhall, and resolved that the design submitted by Mr. Ford-Lloyd for outside lamp at the Bargate Police Station be accepted at 50s. The deputy-chairman went to London with the resident electrical engineer and inspected fittings, and was of opinion that the selections made would be of a satisfactory character. The report was adopted.

Catalogues.—We have received from the Electrical Power Storage Company, Limited, their revised list of prices, which comes in the form of a well-bound thumb-indexed catalogue. We notice that they have added new "Faure-King" type cells in glass and in lead-lined wood boxes, and also the "Faure-King" central-station cells. With regard to this latter, they now list a cell which has a capacity of over 5,200 ampere-hours at a discharge of 730 amperes, and the size of this cell is 4ft. 8in. by 1ft. 6in. by about 16in. high. Their largest cells in glass boxes have now a capacity of nearly 1,400 ampere-hours when discharged in nine hours. They also lay special stress on the fact that their customers can now exchange to the "Faure-King" type, which will enable them (by using the same number of plates, which will in all cases go into the boxes of the older type) to approximately double the capacity and double the discharge rate of the cells without altering the space occupied by the battery, and this in existing installations is often of considerable advantage. The catalogue contains many other items of interest, and is a very useful production.—The Electrical Company, Limited, send us a pamphlet descriptive of their "Luna" arc lamp, with instructions as to its installation and regulation. These lamps are made both

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for direct and alternating current, and are self-focussing. Ample illustrations and diagrams are given.—Messrs. J. H. Heathman and Co. send us a price list of their fire-protection goods, which are really too numerous to mention; everything seems to be obtainable from this firm.

Bootle.—The report of the town clerk and borough engineer upon the Liverpool Corporation Tramways Bill, the Liverpool, Bootle and Litherland Tramways Order, and the Mersey Docks and Harbour Board Bill, was submitted at the Town Council meeting. The committee recommended: 'That no objection be offered to the principle of the Liverpool Corporation working the tramways in Bootle as part of the entire local system in lieu of the existing company, providing satisfactory terms be first agreed between the Council and the Corporation of Liverpool which shall not be less beneficial to this borough than the terms of the existing leases to the company, and shall include (*inter alia*) a provision that the supply of electric energy for working the Bootle tramways shall be taken from this Corporation. That no opposition be offered to the Liverpool, Bootle, and Litherland Tramways Order on its merits, provided satisfactory terms be come to with the tramways company, including (*inter alia*): (*a*) the previous consent of the Corporation to the use of electrical traction on conditions approved by the Council; (*b*) the supply of electrical energy by the Corporation; (*c*) protective clauses as to breaking up of streets, removal of rails, erection of posts and wires; (*d*) the renewal of the company's lease; and (*e*) generally such other clauses as the interests of the borough require." A special meeting of the Council is to be held to consider this business.

Battersea.—The Electric Lighting Committee of the Vestry reported at the last meeting that steps had been taken to secure land for an electric lighting station. It had been agreed to purchase Grove Wharf and Canada Wharf, and land and premises belonging to Messrs. Andoire in the Lombard-road. The area of the land was altogether 47,836ft. super. Mr. Costigan said the committee and the Vestry had gone so far in this matter that it was useless to ask them to retrace their steps. He desired, however, to enter as strong a protest as possible against an expenditure of over £13,000 for land in the Lombard-road. He did not believe that land was suitable. If the electric light was brought into use in the parish at all, nearly all the demands would come from No. 4 ward, and it was near to Lavender-hill that the central electric light station should be situated. Mr. Higgs also protested against such a large expenditure of public money when no definite scheme for electric lighting had been produced. If it were not too late, he would implore the Vestry not to lay fresh burdens upon the poor ratepayers. Mr. Bradford said the financial condition of the parish did not warrant that expenditure. Mr. Chandler prophesied that an electric lighting station built in the position proposed would one day slip into the river. Mr. Gaskell urged that Battersea would be better and more cheaply supplied by private enterprise. Mr. Lathey protested against the expenditure Mr Verdon defended the Electric Lighting Committee, who, he said, had been guided by the opinions of experts.

Dover.—At the meeting of the Town Council the Town Clerk read the following extract from a letter from Mr. Sellon: "Would you be good enough to obtain the assent of the committee to allow me to ask Mr. Blackwell, of 39, Victoria street, Westminster, to tender immediately for bonds and fixing the same. It is of the utmost importance that this work should be done by the most competent men. Mr. Blackwell has bonded most of the newer electric tramways in this country, and he is the sole agent for Chicago bonds, therefore whoever did the work would have in the first place to approach him. Bad bonding results in being unable to comply with the Board of Trade regulations as to leakage, probable electrolytic action to gas and water mains, and interference to telephones, and perhaps trouble with the supply company. I should be glad to hear from you at the earliest moment as regards Mr. Blackwell, so that no time may be lost to enable him to follow up the contractors for the permanent way, as the bonding has to be done before paving commences. I suggest that a sum of £900 be mentioned as extra provision in the permanent-way contract, and your borough engineer and myself have drafted out a clause which I think should meet the case." The Tramway Committee recommended that Mr. Blackwell be employed to electrically bond the rails, and that a clause be added to the contracts providing for the additional payment of £900 for the work. Councillor Fry strongly supported the advice of the Tramway Committee. Unless the bonding was perfect there would be endless trouble. He moved that it should be carried. Councillor Ayers seconded, and the motion was carried.

Whitehaven.—At the meeting of the Town Council Alderman Hastwell, in moving the confirmation of the minutes of the Water and Lighting Committee, said the relaying of the public lighting cables had now been entirely completed, both for town and harbour; and during the last month there had not been a single fault reported, so that they were now in a considerably better position than they were before. He was satisfied that it had been the intention of the contractors, Messrs. Siemens, to give every satisfaction in their power; and was ably represented there during the last few weeks by Mr. Newall, who had been superintending the work, and who seemed most anxious to meet the wishes of the committee. Councillor Barr seconded the confirmation of the minutes. Councillor Cant suggested that an interview might be arranged with the Harbour Commissioners to try to come to some agreement as to the terms for lighting the harbour, and put a stop to the absurd waste resulting from lighting the harbour lights during daylight. Alderman Hastwell said the committee had a scheme to submit to the Harbour Commissioners in the course of a day or two, after which they hoped to have an interview, so that the matter might be settled to the satisfaction of both parties. Alderman Moore asked if anything had been done with a view to lighting Kells streets. It was now two years since Kells was included in the district, and it was still in darkness at nights. Alderman Hastwell said the matter had not yet been dealt with, but he would undertake that it would be considered by the committee before they submitted their estimates for the year. The minutes were confirmed.

Wakefield.—At the City Council meeting Councillor Nicholson moved, and Councillor Wigham seconded, the adoption of the minutes of the four meetings of the Electric Lighting Committee, which asked the Council to affix the common seal to the supplemental contract with the British Insulated Wire Company, Limited, to pay the said company £835. 1s. 4d. on account of laying electric cables; to decide that the central sub station should be situated at the top of Westgate, and that a high-tension cable be laid from the top of Westgate to the Ings-road Board School, at an estimated cost of £325, the route being left to Mr. Hammond and the chairman of the committee to decide upon. Alderman Nicholson, who asked where the central sub-station at the top of Westgate would be placed, and alluded to the estimated cost of the high-tension cable, said it seemed to him to be a very large sum, seeing that the Ings road School would consume very little electricity. Councillor Nicholson replied that he could not say where it had been decided to establish the central sub-station. As to the consumption of electricity at the school, he thought it would be considerable, as they had evening classes. The Town Clerk, at the instigation of the Mayor, remarked that the station alluded to had originally to be placed in the cellar of a building in King-street. When the work was begun it was suggested that the station should be at the top of Westgate, by which a saving of cable would be effected. The cellar of the old corn exchange was thought to be a suitable position, but upon further consideration it was deemed advisable to have the station beneath the large lamp in the centre of the street facing the Yorkshire Penny Bank's offices. The minutes were passed.

Institution of Junior Engineers.—As already announced, "Dynamo Design Construction, and Working up to Date," will be dealt with in the second special course of lectures arranged by the institution. To deliver them, the council have secured the services of Mr. F. A. Nixon, of the Westminster Electric Supply Corporation, and previously with the Brush Electrical Engineering Company. They are being prepared with a special view to the every-day requirements of those engaged in practical work in drawing office, workshop, and electric installation. The dates of delivery are Tuesdays, February 2 and 16; March 2, 16, and 30; and April 13, from 8 to 9.30 p m., at the Westminster Palace Hotel. The following is the syllabus: (1) General principles, electromagnetic and electric, underlying the action of a dynamo. Parts of machine. Electric, magnetic, and mechanical actions and reactions in armature and field magnet. Eddy currents, hysteresis, etc. Objects to be attained in successful design. (2) The magnetic circuit. Magnetic properties of iron and steel. Calculations of resistance and magnetomotive force. Armature winding and connections. (3) Different kinds of machines—continuous and alternating. Calculations for the design of a continuous-current bipolar machine. Limitations observed in first-class design. Application of methods to multipolar machines. (4) Construction of parts of machine—field magnets, armatures, commutators, brush-holder, brushes, etc. (5) Difficulties in the running of dynamos and means of overcoming them. Devices for reducing sparking. Methods of adapting machines to fulfil special conditions of supply. (6) Practical charge of machines for central-station work. Various systems of coupling machines together, and of arranging a network for general supply.

Bingley.—The District Council at their last meeting had under consideration the question of supplying electricity in Bingley by utilising the wash water at the Five Rise Locks of the Leeds and Liverpool Canal, and Mr. Gatecliff (the chairman of the Gas Committee) made a statement that the committee had been in communication with the directors of the canal company respecting the supply of electricity in Bingley. Several suggestions had been made by the committee, but not accepted by the directors, and a meeting had since been held and the matter fully discussed. The canal company would supply electricity at a meter in the town at 4d. per unit, the Council to bear the cost of distributing it. The Gas Committee asked the canal directors to undertake the cost of both generating and distributing the electricity, but the parliamentary powers would not permit distribution, even if they were willing to do so. The directors suggested that the Council should also take a minimum of 60,000 units, and if the offer was not accepted then the canal company would proceed with the works and make use of the electricity in some other way. The committee had fully considered the matter, and had decided that they should have the opinion of some able expert upon the matter. They had that evening had an interview with Mr. Gibbons, who would give an estimate of the cost of making and generating their own electricity, but he could not undertake the charge of any works. The committee now asked for the sanction of the Council to employ Mr. Gibbons to prepare an estimate of the cost. It was the intention of the Council to have it under their own control rather than have dual ownerships. On the motion of Mr. Gatecliffe, seconded by Mr. Sharp, the Council gave their sanction for the committee to engage an expert.

Cromer.—At the Urban District Council meeting Mr. Broadhurst had given notice that he would call attention to the subject of electric lighting, and ask the Council to decide definitely whether it would or would not apply for a provisional order. He

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desired that it should be clearly understood, once and for all, that he did not propose that the Council should become an electric lighting body—they could do that if they pleased. His only object was that they should secure themselves against being invaded by another body. If the Council possessed this order, gentlemen who wanted to make the electric lighting of the town their business would not have to go to the Board of Trade, but would have to treat with the Council, and his opinion was that they would be able to impose conditions which would be absolutely impossible unless the Council had the order. It was for them to decide whether they were going to be the owners of the order or not. The clerk had said that the cost would be £300. He was surprised at that. The Clerk declared that that was the advice of his parliamentary agents. Mr. Broadhurst did not think that the clerk needed to have gone to parliamentary agents. He thought that the Council was capable of approaching the Board of Trade without going to parliamentary agents. The Chairman thought it was the province of the gas company to apply for this order. Mr. Broadhurst pointed out how unwise that suggestion was. The Council were now considering the advisability of purchasing the gasworks. If they did that, they would then have to purchase the provisional order as well. He moved that the Council apply. Mr. Winter seconded the motion, remarking, although he did not favour the acquisition of the gasworks, he believed that Mr. Broadhurst was now on the right track. The proposal was adopted.

Telephonic Communication. — The Postmaster-General has replied in a letter, dated the 18th inst., to the strong memorial recently addressed to him by the Liverpool Chamber of Commerce, complaining of inefficiency in the trunk telephone service between Liverpool and other large towns, and the consequent delay in communication. The Postmaster General, in the course of his communication, states that the efficient working of the trunk wires is engaging his earnest attention, and every effort is being made to ensure a satisfactory service. In 1892, he proceeds, Parliament set aside a million sterling for the purchase of the trunk lines of the National Telephone Company and the construction of new lines, and this sum was increased last year by a further £300 000 Very considerable progress has been made in the erection of new lines; and of two additional circuits from Liverpool to London, one was completed on Monday and the other is well in hand. Eight to Manchester are partly finished and partly in progress. Lines to Bolton, Cardiff, and Leeds are being erected as rapidly as possible; at the same time improvement is being studied as to communication between Liverpool and Sheffield, Birmingham, Bristol, and Blackburn. As to the extension of the three minutes allowed for conversations, the Postmaster-General cannot meet the views of the memorialists, nor can he comply with the wishes of certain firms to rent private wires between Liverpool and London, nor to introduce a system of limiting the use of a trunk wire to particular firms. The Department, however, is erecting additional telephone wires from London to the North, and an underground line to Birmingham is being constructed, to which the telegraph circuits will be gradually transferred, so as to leave the existing overground routes available for telephoning. This last work, the Postmaster adds, will be undertaken forthwith, but it will be one of great magnitude and must occupy several years.

Huddersfield.—The Huddersfield Property Owners and Ratepayers' Association have sent to the Board of Trade a statement of objections to the provisional order which the Corporation have applied for, empowering them to extend the tramways of the borough, to work the existing and additional tramways, and to borrow money to carry out the works. The association state that at the time the promotion of a Bill was sanctioned by the property owners, the mayor and town clerk gave a distinct pledge that the Corporation did not intend in the Bill to seek powers to extend the tramways or to increase their borrowing powers. No reference was made at the meeting to any intended provisional order, and although the assurances of the Mayor related in terms to the proposed Bill, they were understood and accepted by the meeting as relating generally to the course which the Corporation intended to take as regards obtaining parliamentary powers. Not till some time after the meeting of property owners and ratepayers were the Mayor and the majority of the Council made aware of the proposal to obtain a provisional order; the resolution for proceeding with a certain portion of the extension was carried by a majority of only one, and ultimately the formal resolution in favour of proceeding with the provisional order was not put to the vote, and therefore the application for the provisional order was not legally sanctioned by the Council. Two of the proposed new lines have already been laid and worked for several months without parliamentary authority. In the opinion of the objectors, the existing borrowing powers of the Corporation are already excessive, the total debt being £2,334,242. This is equal to a debt of £23 per head of the population, which is higher than that of any other municipal borough in the kingdom, with the exception of Manchester, whose unenviable position has been brought about by the City Council having lent large sums of money to the Ship Canal Company. The license of the Board of Trade to the Corporation to work the tramways has been renewed until September 16 next. This will cover the period during which the Board of Trade and Parliament will have under consideration the application of the Corporation for a provisional order empowering the Corporation to extend the tramways to borrow money for that purpose, and to work them permanently.

Walton (Surrey).—The question was considered at the Urban District Council meeting as to whether the Council should give their consent or refusal to the application by the Walton-on-Thames Electric Lighting and Power Company, Limited, for a provisional order under the Electric Lighting Acts, 1882 to 1888. Mr. Negus said he had read the draft provisional order, which incorporated the standing provisions which the Board of Trade from their experience found necessary to embody in that order. Although he thought the Council should make every effort to improve the district, he did not think from what they saw in adjoining districts that the scheme would prove financially successful. That, however, was entirely a matter for the promoters of the Bill. One paragraph stated that a sum of £500 was to be deposited as a security for the execution of the works referred to and contemplated. He did not think that sum sufficient for such purpose. If it was possible for them to amend that sum to £1,000, he thought they should take steps to do so. He took it that that Council were not prepared to undertake or promote a scheme for supplying electricity for the urban district of Walton on-Thames. Very possibly the chairman of the Lighting Committee had had his labours made easier lately from the fact that an advantegeous contract had been made with the gas company. He moved that, having regard to the wants of the district, the Council did not assent to the scheme. Mr. Summerson asked whether the Bill, as proposed, gave the company absolute monopoly of the supply? Mr. Negus: That is so, within the district. The Chairman said the company had to give the Council special terms for public lighting. Mr. Negus: Yes, but it is to be referred to arbitration if there is any dispute. Mr. Summerson said they had had some experience of monopoly, and the result had not been favourable. Mr. Negus said they could only prevent that by applying for the order themselves now. The Council could acquire the undertaking at the end of 21 years, or in the event of failure the Council itself would have the first opportunity of acquiring it, but he took it that a bankrupt concern would not be of much advantage to the Council. Mr. Miskin, speaking with regard to laying the cables, said they hardly ever got adequate compensation when the roads were taken up. After further discussion Mr. Brown seconded the resolution, which was carried. A further resolution, proposed by Mr. Summerson, seconded by Mr. Martin, that the Board of Trade be informed that the Council thought in any case the deposit should be increased to £1,000 was also carried.

Yarmouth —The Lands Committee reported at the Town Council meeting that they approved the route of the lines subject to the proviso that the Regent street and Regent-road route be authorised, in which event a clause is to be inserted in the provisional order to the effect that previous to the exercise of any powers the promoters shall obtain the express permission of the Corporation. The clauses drafted by the town clerk for the protection of the Corporation to be inserted in the provisional order were to the effect that the promoters should not open or break up any road until they had satisfied the Corporation that at least a certain proportion of the money had been subscribed (say, two thirds of their authorised capital), nor until they have deposited a sum with nominees as a guarantee for the due performance of their obligations to the Corporation of, say, £2,000; that in the event of failure to construct all the tramways authorised within the limited two years, empower the Corporation to resolve that such of the tramways as are constructed shall be treated as discontinued; that the promoters should pave with setts the whole width of certain streets, and not to break up certain roads within specified times; that the Corporation have the option to repair the roads at the expense of the promoters; that the promoters pay £10 per mile per annum towards the cost of keeping up the roadways on each side of the tramlines; tramways to be worked by electric power, and such power to be supplied by the Corporation upon terms to be arranged; such a number of cars to be run daily during the winter months as would give at least a 15 minutes' service, and such additional cars during the summer as may be required in the public interest; that Mr. W. H. Preece, C.B., be consulted at a fee of 50 guineas, provided the promoters undertake to pay such fee. Alderman Wiltshire moved that the approval of the Council be not at present given to the scheme. He urged the Council, in view of the constantly improved methods of motive power, to await experiments being made elsewhere with the view of deciding upon the best. The overhead system was accompanied by many disadvantages. Mr. F. Burton seconded, considering the route was an unwise one, that it would be dangerous and unworkable, and not in the interests of the ratepayers. Mr. A. Stanley, supporting the amendment, said that if tramways could be made to pay they should be undertaken by the Corporation, and if they could not the Council should prevent a company losing their money. Mr. N. Suffling pointed out that all improvements in the past had been opposed in the first instance. The company would pay the Corporation at least £1,600 a year for electric power, and remembering that if the scheme failed the town would not lose a penny, the Council should hesitate before placing an obstacle in the way of what he was assured would be an immense improvement. Mr. R. Martins referred to the fact that other corporations had decided upon electric tramways in the face of similar opposition. The Corporation were certain of a large profit by supplying electricity, and they were subject to no risk. The overhead system was not particularly unsightly, and had been found to be the easiest and best method. Mr. J. H. Palmer said he was surprised after the principle of tramways had been previously approved, that such a general discussion should take place. If the scheme were carried it would be a great convenience and improvement. Undoubtedly the overhead system was the best, and had been reported upon preferentially to any other at Glasgow, and people soon got used to the wires. It was reported that during the past month five customers had been secured for 139 more lamps, so that there are now 200 customers using 9,868 lamps. The month's

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receipts were £453. 13s. 4d., and the expenditure £205 0s. 6d, a balance of £248 12s. 10d. being left to meet capital and sundry charges of £150 per month.

PROVISIONAL PATENTS, 1897.

JANUARY 11.

683. **Improvements relating to electric traction on the surface contact system.** James McKenny, Thomas Edward Doyle, and Arthur Edward Porte, 116 Stephen's-green W., Dublin.

749. **Improvements in and connected with apparatus for lighting and extinguishing gas-jets by means of electricity.** William Henry Gritton and Henry Brinsley Sheridan, 11, Furnival-street, Holborn, London.

JANUARY 12.

846. **Improvements in automatic by-pass or governor for gas electrically controlled.** Leicester Bradney Stevens, Darlington Works, Southwark Bridge-road, London.

851. **Improvements in brush-holders for dynamo-electric machines.** P. R. Jackson and Co, Limited, and Joseph Slater Lewis, 322, High Holborn, London.

859. **Process for the extraction of metallic alloys and pure metals by electric heat.** Aschermann, 70, Chancery-lane, London. (Complete specification.)

877. **An improved combined electric and hydraulic screw-controlled elevator engine.** Percy Richard Julius Willis, 55, Chancery-lane, London. (John Parkinson, United States.)

902. **Automatic electric marine sounding apparatus.** James Frederick Babcock, 18, Southampton buildings, Chancery-lane, London. (Complete specification.)

907. **An improved appliance to be used as an indicator signal or relay in connection with telephone switchboards and other analogous apparatus.** Parnell Rabbidge, 111, Hatton-garden, London.

JANUARY 13

916. **Improvements in and relating to electric and incandescent gas globes and chimneys.** Jabez Jackson, Linton House, Starley road Coventry.

946. **An improved combined electric and hydraulic elevator.** Percy Richard Julius Willis, 55, Chancery-lane, London (John Parkinson, United States.)

964. **Improvements in reflectors for electric lamps and in supports for the same.** Frederick Alfred Anderson and William Gordon Waterman, 24, Southampton-buildings, Chancery-lane, London.

968. **Improved combined electric and hydraulic elevator.** Percy Richard Julius Willis, 55, Chancery-lane, London. (John Parkinson, United States.)

995. **Improvements in galvanic batteries.** Walter Scott Doe, 53, Chancery-lane, London.

996. **Improvements in and relating to accumulator plates.** Wilhelm Majert, 18, Southampton-buildings, Chancery-lane, London.

JANUARY 14.

997. **Improvements in electric cables.** Silvanus Phillips Thompson, Morland, Chislett road, West Hampstead, London.

1016. **Improved method of staying filaments in incandescent lamps.** Herbert Edmund Moul and the British Incandescent Electric Lamp Company, Limited, Dunedin House, Basinghall-avenue, London.

1026. **Improvements in apparatus for the electro-deposition of metals.** John Eborall Hartley, 12, Cherry-street, Birmingham. (Partly communicated by Frederick William Zingsem, United States.)

1038. **Process and apparatus for electro-thermally treating materials.** William Henry Graham, 377, Norwood-road, Norwood, London.

JANUARY 15.

1066. **An improved governing appliance for electrical machines, applicable also for other purposes.** James Hardie McLean, 1, Furnival-street, Holborn, London.

1087. **Improvements in pipes and conduits used for electric cable mains and in jointing the same.** Nimrod Simmons, Victoria-street, Clifton, Bristol.

1099. **Improvements in and relating to accumulators or storage batteries.** Walter Rowbotham, 27, Vittoria-street, Birmingham.

1110. **Improvements in regulating and controlling the resistance of electric currents.** Rowland Hill Barnett, Akenside-hill, Newcastle-upon-Tyne.

1143. **Depolarising material for galvanic elements.** Friedrich Mayer, 28, Southampton-buildings, Chancery-lane, London.

1150. **Improvements in portable electric railways with overhead conductors.** Arthur Koppel, 4, South-street, Finsbury, London.

1158. **An improved electric dynamo-motor.** Ernest Kilburn Scott and Anthony George New, Palace-chambers, Westminster, London. (Complete specification.)

1159. **An electrically-driven surfacing lathe.** Ernest Kilburn Scott and Anthony George New, Palace-chambers, Westminster, London.

JANUARY 16.

1203. **An improved secondary battery plate.** Henry William Hancock and Alfred Herbert Dykes, 5, Victoria-street, Westminster, London.

1204. **An improved method of preparing positive plates for secondary batteries.** Henry William Hancock and Alfred Herbert Dykes, 5, Victoria-street, Westminster, London.

1231. **Universally adjustable reflector or screen for electric glow lamps.** Paul de Kilduchevsky, 53, Chancery-lane, London.

1239. **Improvements in the means and apparatus for effecting electrical traction on railways and tramways by a contact rail and trolleys at the ground level.** Raoul Demeuse, 28, Southampton-buildings, Chancery-lane, London. (Complete specification.)

1249. **Improvements in electrical switches.** George William de Tunzelmann, 27, Martin's-lane, Cannon-street, London.

SPECIFICATIONS PUBLISHED.

1895.

25002. **Electrolytical apparatus.** Heathfield and Rawson.

1896.

842. **Manufacture of electric conductors for use as leading-in wires or strips, in the manufacture of incandescent electric lamps, vacuum tubes, and the like.** Cowper-Coles.

2581. **Telephonic apparatus.** Smith and the New Phonophore Telephone Company, Limited.

4371. **Construction of standards of electrical resistance.** Hugheon.

9402. **Electric gas-lighting devices.** Von Morstein.

17659. **Receptacle or conduit for electric and other wires or pipes containing the same.** Jones.

18892 **Switch fuses for electric circuits.** Hall and Fuller.

21559. **Dynamo-electric machines.** The British Thomson-Company, Limited. (Steinmetz.)

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	£5	9-9½
Brush Company, Ordinary	£3	⅝-1
—— Non. Cum., 6 per cent. Pref.	£2	1-1½
—— 4½ per cent. Debenture Stock	100	109-112
—— 4½ per cent. 2nd Debenture Stock	100	94-98
Central London Railway, Ordinary	10	9¾-10½
——	£4	2¾-4
Charing Cross and Strand	£5	9¾-10½
Chelsea Electricity Company	£5	8½-9
—— 4½ per cent. Debentures	100	112-115
City of London, Ordinary	10	15½-16½
—— 6 per cent. Cumulative Pref.	10	16½-17½
—— 5 per cent. Debenture Stock	100	128-132
City and South London Railway, Consolidated Ordinary	100	58 60
—— 4 per cent. Debenture Stock	100	136-138
—— 5 per cent. Pref. Shares	10	15½-16
County of London and Brush Provincial Co., Ordinary	10	8-9
—— 6 per cent. Cum. Pref.	10	13¾-14½
—— 4½ per cent. 2nd Debenture Stock	£5	9½-10¾
Crompton and Co., 7 per cent. Cum. Pref. Shares	£5	1¾-2¾
—— 5 per cent. Debentures	—	93 98
Edison and Swan United Ordinary	£3	1¾-2¾
—— 5 per cent. Debentures	£5	3-4
—— 4½ per cent. Debentures	100	105-110
Electric Construction, Limited	£2	1¾-1¾
—— 7 per cent. Cumulative Pref.	£2	2¼-3
Elmore's Copper Depositing	£2	⅝-¾
Elmore's Wire Company	£2	2-2¼
W. T. Henley's Telegraph Works, Ordinary	10	17½-18½
—— 7 per cent. Preference	10	18½-19½
—— 4½ per cent. Debentures	100	109-114
House-to-House Company, Ordinary	£5	4¼-5¾
—— 7 per cent. Preference	£5	8¾-9¼
India Rubber and Gutta Percha Works	10	20½-21½
—— 4½ per cent. Debentures	100	106-109
Kensington and Knightsbridge Ordinary	£5	9½-10½
—— 6 per cent. Pref.	£5	8-8¾
London Electric Supply	£5	1-1¼
Metropolitan Electric Supply	10	13-14
—— 4½ per cent. First Mortgage Debenture Stock	100	119-122
National Telephone, Ordinary	£5	7½-7¾
—— 6 per cent. Cum. First Pref.	10	17-19
—— 6 per cent. Cum. Second Pref.	10	17-19
—— 5 per cent. Non. Cum. Third Pref.	£5	6¾-7
—— 3½ per cent. Deb. Stock	100	105-108
Notting Hill Company	10	11-12
Oriental, Limited, £1 shares	£1	1¼-2
—— £5 Shares	£5	8½-9
—— £4½ shares	£4½	7½-8
Oriental Telephone and Electric Company	£1	11/16-13/16
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	103-105
Southampton Electric Company	£5	4¾-5¼
St. James's and Pall Mall, Ordinary	£5	13-14
—— 7 per cent. Pref.	£5	9½-10¼
Telegraph Construction and Maintenance	£12	40-45
—— 5 per cent. Bonds	100	103-106
Waterloo and City Railway, Ordinary	£6	7½-8
Westminster Electric Supply, Ordinary	£5	11-12
Yorkshire House-to-House	£5	7½-8

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NOTES.

Obituary.—The death is announced of Mr. David Kirkcaldy, the engineer.

Electro-Harmonic Society.—There is an Electro-Harmonic concert to-night. The time and place are as usual, and the programme we gave last week.

The Junior Engineers.—The first lecture of the course of six on "Dynamo Design, Construction, and Working," to be delivered by Mr. F. A. Nixon, for the Institution of Junior Engineers, is fixed for Tuesday, February 2, at 8 p.m., at the Westminster Palace Hotel.

A Scientific Jubilee.—The Paris Academy of Sciences has been celebrating the golden jubilee of Mr. Faye, who was the pupil of François Arago, and entered the institute in 1843. Mr. Faye, who is 83, is an astronomer, and has discovered, among other things, comets.

Society of Engineers.—The first ordinary meeting of the society for the year 1897 will be held on Monday, February 1, at the Royal United Service Institution, Whitehall. The president for the past year, Mr. Samuel Herbert Cox, will present the premiums awarded for papers read during the year, and the president for the present year, Mr. George Maxwell Lawford, will deliver his inaugural address.

Street-Lighting.—We understand that Rangoon is the latest town to adopt electric arc lamps placed on posts in the centre of the streets. The system is at present being tried in a street 100ft. wide, and some complaints are being made as to the obstruction caused by the posts. The cabdrivers of Rangoon evidently want such an abundance of room as would deprive the London hansom driver of his sole pleasure in life.

Belgian Society of Electricians.—We have received the *Bulletin* of the Société Belge d'Electriciens. There is a great deal about the photometric units of the Geneva Electrical Congress, which is now somewhat old matter, and also the report on telegraphic disturbances by tramway lines presented at the congress is reprinted in full. Mr. Blondel writes on wattless currents. There is a good deal of it, including some mathematics (elementary), and we have not yet had time to see what it all amounts to. There is also an illustrated description of the Siemens and Halske electric drill.

The Junior Engineers' Dinner.—Though it begins at the untimely hour of 6.30, the Junior Engineers' is by no manner of means the least enjoyable of the societies' dinners. What was said at the Westminster Palace Hotel last Saturday will be found reported at length elsewhere, but there are occasions, and after dinner is one of them, when how it is said is as important as what is said, and though one gentleman was a little bit discursive, the speaking was, as usual, really excellent. The getting there was abominable, but an English winter is at present beyond the making or marring of either Junior or Senior Engineers.

Electric Traction.—The *Canadian Engineer* congratulates the mother country on the fact that Mr. W. Rutherford, for many years chief engineer of the Canadian General Electric Company, has tranferred his services to the Scotch firm of Dick, Kerr, and Co. We are extremely glad that this firm of experts in cable tramway work are taking up electricity as a motive power, and also are pleased that so able a man has been selected to superintend the new departure. We note that our Colonial contemporary thinks that "the development of electric traction in England, while hampered up to the present by the traditional conservatism of the old land, seems now likely to proceed with great rapidity under conditions which are otherwise peculiarly favourable."

The Pender Memorial.—It has been decided that the memorial to the late Sir John Pender shall take the form of a bust of Sir John Pender, to be placed in some institution in London, and costing about £500. A sum of not less than £5,000 is placed in trust with the council of University College, London, to form an endowment fund for the maintenance of the electrical laboratory in that college, on condition that the council name it the "Pender Laboratory," and of the existing chair of electrical engineering, to be called the "Pender Chair of Electrical Engineering," and, lastly, a "Pender Scholarship and Gold Medal" in connection with electrical subjects to be established in Glasgow. The distribution and assignment of the funds available seem entirely unexceptionable.

Solution Conductivity.—The following abstract of work on the subject of the electrical conductivity of diethylammonium chloride in aqueous alcohol, by Dr. James Walker and Mr. F. J. Hambly, is taken from the *Proceedings* of the Chemical Society. It is condensed so closely that further summarisation appears difficult, and is therefore inserted here in full on the chance that it may be of interest to someone: "The authors have determined the conductivity of diethylammonium chloride dissolved in pure water, and in 10·1, 30·7, 49·2, 72·0, 90·3, and 99·0 per cent. alcohol, by volume, at dilutions ranging from 10 litres to 8,000 litres. Tables and curves have been constructed, showing the variation of the molecular conductivity and the degree of dissociation with varying dilution and varying proportions of alcohol." Whether the solution of—no; not twice—$N(CH_3)_2H_2Cl$ presents any interesting peculiarities in the way of conductivity is one of those things which, if the writer ever knew, he has unfortunately forgotten.

Society of Arts.—The programme for next week is Mr. Burton on pottery, on Monday, and Prof. Ewing on the production of cold, on Thursday. On Wednesday Mr. Horace Plunkett deals with the industrial progress of Ireland. There is an afternoon meeting on Tuesday (Sir C. Dilke). Never put off till next week what can be done this, is in its way an excellent principle, but hasty work has its drawbacks, and the writer must plead guilty to writing "roller" friction where he meant "skin" friction, in a brief note last week on Mr. Gautier's description of the Bazin boat. That gentleman returned to Paris almost immediately after his lecture at the Society of Arts, and having been duly interviewed expressed some surprise that, being a foreigner, he was so cordially received in England. (Assuredly the Bazin boat was criticised pretty keenly if the lecturer was not.) It is almost as curious that Frenchmen should fail to recognise that we English are sincerely desirous of living on good terms with them and dealing fairly by them, as it is that so large a section of our countrymen should remain blind to the fact that, do what we may, the French nation as a whole will not really wish this country well.

The Michigan Mining School.—We have received the prospectus of the above school, which is most interesting reading. This mining school was established in 1885 by an Act of the Legislature, and opened September 15, 1886. Its founders determined to restrict the school to the special requirements of mining and the subjects relating thereto; hence the course is designed to teach the student to conduct explorations in the forest and field, to distinguish the useful minerals and rocks, to understand the geological principles that govern the formation and association of useful mineral products, and to determine approximately

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their values, and the best way to work them. The school appears to be situated in the very centre of the mining interest. The students are admitted directly after their ordinary school training, but we note that practical young men who have been employed in mining up to the age of, say, 18 to 25, are considered to be the best students. A four years' course is arranged, and it is interesting to compare the cost per head with that of students attending the Central Institution. This cost at Michigan comes out to about £80 per student per annum, with a total attendance of 94. The education is entirely free, no fee being charged.

Institute of Chemistry.—The following are the names of candidates who have passed the practical examination for the associateship of the Institute of Chemistry of Great Britain and Ireland: W. H. Barlow, Finsbury Technical College; Charles Beavis, Ph.D. (Würzburg) (for fellowship); C. J. Brooks, King's College, London: E. M. Hawkins, Finsbury Technical College, London; C. J. S. Makin, Royal College of Science, London, and the Fresenius Laboratory, Wiesbaden; W. Moore, University College, London; Sigmund S. G. Rosenblum (for fellowship), University of Warsaw and Fresenius Laboratory, Wiesbaden. The following have passed the final examination for the associateship: In Branch A (Mineral Analysis)—F. Collingridge, B.Sc. (Lond.), University College, London; W. R. Cooper, Royal University of Ireland, and King's College, London; J. A. Walker, Oxford University. In Branch E (Analysis of Water, Food, and Drugs)—R. St. G. Ross (for fellowship), Owens College, Manchester, and Dresden Polytechnic. The list is interesting as showing the proportion of candidates who for various reasons considered it desirable to supplement the teaching obtainable in this country by that obtained abroad.

Royal School of Mines.—At the twenty-fourth dinner of the old students of the Royal School of Mines, held at the Criterion Restaurant, the chair was taken by Mr. T. K. Rose, of the Royal Mint, and those present included Sir G. G. Stokes, Captain W. Abney, Prof. Le Neve Foster, Mr. E. Windsor Richards (president of the Institution of Mechanical Engineers), Prof. Roberts-Austen, Mr. H. J. Chaney (superintendent of standards, Board of Trade), Prof. A. W. Rücker, Prof. W. A. Tilden, Prof. Galloway, Prof. G. B. Howes, Prof. W. P. Wynne, Mr. W. Gowland, Prof. J. Perry, Lieut.-General McMahon, and Mr. B. H. Brough (secretary of the Iron and Steel Institute). In response to the toast of "The Professors Past and Present," Sir G. Stokes spoke, and Prof. Tilden also replied, and referred to the fact that the two past presidents of the Royal Society had been professors of the School of Mines. The Chairman proposed "Success to the Mining and Metallurgical Industries," and referred to the manufacture of aluminium, which had been going up by leaps and bounds. What was of more interest to them as Englishmen was the fact that in 1896 the production of pig iron reached the figure of 8¾ millions of tons, which brought it level with the production of the United States, and well in advance of any other country. He then went on to speak of statements with reference to the amounts spent by German firms on research, and observed that in England the researches of the past year had not been unimportant.

Royal Institution.—Prof. Dewar's discourse on Friday last forms the subject of another note. Liquid oxygen may almost be called one of the specialities of Albemarle-street, and much interest is always taken in it by the audience. On Friday Sir Frederick Bramwell presided. Lord Rayleigh was there, and so were Sir Frederick Abel, Sir W. Anderson, Sir James Crichton-Browne, Prof. Fleming, Dr. Frankland, Dr. Gladstone, and Prof. Armstrong. This (Friday) evening's discourse is to be by Prof. J. C. Bose, the gentleman who had so much nonsense fathered upon him about the electric eye. Hertzian waves are not an easy subject by any means, and it will be interesting to see how a native Indian man of science treats it. The week after we are to have the Bishop of London, which is a decided change. Dr. Waller's lectures on "Animal Electricity" on Tuesday afternoons are but the beginning of a long course. They are certainly not reportable independently of each other, and the subject being confessedly in a somewhat inchoate condition, it will do no harm to postpone reference to last Tuesday's lecture until Dr. Waller has got further into his exposition of it. Whether among the secrets Prof. Miers is telling about crystals there are any that would be of interest to electrical engineers the writer confesses he does not know—for the very obvious reason that he has not been able to go and hear.

Tramways in Europe.—If the *Canadian Engineer* thinks that there is a great future for electric traction on this side of the Atlantic, the *Financial News*, which has got hold of the report of Mr. Moore, the United States consul at Weimar, has on the basis of that document come to quite an opposite conclusion, and thinks that the progress of electric traction in Europe during the past year has not been commensurate with what was hoped. "The aggregate mileage of European railways built for electric operation during 1896 reached only 125 miles, the total increasing from 435 miles to 560 miles. Nearly half of this aggregate is found in Germany, which has 252 miles of line; France follows with 82 miles, Great Britain is next with 66 miles, Austria-Hungary is fourth with 44 miles, Switzerland has 29 miles, Italy 24, Russia, Belgium, Spain, and Servia have from 6 to 18 miles each, and the other States less than five miles each." We somehow seem to have seen these figures, or something like them, before. Still, "the number of cars increased during the year from 1,236 to 1,747, or over 40 per cent.," which indicates a great addition to the traffic. "The overhead trolley, used on 91 out of the 111 lines, shows that the roads have been built with a view to economy, though the other 11, which use the underground conduit (in addition to eight with accumulators), may possibly fare best in the end." The last sentence will enable our readers to fairly gauge the value of the opinion and the report from a technical point of view.

Uriage aux Tenebres.—The following appears in *L'Energie Electrique* in reference to the electric lighting of Uriage-les-Bains, which is a rather fashionable inland watering-place in the foothills of the Alps in the department of Isére: "Can anything more tantalising be imagined than a whole district having to wait for its light? The lamps are erected, the buildings wired, and the work paid for—for the most part—and yet all is darkness. In reply to the natural outcry from all the residents the contractors put the blame on the shoulders of the great Creusot firm, who, they say, are alone responsible for the delay. The Thury dynamos—for which it appears this firm holds the patent license for France—not being ready, Messrs. Schneider forwarded express a Ganz dynamo to provide a supply. The dynamo has been set up at the generating station, and runs at 350 volts and 60 amperes. At Uriage, however, at the terminals of the accumulator the specified 60 amperes is obtained, but at only 150 volts, which represents a transmission factor of about 40 per cent." Whether our contemporary wishes its readers to conclude that a Ganz is not as good a dynamo

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as a Thury (put it all on to the machine), or that Messrs. Schneider do not know whether a dynamo is wound for 350 or 150, or that the transmission line is ever so much too small, or something else is wrong altogether, can only be conjectured, since the inference to be drawn may be as doubtful as is the arithmetic. Even the information derived from a short visit to Uriage last autumn does not enable the writer to determine the point.

Safety Lamps.—The Shipmasters' Society has been meeting at Gresham College to hear a paper from Prof. F. Clowes on "The Detection of Inflammable Gas and Vapour on Board Ships." What happened to the "Scotia' has given the matter an immediate interest. The writer gathers that Prof. Clowes does not like the electric lamp, apparently because in a dangerous atmosphere it is absolutely safe. The miner's safety lamp presents, he thought, a great advantage over electric hand lamps. The electric lamp gave no indication of a dangerous condition of the atmosphere, while the suitably-fitted safety lamp gave the most ready, trustworthy, and delicate tests for such dangerous gas or vapour in the air. That is intelligible, though to an outsider it might seem that to have to at once extinguish your light and remain lost in the darkness, with the probability of ultimate suffocation, was a heavy price to pay for combining your lamp and gas indicator in one instrument. After this, the report seems to mix up irrespirable and explosive gases somewhat. (The irrespirable gases which are met with in practice do not explode or even burn.) But it seems that Prof. Clowes and Mr. Redwood have devised an improved kind of safety lamp (not electric) that will do almost everything except speak, and a gas-testing apparatus that you do not take into the place where the inflammable gas is supposed to be. But it was decidedly unkind to suggest that it should be used in "electric light culverts," even though it is only to show the presence of our old friend from the gasworks that will stray out of its own pipes and hang about in conduits and transformer-chambers, where it certainly has no right of entrance.

Foot-Warming.—If an incandescent lamp happens to get accidentally buried under a heap of material which is a bad conductor of heat, it has been a subject of debate as to whether or when it will set it alight. The following is from our New York namesake, the *Electrical Engineer*: "The idea of putting an incandescent lamp into a bed to serve as a foot-warmer is ingenious, if not entirely new, but it requires care in its employment. Mr. Van Cott, of Unadilla, N.Y., went out skating, returned home with cold feet, and took a lamp to bed with him after warming his hands with it. The flexible cord was long enough to permit the use of the lamp in this way; but as the glas bulb, had no wire guard, it got crushed by the feet of Mr. Van Cott while he slept. This did not awaken the tired skater, but as the current still remained on, the bedclothes soon caught fire, and Mr. Van Cott found his feet warmer than was altogether comfortable. He jumped out, friends came to his assistance, the fire was extinguished in the room, the bedding was thrown through the window to consume itself in the yard, and Mr. Van Cott now limps around on wounded feet, but with a larger knowledge of the principles of electricity." The "principles of electricity" may be taken as merely a literary flourish which nicely rounds the sentence. The question is, was the glass crushed? There seem easier ways of developing a "short" in an overheated lamp and socket, and the glass itself might do it if it went suddenly. People that have amused themselves by putting old lamps in the fire (we do not recommend the experiment) have noticed that the way in which the bulb collapses is not by any means always the same. Probably any attempt to find out experimentally what happened would result in total and complete failure to set things on fire at all.

Physical Society.—Prof. Ayrton presided at last Friday's meeting. Mr. Croft exhibited some simple forms of apparatus, mostly stands and holders, and which would be likely to be useful in the demonstration of physical optics, including, of course, Röntgen radiation work. Mr. Baly's paper followed on the "Passage of Electricity through Gases"—not, be it observed, gaseous conduction. The paper was of a somewhat controversial type, the author maintaining the thesis that electrical conduction in gases was a process of an entirely different nature to the sort of thing that takes place in a fluid. Prof. Armstrong's remark on the subject was that Mr. Baly's conclusions were vitiated by the fact that he assumed the whole of the ionic hypothesis, in which Lord Kelvin did not believe, and ignored everyone's work except Prof. J. J. Thomson's. The ionic hypothesis is certainly not able to carry anything more than its own weight at present, and what Lord Kelvin has really done is to point out that the experimental laws on which it is founded are capable of other explanations, and, as a matter of fact, do not (as they ought if the hypothesis were a complete explanation) meet the facts of one of the most important classes of electrolytes. It is, of course, not impossible that there are really two or even three different kinds of action when a discharge takes place through a gas, and the relative proportions and importance of these depend greatly upon the pressure of the gas, the potential difference, and the current density of the discharge. The discussion which followed Mr. Baly's paper cannot very well be summarised in a note, and as it deals with a matter of some theoretical interest, and, moreover, one in which important developments may be expected to take place, we hope to give it (though not this week nor, perhaps, next) in another part of the paper.

Recording Instruments.—The use of instruments for recording automatically different physical quantities has found great favour in electricity supply stations. Thus, in measuring the output of the station, the old methods of recording by hand the reading of current and voltage every five minutes is found to be cumbersome, and also at times unreliable. Thus, who would expect an inattentive switchboard attendant to note the fact that he had allowed the voltage at a feeding point to fall below the Board of Trade limit. He will doubtless correct the fault, and then record the result. A recording voltmeter gives the engineer-in-charge a truthful record of the fluctuations which have occurred, and also of the care taken by the switchboard attendant. Then again, a recording wattmeter, giving the total current generated at the station, gives a most valuable adjunct to the integrating meter, which gives a total irrespective of time. Another use of the recorder is that of ascertaining the voltages at different points on the network. It is, however, not only in the electrical measurements that the recorder finds favour. Thus in stations where the plant is heavily loaded in the evening systematical records keep the engineer-in-charge well informed as to the working of different divisions of the staff. Thus, when the boilers are hard pressed, a recording steam-gauge shows the fact as the dark evenings come on, and enables provision to be made for keeping the fires in good order to meet the strain. In fact, recording instruments dotted about the supply station act as eyes for the engineer-in-charge, and enable him to check the working of his plant without being always on the spot. We appreciate the good which the London technical colleges have done in teaching men to take accurate readings at regular intervals, a simple thing which the

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average man is utterly incapable of. Still, we look forward to the time when these men will no longer be expected to act as a machine day by day after leaving college.

Meters.—In the House of Commons last Monday Mr. Ritchie, replying to Mr. Lough, the member for West Islington, said the Board of Trade had approved the pattern and construction of two electricity meters for use generally "for the measurement of electrical quantity when supplied on the constant-pressure continuous-current system, and of one meter for use in certain metropolitan districts for the measurement of electrical quantity when supplied on the alternating-current system." There was no statutory provision that such meters should be submitted periodically to a local authority for testing purposes. Under the provisional orders granted under the Electric Lighting Acts, it devolved on local electric inspectors to certify meters used otherwise than by agreement to be correct, and to be of some pattern and construction approved by the Board of Trade. That being so, there was no question of margin of error allowed by the Board of Trade. That is doubtless a good House of Commons answer, but it might be (and presumably is) a question for the Board in approving of a meter of given construction to consider what margin of error there might or might not possibly be with that particular construction of meter under various circumstances, which need not be further particularised. It is pretty evident that Mr. Lough merely wanted to know in a general way, and would have been glad of any information, because after having, on the principle of *juniores priores*, or perhaps because they measure a superior article, inquired respecting "electricity meters," he immediately put a similar question as to gas-meters. The answer he got ran on much the same lines. Mr. Ritchie said under the Sale of Gas Act, 1859, the duty of testing gas-meters was imposed, not on the Board of Trade, but upon inspectors appointed by the local authorities. The statute did not provide that meters should be retested at stated intervals, but it is open to gas companies or consumers to send the meters at any time to be retested by the inspector.

The Chambers of Commerce.—The thirty-seventh annual meeting of the Association of Chambers of Commerce will be held at the Hôtel Métropole on March 9, 10, and 11 next, under the presidency of Sir H. Stafford Northcote, M.P. Among the subjects to be dealt with are private Bill legislation, employers' liability, and the telegraph rates between Great Britain and France. In reference to telephonic charges, Mr. J. C. Lamb, C.B., C.M.G., writing by direction of the Postmaster-General to the secretary of the Association of Chambers of Commerce, makes the following statements with regard to the charges for ineffectual calls and time lost: "With the respect to the suggestion that no charge should be made for ineffectual calls, I am to say that every allowance is made in cases in which the failure is due to some fault or error in the service of this Department; but, having in view the desirability of maintaining the efficiency of the service, his Grace regrets that he does not see his way to altogether forego the charges for calls which prove to be ineffectual owing to causes for which the subscribers are themselves responsible. The suggestion of the association that no additional sum should be charged for the time lost in securing reasonable conversation is understood to have reference to cases in which, although communication has been established between the offices of subscribers, the particular person with whom it is desired to effect conversation cannot attend immediately at the telephone. Special measures are being taken to ensure that subscribers shall in all cases have the full time for which they are charged, but it is not in the power of the Postmaster-General to allow the duration of a call to be reckoned merely from the moment when the attendance of a particular person can be obtained; all he can do is to place the service at the disposal of the subscribers for the full time for which payment is made." It is exceedingly kind of the Post Office to say that they will not charge for time wasted by their own fault.

Technical Education.—In an article not particularly unfavourable to the Central Technical Institute (Who knows it best most highly thinks of it), the *Engineer* has thrown out something like an *obiter dictum* that any school which cannot show that 50 per cent. of its pupils have derived a direct pecuniary benefit from its teaching must be regarded as a failure from a business point of view. If a test only one-tenth part as severe as this were to be applied to the country grammar schools and endowed schools of still higher pretension which do the practical work of secondary education in this country, there would be a pretty clear sweep made, and plenty of funds would be available for the teaching of other subjects than elementary classics and mathematics kept so carefully "pure" that a lad of 16 may have no notion of what specific gravity is, and repudiate with scorn the notion that a lever is anything else than a tool or could ever be regarded as belonging in any way to the same branch of learning as his Euclid, algebra, and trigonometry. The best teaching in the world cannot cope with the fact that many, if not most, men, and not unfrequently the best ones, only find their true power at a later period in life. It is this reason that makes the present tendency to draw tighter the lines hedging the entrance to the professions so much to be deprecated. But that is another story, and it is just as well to keep to one subject in one note. Meanwhile, to return to the original matter, at the annual meeting of the Association of Technical Institutions Mr. Mundella has been speaking of the difficulty that technical institutions experienced from students coming to them with imperfect preparatory instruction in elementary science, and Mr. Hobhouse declaring that in the management of technical education specialised training should not begin too early in life, but should be based upon proper elementary training. In the early years of school life a headmaster often had to counteract the tendency towards a purely bread-and-butter education. A technical institute should be an organic whole, and not a mere collection of classes, and in properly-managed institutions there should be no cramming for examinations.

German Competition.—The following is a letter from Sir Bernhard Samuelson to the *Times*, which relates to a matter too important to be passed over without notice: "In your [the *Times'*] leader on the report of my late colleagues on technical progress in Germany you refer to the fact that the production of dyes from coal tar, in which we have been so compeletely distanced by the Germans, was originated by Dr. Perkins, and, it might have been added, by Dr. Hoffmann, in this country. It is not generally known that we lost this manufacture because the trade in England was shut up for 14 years by a 'master patent,' whilst no controlling patent had been sanctioned in Germany, so that anyone could take up the manufacture there; the result being, of course, development abroad in place of stagnation at home. At the present time we, in this country, are handicapped as much as before, but from an opposition of things. The Germans having taken the lead, with their acquired experience and large capital, keep it by patenting their new processes in this country, but carry out their manufacture abroad. So long as they keep our market

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supplied, which they take care to do, nobody is at liberty to make the patented articles here. I believe ours is the only country in which it is not a condition of every patent that the invention shall be exercised within the realm. Surely it is 'free trade run mad' to allow the foreigner to prevent a process from being carried out in this country by our people if he does not choose to come and do so himself." Unfortunately, with a large section of our countrymen the mere mention of the words "free trade" in the last sentence will be conceived to take the matter into the domain of party politics. It is, of course, nothing of the sort, but merely a quantitative problem in the applied science of economics. But since it will not be held so, and since it is the practice of these notes to keep clear of subjects in which most people allow the processes of pure reason to be appreciably affected by sentiment, feeling, and the desire that "our side should win," the writer has preferred to reproduce the letter without other comment rather than mutilate it by the omission of what its author may possibly consider its essential conclusion.

The Civil Engineers.—At the meeting of the Institution of Civil Engineers on Tuesday, Mr. John Wolfe Barry, C.B., F.R.S., the president, in the chair, the paper read was on "The Diversion of the Periyar," by Colonel J. Pennycuick, C.S.I., late R.E. It was shown how from time immemorial the Madura district of the Madras Presidency had suffered from want of water for irrigation, and how it was proposed to meet this want by diverting the Periyar River from its natural course through Travancore into the Arabian Sea, so as to traverse the valley of the Vaigai, which runs through Madura to the Bay of Bengal. The work involved the closure of the existing course of the river by a solid masonry dam, the provision of a passage for its waters through the mountain chain separating the watershed of the Bay of Bengal from that of the Arabian Sea, and the construction of the works required for the control and distribution of the water thus diverted for the purpose of irrigation in the Madura district. The dam for closing the existing bed of the Periyar had to be 178ft. in height, and the difficulties inherent in the construction of a work of this magnitude across a river with an average discharge of 1,200 cubic feet per second, rising in floods to 25,000 cubic feet per second, and on one recorded occasion to five times the latter amount, had been enhanced by the fact that the work had to be carried out in an uninhabited jungle, 20 miles from the nearest cultivated land and 80 miles from the nearest railway station. The climate also was so unhealthy that for three months in each year engineering operations on any but the smallest scale were impossible, while for six of the remaining nine, floods in the river were so frequent as to prohibit any attempt at work in its bed. These, however, are "mere matters of civil engineering," as the politician said. What concerns our own branch of the profession is that construction of the dam has created a potential energy of about 60,000 h.p., the conditions for the development of which were singularly favourable. Unfortunately, the conditions for its employment are not at present as favourable as those for its development, but Colonel Pennycuick believes that in the future the returns from this source should rival, if they do not exceed, those now obtained from irrigation. The paper was supplemented by an account of "The Periyar Tunnel," by Mr. P. Roscoe Allen, A.M.I.C.E. It will be discussed at the next meeting on Tuesday, February 2, and, time permitting, a paper will then be read on "Cold Storage at the London and India Docks" by Mr. H. F. Donaldson, M.I.C.E. Tuesday is also the evening for the monthly ballot for members. To-day (Friday), at 8 p.m., there is a students' meeting for a paper on "An Experimental Investigation of the Efficiency of a Pelton Waterwheel," by Mr. S. H. Barraclough. Dr. A. B. W. Kennedy will preside. There is a students' visit to Messrs. Elliott Bros. manufactory on February 4.

Liquid Oxygen.—Last Friday evening's discourse at the Royal Institution was by Prof. Dewar. The subject was a further exposition of some of the properties of liquid oxygen. Much of the recent work of Prof. Dewar and Prof. Fleming in this direction has been given pretty fully in our columns, but a discourse at the Royal Institution is necessarily of a different and more popular character than papers before the Royal Society. It may therefore be said, briefly, that last Friday Prof. Dewar remarked that since after studying gaseous oxygen for over 120 years there was still very much to be found out respecting it, it might be expected that with liquid oxygen there would be difficult points which would remain for some time. The importance of liquid oxygen in low-temperature research was from its giving a constant temperature. The temperature of fresh liquid air was lower than that of oxgen, but was not constant; it rose continuously as the nitrogen evaporated, till it approached that of liquid oxygen, depending, in fact, on the proportion of the two gases in the mixture. A brief mention of the means available for the measurement of these low temperatures led to a reference to the thermo-electric diagram of Lord Kelvin and Prof. Tait, and it was shown that the temperature of liquid oxygen might be proved to be – 182deg. C. by immersing one thermo-electric junction in it and another in a substance boiling at + 182deg., and noticing that the two currents exactly balanced each other. Barring accidents, the earth is going to get cold some day or other (the professors have not yet agreed as to the exact time), and when that happens, and the air comes down in rain or snow (it will be a dirty-blue-looking sort of stuff, but there will be no one to see it), will it form lakes and seas like the water does now? Prof. Dewar has worked it out and says, no. If the air were the same density throughout, instead of thinning away to nothing as you get up, it is an easy deduction from the barometer reading that the height of the "homogeneous atmosphere" would be about five miles. That is the amount of air there is to be measured, but, of course, the actual height to which a sensible atmosphere extends is not nearly so simple a matter to ascertain as the elementary theory would seem to indicate. For the purpose in hand it is only necessary to liquefy the air in a tube of known length, and the problem resolves itself into a sum in simple proportion. Prof. Dewar has done it, and the result is that the total "airfall" would be a matter of a very reasonable number of inches. Turning to some of the optical properties of oxygen, Prof. Dewar spoke of the oxygen (air) lines seen at sunrise and sunset in the solar spectrum. The same effects could be imitated by passing light through oxygen at various pressures, and, more than that, liquid oxygen of equivalent thickness would show the same bands. It was remarkable that the same absorption was to be found when the substance was at a high temperature as a gas, when it was a liquid, and when it was at the lowest temperatures. Oxygen, again, was remarkable as an element that was magnetic as a gas, as a liquid, and, perhaps, as a solid. The measurements, particularly the accurate measurements, which alone were valued in these days of the various constants of liquid oxygen, were exceedingly intricate and laborious. In this connection, a ball weakly magnetic in air was shown to be apparently diamagnetic when immersed in liquid oxygen. In air a magnet attracted it, in the liquid the same magnet repelled it.

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THE PRINCIPLES OF ALTERNATE-CURRENT WORKING.*

BY ALFRED HAY, B.Sc.(EDIN.), A.I.E.E.

(Continued from page 103.)

135. No account of the principles which underlie alternate-current working would be complete without a reference to *polyphase* alternating currents, which are coming largely into use for purposes of power distribution. Polyphase currents enable us to produce a *rotating magnetic field* without any rotation of the mass of iron which carries the exciting coils. Such a rotating magnetic field may be used for constructing motors which are self-starting, non-synchronous (Art. 123), and which require no commutator or sliding contacts of any description.

136. Let us imagine the field magnets of an ordinary continuous-current dynamo mounted so as to be capable of rotating about the armature axis; let the armature be an ordinary ring or drum armature, but let the windings, instead of being connected to a commutator, form closed independent circuits (Fig. 91) surrounding the core, each coil being short-circuited by having its two ends soldered together; or we may suppose that the armature is not in any way interfered with, but that a tight-fitting ring of copper is slipped over the commutator so as to short-circuit the coils. Let the brushes be removed, and the field

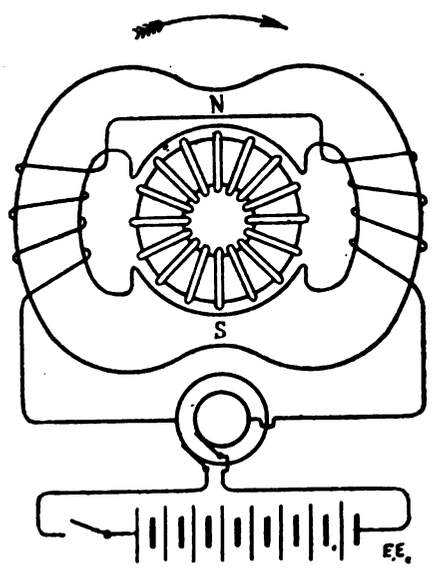
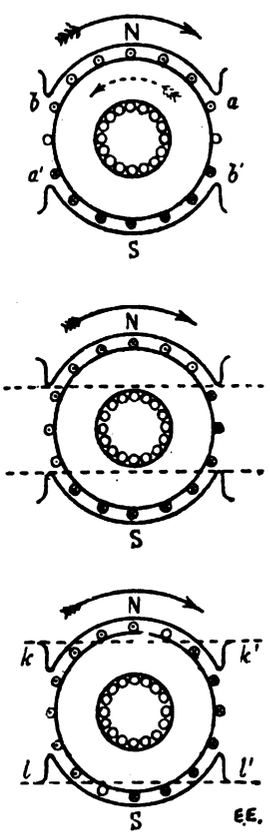


FIG. 91.

winding disconnected entirely from the armature and terminals of the machine, and connected to two contact rings capable of revolving with the magnets. Fig. 91 shows the arrangement diagrammatically. Both field magnets and armature are now capable of rotation. Let the field-magnets be excited by means of a secondary battery connected to two brushes pressing against the contact rings, and let the magnets be driven round right-handedly, as shown in Fig. 91. Currents will be induced in the short-circuited coils by the revolving field, the direction of these currents being the same as that which would result if the field were kept stationary and the armature driven round in the opposite direction. The currents induced in the armature coils tend to resist the relative motion of the field and the armature; hence the latter experiences a torque, and begins to run in the same direction as the field. The torque acting on the armature is proportional to the product of the field intensity and the current in the short-circuited coils. If the armature is not loaded, a very small current will be sufficient to provide the torque required to overcome the frictional resistances to the motion of the armature. But if a brake is applied to the armature pulley a much larger torque must be provided, and hence, assuming the field to remain constant, a larger current in the short-circuited coils. Now, the current induced in the coils is proportional to the E.M.F., and the latter depends on the *relative* velocity of field and armature, generally called the *slip*. The E.M.F. is directly proportional to the slip. Hence as the load is increased, the slip increases (up to a certain limit) in direct proportion to the load—*i.e.*, the speed of the armature diminishes as the load is increased.

137. We may imagine the armature rigidly coupled to a line of shafting driving machinery, and we may suppose that the engine, instead of driving the shafting directly, is made to drive the field magnet of the dynamo. The torque communicated to the field magnet by the engine will then be transmitted to the armature, which will tend to follow the motion of the magnet. Our modified dynamo, in fact, forms a sort of flexible electromagnetic coupling between the engine and the line of shafting. If the engine be supposed to run at a perfectly constant speed, the speed of the shafting will not be constant, but will depend on the load, since the armature slip, as we have seen, increases with an increase of load.

The resistance of the short-circuited coils being extremely low, a very small induced E.M.F. will be sufficient to give rise to a powerful current. Hence the slip is never very great. The slip is conveniently expressed as a percentage



FIGS. 92, 93, AND 94.

of the field velocity. We may also express it in revolutions per second or per minute.

It is obvious that (as in the case of a dynamo) the current in each coil undergoes a double reversal during each *slip* revolution. The induced E.M.F. begins to act on each conductor as it enters the fringe (*a*, Fig. 92) of the magnetic field under the polar tip, and continues to act on it so long as it is under the polar surface; the E.M.F. then rapidly diminishes as the conductor passes out of the field through the fringe, *b*, on the other side, and during the motion of the conductor across the interpolar space there is no impressed E M.F. acting on it. When it reaches the fringe, *a'*, of the opposite polar surface another E.M.F., acting in the reverse direction, makes its appearance, and continues to act until the conductor once more passes out of the field at *b'*.

The directions of the E.M.F.'s impressed on the various conductors are shown in Fig. 92, the field being supposed to rotate clockwise. The *relative* motion of the armature to the field will then be counter-clockwise, as shown by the dotted arrow. The conductors marked with dots have E.M.F.'s impressed on them which act from back to front, and those marked with crosses E.M.F.'s which act from front to back of the armature. The conductors out of the

* Based on a series of evening lectures delivered at the University College, Liverpool.

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magnetic field are obviously not subjected to any impressed E.M.F.'s.

138. The variations of current which take place in each coil during one slip revolution depend not merely on the impressed E.M.F. and resistance, but also on the *inductance* of each coil (Arts. 33-36). The rapidity with which a current establishes itself in a circuit depends on the time-constant (Art. 35) of the circuit. If the time-constant of the short-circuited coil were negligible, the changes of current in it would follow precisely the changes of impressed E.M.F., and for any given relative position of the field and armature, the currents would be distributed as in Fig. 92. For such a distribution of currents, we notice that the *force acting on each conductor tends to accelerate the rotation of the armature*; all the conductors in the upper half of Fig. 92 tending to move across the field from left to right, while all those in the lower half tend to move from right to left.

139. The time-constant, however, of the short-circuited coils is by no means negligible: their resistance is relatively low, and their inductance, owing to the presence of the iron core, is high. The effect produced by the retardation of both the rise and decay of current in a short-circuited coil will to a large extent depend on the slip of the armature. If the slip is very small, then the armature (although rotating rapidly in space) revolves comparatively slowly with regard to the field. As a result, the current in a conductor will have time to decay almost completely during the motion over the neutral or interpolar space, and it will have time to establish itself soon after the application of the impressed E.M.F. But if the slip be considerable, then, owing to the more rapid rotation of the armature relatively to the field, the current in the short-circuited coil may persist during the whole of the movement of the conductor over the neutral space, and the conductor may move over an appreciable portion of the field before a current in the opposite direction is fully established in it. The distribution of currents in such a case is shown in Fig. 93.

If the slip is very great, and the time-constant of the windings considerable, then it may happen that the current persists in a conductor long after the latter has entered the reversing field. We may then have a distribution of currents such as that shown in Fig. 94. One important result is at once apparent: under each pole-piece we now have a number of conductors, some of which tend to move in one direction, others in the opposite direction. The actual torque of the armature will be determined by the differential action between the two groups of conductors under each pole-piece. The torque will be greatly reduced, both on account of this differential action and the weakening of the field due to the demagnetising belt of conductors included between the planes $k\,k'$ and $l\,l'$ (Fig. 94).

140. The above considerations show that it would be undesirable to have armature windings with a large time-constant. The effects considered in the last article are most marked at starting. Suppose the armature to be at rest, and the field magnet rotating at its normal speed, but without being excited. Let now the exciting current be suddenly switched on. The armature slip at starting is enormous, being equal to the speed of rotation of the magnet. Hence the effects we have just considered will be very marked, and the starting torque of the armature small, in spite of the fact that the currents circulating in the armature coils may be abnormally large. As the armature gains speed, however (supposing the initial torque to be large enough to start it against its load), the changes of current become more gradual, and although the actual currents in the coils are reduced, the differential action and demagnetising effect are also reduced, and the torque increases. This increase of torque will go on up to a certain limit. Beyond that, any further increase of speed will so much reduce the slip that the currents in the conductors will be materially weakened, and the torque will diminish.* Hence the curve connecting torque with speed or slip will be of the shape shown in Fig. 95 (full-line curve).

* Beyond the point of maximum torque, the *slip* will practically vary directly as the load (Art. 136). This is another way of stating the fact that the curves of Fig. 95 are approximately straight lines for small values of the slip.

Suppose we have the means of varying the resistance of the armature coils (without altering their inductance), then by an increase of their resistance we can reduce the time-constant and so obtain the maximum torque with a greater slip, as shown by the dotted curve of Fig. 95. By increasing the resistance still further, we can even cause the torque to be greatest at starting, as shown by the chain-dotted curve of Fig. 95. It will thus be evident that by providing means for introducing non-inductive resistances into the armature coil, we can obtain complete control over the torque of the motor.

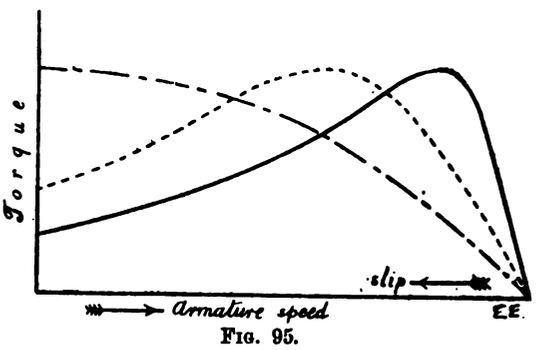

FIG. 95.

141. We have now investigated the behaviour of our electromagnetic coupling, consisting of an armature with short-circuited coils and a field magnet revolving around it. The only function, however, which the revolving field magnet performs is that of providing *a rotating magnetic field*. Now a rotating magnetic field may be produced in a *stationary* mass of iron by two or more alternating currents which differ in phase. Let the revolving magnet be replaced by a *stationary* one, so wound that when suitable alternating currents are sent through its coils it gives rise to a rotating magnetic field. Then we have transformed our electromagnetic coupling into a *motor*. Such motors are variously termed *polyphase* motors, *rotary-current* motors, or *induction* motors.

(To be continued.)

THE MECHANICAL CONSTRUCTION OF ELECTRICAL MACHINERY.

BY F. M. WEYMOUTH.

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THE DYNAMO.

(Continued from page 105.)

Fig. 34 is added here, while we deal with bosses generally, to show a design to be avoided. This is a

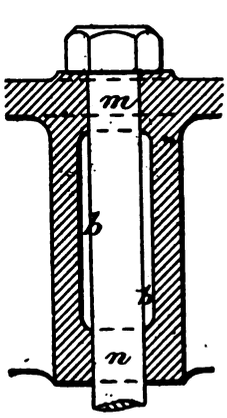

FIG. 34.

turned bolt put through a long boss, which latter is chambered in the middle as shown, $b\,b$, ostensibly to save drilling. The narrow parts, $m\,n$, are drilled; but the holes, $m\,n$, have to be cored, in the first instance, to a smaller diameter, together with chamber $b\,b$. An evil is thus involved that in subsequently drilling out these small holes the edge of the tool is cutting against hard skin all the way down, as compared with merely breaking through the

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skin once in an ordinary case. This is severe on, if not damaging to, the tool. But also, as the cored hole would probably be a little out of place, it would be much more difficult to correct its centre, than to drill through solid metal from the beginning, when it would only be necessary to see that a right start was made. In cases where such holes are well over an inch in diameter, and this design is not easily avoided, it is better to bore them out with a boring bar, rather than attempt to drill them.

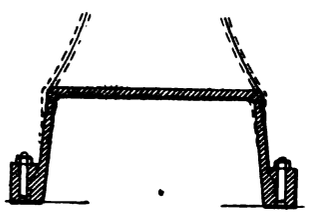


FIG. 35.

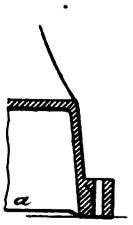


FIG. 36.

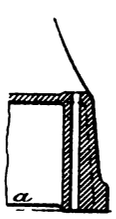
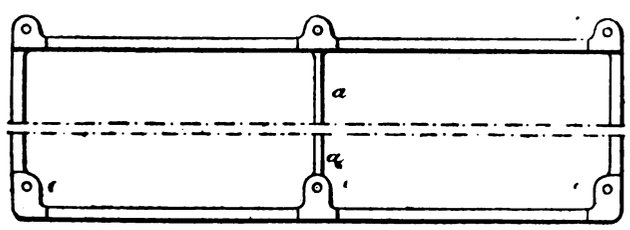


FIG. 37.

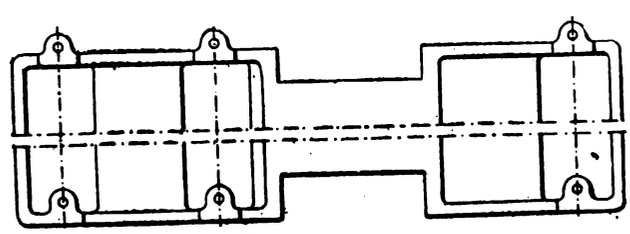
Bosses, in order most effectively to fulfil their functions, should be cast on some rigid portion of the bed-plate. If cast on an unsupported wall, as at the middle of a bed-plate side, then vibration would be possible, as shown exaggerated by dotted lines, Fig. 35. To prevent this effect, a web needs to be cast across, as shown at *a a* in Figs. 36 and 38 for outside bosses, and Figs. 37 and 39 for inside bosses. It will be noted that in Figs. 38 and 39, which are inverted half plans, the bosses are shown placed to their best advantage, and incorporated in the corners. As is often the case, however, practice is a compromise with theory; and we find that, as shown in Figs. 40 and 41, in order to bring the end bosses on the same transverse centre line as



FIGS. 38 AND 39.

the pedestals that they may together come conveniently over the centre of the rails, the bosses will be put a little way back from the ends of the bed-plate instead of being quite in the corners. In these latter cases also, which deal with overtype machines, the presence of the yoke cast in the bed-plate precludes the necessity for a special web for supporting the central bosses; and these latter are at least as well supported as those at the ends. But a web would be required in a three-pedestal bed-plate for an undertype machine.

To return more especially to the bed-plates above illustrated, we may note some points as regards the machined surfaces, which will also, however, bear on



FIGS. 40 AND 41.

our subject generally. It will be seen that, in the cases of Figs. 25 and 27, where the facings, *n n*, are circular, these can be tooled with a revolving cutter in the same machine as that by which the sockets are bored; but the tops of the pedestals and the bottom facings, *g g*, and, in fact, all such facings as have been depicted on bed-plates heretofore illustrated, must be done in a planing machine. Now, it is optional sometimes to do this planing either lengthways with the bed-plate, or across it. It may be noted that the bottom facings in Fig. 40 are arranged for planing lengthways, and the bed-plate ends are set up like the lower edge of web *a* in Figs. 36 and 37: but in Fig. 41 transverse planing is assumed, and the ends are faced right across. One special point to be noted here is that while any ordinary planing machine will receive a bed-plate for planing it lengthways, a very wide machine, or perhaps a wall planing machine, would be required to do the planing crossways. A point, thus, of practical importance in arranging the machining in a design is to suit this to the capabilities of the machines that may be at disposal for its accomplishment. Hence, in circumstances where there are no wide planing machines, or, if any, where they are occupied with other work, it becomes necessary to arrange for lengthways planing only. Yet another reason, however,

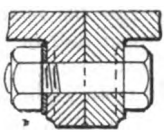


FIG. 42.

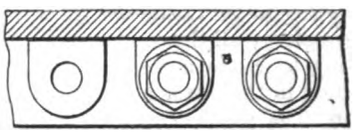


FIG. 43.

for adopting this course is that when the rent of the machine is charged to the work done by it, to suit the tooling to a small planing machine will obviously come cheaper in respect of such rent than when the use of a large and expensive machine is involved. Points such as these, therefore, are some that at times require attention.

Bottom facings, as in Fig. 41, may, of course, be planed lengthways with the bed-plate, and no doubt generally are so done. Yet to plane across a thin edge, unsupported and liable to vibrate, is objectionable, and may result in little chips of the skin breaking away from the side just below the tool as the latter completes a cut. It is obviously much more desirable, as when planing an edge lengthways, or some extended surface, that the metal should offer a solid and steady resistance to the tool. And, further, with the feed of the tool unaltered, it would take as long, and

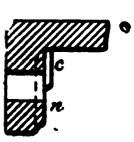


FIG. 44.

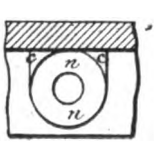


FIG. 45.

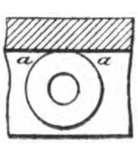


FIG. 46.

cost about as much, to plane all these edges, as to plane a whole surface measured by the length and breadth of the casting; and the tool, even on the cutting stroke, by far the greater part of the time will be idle in mid-air. To reduce this loss, a quicker feed may be given the cutter when doing the ends, which is the more objectionable on account of the vibration above referred to: or each end may be done separately so as to avoid the long idle stroke. But workmen are not always addicted to this kind of economy unless well looked after. Hence it would seem preferable on the whole not to machine the ends, but to leave them set up as in Fig. 40 and other previously illustrated examples.

The proper arrangement of facings, however, has its importance in other respects, for they may much affect the

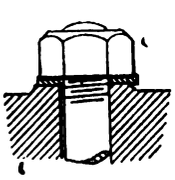


FIG. 47.

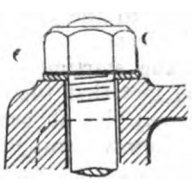


FIG. 48.

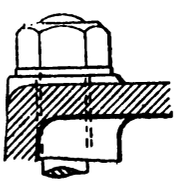


FIG. 49.

general appearance of a machine when finished. Small facings are used for bolt-heads and nuts and large ones for bearings, shoes, brackets, etc., to be seated on or against. The former are usually circular, but sometimes horseshoe shaped, or are elongated to suit a slotted hole. The horseshoe pattern is usual on the deep holding-down bosses when outside, but the circular when inside. Generally, horseshoe facings (shown in Fig. 43) are used when they are easier to mould than if circular; also if the nut is very close up to the side of the casting. Sometimes they are made extra deep, like low bosses, so as to strengthen the metal immediately strained by the pressure

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of the nut; and in any case a facing more or less makes good the loss of strength due to the hole. In Figs. 42 and 43 it will be seen that these facings will easily draw upwards out of the mould. If cast circular, as in Fig. 46, which might be done by letting the facing be loose on the pattern, the interstices at *a a* would not probably cast clean, as the parts of the mould just here would not withstand undamaged the rush of molten metal. The horseshoe will cast cleaner. In machining such a facing, a revolving cutter would be used which would leave a circular face, *n n* (Figs. 44 and 45); and the upstanding portions, *c c*, if not left, as they sometimes are, can be removed with chisel and file. If a row of such facings can be planed, this, of course, would facilitate matters. These small facings for bolts and nuts should rise at least as much as the thickness of the corresponding washer: a $\frac{1}{16}$in. more is sometimes better. Thicknesses of washers were given on an earlier page. The outside diameter should exceed that of the washer by not less than $\frac{1}{8}$in., or should be $\frac{3}{16}$in. or $\frac{1}{4}$in. more if there is room; or may be $\frac{3}{8}$in. more with a cored hole. This gives an allowance for the possibility, or probability, of the hole not being quite central with the facing. It looks very poor when a facing is too small, and the side of the nut or washer projects over its edge, as depicted in Fig. 47. This latter can be compared with Fig. 48, for instance, or with other illustrations. A wide base for the nut to rest on is also more pleasing to the eye, and is generally agreeable with a natural sense of fitness; and these points all count in a good design. Figs. 48 and 49 show circular facings for inside bosses. A compromise between them would look well; but if Fig. 48 looks better than Fig. 49, the latter is cheaper in respect of the amount of metal in the boss below.

(To be continued.)

LOAD CURVES.

BY A. G. SEAMAN.

In all cases where a plant has to be laid down to produce an article for which the demand fluctuates, the closest connection exists between the cost of production and the adaptability of plant to suit itself to the fluctuations of demand. More particularly is this so in an electric supply station, and the consideration of the exact nature of the demand becomes of the greatest importance in designing the station.

It is now some years since Mr. Crompton directed attention to this subject; since then numbers of load curves of various stations have been published, and are of the greatest interest. It might almost be said that the load curve is the pulse of a station, and is of a twofold interest: (1) as regards the running of the plant in the manner to produce the most economical results; and (2) as an indication in which direction to look for an improvement of the conditions of working.

There is scarcely a condition in the supply which is not reflected in some way or other. The class of customer, whether residential or business, and the time and season of the year, are most clearly discernible under the more varying influences of special circumstances, changes of the weather, sudden approaches of fog, etc. The latter are often detected by the engineer-in-charge long before the general public has become aware of them, and the writer has seen the load double itself three times in five minutes. Many schemes have been devised for improving the shape of the load curves of our supply stations, and the curves of the Kensington Court station, published in the *Electrical Engineer* of January 1, show with what success in the case of one of the large London companies. In nearly all supplies special inducements are being offered to foster the use of electric cooking and heating appliances and small motors, and their use will probably grow rapidly as their extreme convenience becomes realised, and the continual cheapening of supply brings them more and more within reach. The question of the nature of the demand and the best method of meeting it, is one which in a great majority of cases has of necessity been solved by experience.

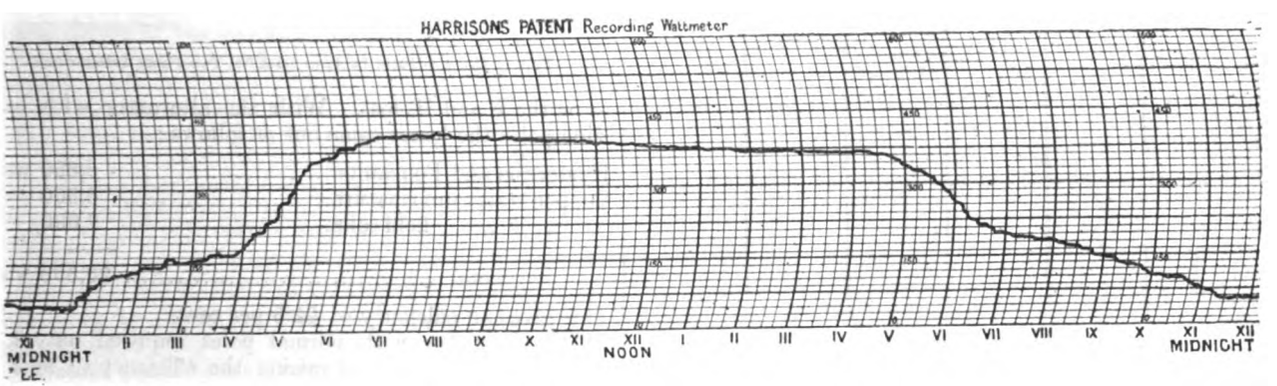
Apart from the general conditions determining the design of the station, the choice of the number and size of the units to be employed is of the greatest importance, as on this to a large extent depends the working economy of the station.

It is impossible to draw any hard-and-fast line, but, generally speaking, the more variable the load a larger number and a smaller size unit is advisable, while under steadier conditions a larger size and as small a number consistent with suitable space the better. The same considerations will often affect the boiler and engine plant differently, the essential object in all cases being obviously to use the several units so that they work at their highest efficiency.

In lighting stations it is usual to employ two or three sizes of plant, the smaller or medium size being put down first, and the others added as extensions are required.

Another method of improving the load curve which during the last few years has been increasingly forcing itself to the front, is the employment of accumulators. A steady improvement has taken place, particularly as regards durability under high rates of discharge, and they are now being employed, more or less, in all modern direct-current stations. Not only do they assist in meeting sudden variations of the demand, but they enable the station to be equipped with larger units, and these to be kept at their most economical output. By means of accumulator substations, the area of supply by direct current may be considerably extended, and are being used with great success, especially on tramway systems, considerably lightening the difficulties of distribution and maintaining a uniform load on the generating plant.

The load curves herewith, taken from a recording



wattmeter, are from the Central (Meat) Market electric light supply, West Smithfield, the day before Christmas Eve. The customers on this supply are of two classes: those engaged in the meat trade and poultry and provision trade respectively, the former being the largest. The market opened for regular business at 1 a.m., and the demand from that time till 4, when real business commences, is for "shooting the meat"—*i.e.*, bring the meat in and hanging ready for sale. The poultry and provision trade commences about 6 a.m. and accounts for the further rise of the curve till 7 a.m. In the ordinary course of events the load would begin to fall off at from 8 to 9; the long run of full load on the day in question being due to the dull state of the weather and the abnormal state of these trades just before Christmas. The sharp slope in the

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curve is due to large wholesale meat trade, which usually clears up very sharply between 9 and 10 a.m. The load at 12 midnight is principally due to public lighting.

THE HUTIN-LEBLANC ALTERNATORS AND TRANSFORMERS.

We have described in a previous number (*Electrical Engineer*, vol. xxiii., pp. 580) a 400-kilowatt flywheel alternator of the Hutin-Leblanc type. The machine in question was installed in the Champs Elysées station. It

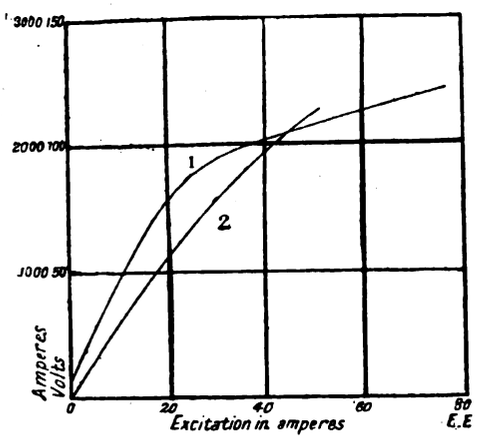


FIG. 1.—Characteristic Curves of Alternator with Wide Poles giving Large Magnetic Leakage. Curve 1 is the open-circuit volt characteristic and Curve 2 the short-circuited current curve.

seems that the company supplying light and power to the Saint-Ouen district had originally a high-tension direct-current system of distribution at 2,400 volts, feeding on to a 110-volt network by means of revolving motor-generators. We gather from *L'Industrie Electrique* that these machines, which delivered power to Saint-Denis and Asnières, did not give an economical combination. Still, as accumulators were largely used in the receiving station, the company did not like to change entirely to an alternating-current system. The arrangements adopted are to transmit the power by high-tension alternating two-phase currents, and to rectify the same at the sub-station.

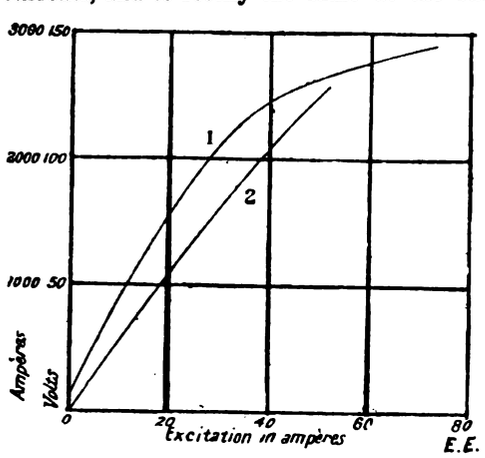
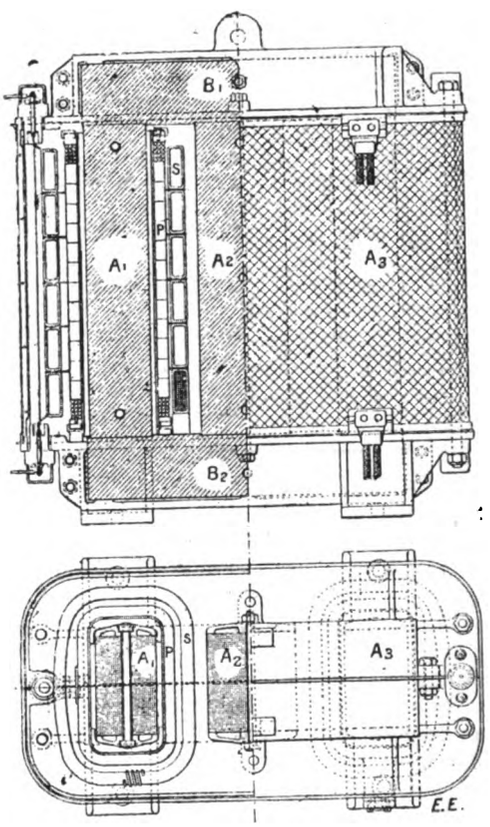


FIG. 2.—Characteristic Curves of Alternator with Normal Poles. Curve 1 is for open-circuit and Curve 2 for short-circuited armature.

The design of the new equipment was placed in the hands of Messrs. Hutin and Leblanc. The contractors are Messrs. J. Farcot and Co. and the Société anonyme pour la transmission de la force par l'électricité. Two engines of 350 h.p., of the Corliss type, have been now fixed. These engines run at 65 revolutions per minute, and have the alternators built up on their flywheels. The design of these alternators is the same as that described in our last volume, and differs only in size. Each alternator circuit gives 1,420 amperes at 80 volts. There are 72 poles in the machines, giving thus 39 ⁓ per second. There are 36 armature sections. The armature conductors are copper bars having a section of 1·12 square inches. They are placed in 36 × 12 = 432 holes in surface of the iron core. These bars are connected in the zigzag method to give six different circuits, having E.M.F. varying in phase by successive steps of one-twelfth of the complete wave-lengths. The first three circuits are then connected in parallel, as are also the last three circuits, giving thus two E.M.F.'s at quadrature. The air-gap of these alternators is ·315in., the external diameter of the revolving field-magnet system is 20ft. ½in., and the breadth of the magnet face is 15¾in.

The curves (Figs. 1 and 2) are the characteristic curves of these alternators both on open and on short circuit. The difference between the curves is due to a difference in the angular width of the polar faces. One machine has a large stray field. The efficiency of the two alternators was obtained from a summation of the various losses. The losses of eddy currents and hysteresis were tested by taking two series of indicator diagrams on the engine when running at the normal speed. The first was taken with the magnets unexcited, and the other at normal excitation. The difference in the mean indicated horse-power was taken



FIGS. 3 AND 4.—Hutin-Leblanc 200-K.W. Two-Phase Transformer.

to be the F and H loss. With the alternator with extra wide poles the losses came out as follows:

Hysteresis and Foucaults	6,850 watts.
Copper watts in armature.....	6,500
„ „ field coils.....	7,000
Total	20,350 watts

This gives an efficiency of 92·5 per cent.

The alternator with normal poles required only 2,150 watts for excitation, thus raising the efficiency to 94·3 per cent. We give these figures as obtained from the above-mentioned source, but do not consider the method of obtaining them to be a correct one. The hysteresis and Foucault current losses at no load are not by any means the same as the losses due to the same causes at full load. The distribution of magnetic density is then not uniform, and it is likely that the copper in the pole-pieces may be called upon to check these variations. A test of the two alternators or a modification of the Hopkinson method would have been more satisfactory.

Each alternator supplies current to a transformer of equal power with itself, having a transforming ratio of 88 to 6,000 volts. These 250-kilowatt two-phase transformers are shown in Figs. 3 and 4. They each consist practically of two single-phase transformers with a common magnetic return. Of the three vertical cores the central

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one, A_2, has a sectional area of 1·41 times that of each of the others. The conductors are only wound round the two outside cores, A_1, A_3. The horizontal yokes, B_1, B_2, which complete the magnetic circuit, are encased in the cast-iron frames of the transformer. These castings are held together by iron tie-rods. The primary windings placed next to the core consist each of 13 turns. The conductor is built up of 15 wires, each of a sectional area of ·147 square inch, giving thus 2·22 square inches total section. The terminals are placed one at the top and one at the bottom of the transformer limbs. The secondary winding consists of six distinct coils, each of 161 turns, or 966 turns in all. Each coil is insulated by micanite over all, and so placed that there is a good air circulation round it. The design of the transformer is compact, the height and breadth being about the same—*i.e.*, about 5ft. 10in.; and it is claimed that there is little stray field (10 per cent.). The different losses in the transformers are:

Hysteresis and Foucaults	5,900	watts.
Copper loss in primary	1,420	,,
,, ,, secondary	1,560	,,
	8,880	watts.

This gives a full load efficiency of 96·7 per cent. The alternators are said to work very well in parallel.

INSTITUTION OF JUNIOR ENGINEERS.

The twelfth anniversary dinner of the Institution of Junior Engineers was held on Saturday, 23rd inst., at the Westminster Palace Hotel. About 90 guests attended, including Mr. Alexander R. Binnie, the president, who took the chair; Sir George D. Harris, Sir Henry C. Mance (Pres. I.E.E.), Mr. Edward Goulding, M.P., Commander Lionel Wells, R.N. (chief of the Metropolitan Fire Brigade), Prof. A. Barr, Mr. Armstrong (vice-president), Mr. H. Bloomfield Vorley (chairman), Mr. Basil Joy (vice-chairman), Mr. E. A. Berry, Mr. Young (past chairman), Mr. E. C. de Segundo, Mr. T. E. Gatehouse, Mr. W. Binnie, Mr. A. T. Binnie, Mr. Clifford Smith, Mr. Martin, Mr. W. Hunter, Mr. E. King, Mr. K. Gray, Mr. B. T. King, Mr. Eade, Mr. Tennant (past chairman), Mr. Boulding (past-chairman), Mr. A. Hunter, and Mr. Dunn (the secretary). The *menu* was an excellent one, and the after-dinner speeches were remarkable for their even tenor of excellence. One has become accustomed to expect good speech-making at the annual dinner of the Institution of Junior Engineers. Nor was disappointment in store on this occasion; in fact, the speeches made merit repetition, as speeches, at much greater length than our available space will permit.

The PRESIDENT, in proposing the toast "Her Majesty the Queen and the Royal Family," made a few appropriate comments on the Queen's long and prosperous reign and the great progress made both in the scientific, engineering, and commercial worlds during that period of 60 years. Mr. BINNIE, the president, also proposed "The Houses of Parliament," which toast was acknowledged by Mr. EDWARD GOULDING, an Irish M.P., whose remarks were decidedly humorous and witty.

"Great Britain" was proposed by Sir HENRY MANCE. Having, he remarked, spent a quarter of a century in India, he was able to speak authoritatively as to the British Empire in the broader sense of the term. By the British occupation India had gained immense advantages. A network of telegraph lines had been extended over the country from the principal and coast towns right up to the frontier, and communication had been effected with England on the west and with Australia on the east by means of submarine cables. Engineers had also intersected the country with railways and constructed vast irrigation works etc., which, although not entirely safeguarding the inhabitants against the scourge of famine, had greatly minimised the effects of such visitations. He also dwelt upon the immense importance of the telegraph cables which connect us with our various Colonies—by their means the strength and security of the nation was, he considered, doubled. The telegraph supplied a security second only to the navy in importance. About 40 millions of money had been spent in cables, yet one great work remained undone—that of making a complete girdle round the earth, but he hoped to see this great work undertaken during the Queen's reign, and completed by British capital, British energies, and British engineers. He thought that the progress made during the last 60 years was only a foretaste of the progress which would be made during the next 60.

Sir GEORGE D. HARRIS, replying to this toast, said he had also had 25 years' experience in the Colonies, having left London at the age of 17. The old prevailing idea that our Colonies were a source of weakness had long since been exploded, and it was recognised now that "trade follows the flag." Many engineers had made reputations and left their names in the Colonies, and his advice to young engineers was "Go to the Colonies." Even for a short time the amount of experience gained and the advantages derived from travel were not to be despised. Sir George D. Harris also referred to the work done by Mr. Alexander R. Binnie for the London County Council, and remarked that, though the London County Council had made many mistakes, they had made no mistake in selecting their engineer.

"The Honorary Members" was next proposed by Mr. BASIL H. JOY, who spoke to the effect that the advantage of having honorary members on the council of the institution was all on the side of the junior members. While it was one of the rules of the institution that honorary members should receive no reward for their services, yet the junior members received a reward in the valuable instruction and assistance rendered by these members. Engineers of the future, he remarked, will have to be first-rate men if the rate of progression which their forefathers have set them is to be maintained.

This toast was fittingly acknowledged by Prof. A. BARR. After opening his speech with a few humorous remarks, Prof. Barr said that the hopes of the older members of the profession rested on their juniors. Older engineers look to their juniors to carry on in an extended way the example set. Junior engineers had the accumulated experience of their elders to work upon, and if this experience and the advice tendered with it was regarded, engineering was in no danger of falling into disrepute.

In proposing "The Institution of Junior Engineers," Commander LIONEL WELLS, R.N., expressed a wish that the institution in its visits to various works in search of information would, instead of always going so far abroad, look nearer home for once and pay a visit to Southwark.

Mr. H. BLOOMFIELD VORLEY (chairman of the institution) replied to this toast, and in the course of his remarks stated that the independence of the institution had been preserved: no amalgamation existed with any other large bodies—a fact to be proud of. The institution, moreover, did not clash with any other; its object being to enable young engineers to present their thoughts and ideas and to have intercourse with older and more experienced members of the profession, and to meet together to discuss improvements, etc., for their mutual benefit. The gentlemen who provided the greatest amount of instruction were the owners of large works, etc., who threw these open for inspection by the members of the institution. The visits which the institution made to different works, etc., helped to keep its members in touch with engineering in all its branches.

The next toast on the list was "The President," proposed by Mr. EDMONDS A. BERRY. Mr. Berry mentioned the Blackwall tunnel as one of the great works which the president had been engineer to. The institution had visited this work twice during its construction, and was to visit it again. Practice was not much use without theory; a combination of the two was shown to great advantage in Mr. Binnie. To become a competent engineer meant very hard work, and Mr. Binnie was an example of what industry and hard work meant. A happy combination of theory with practice made the best engineers. Men splendid in theory were not always so competent as they might be owing to lack of practical knowledge.

The PRESIDENT, in responding to this toast, said it was an honour to him to preside over such an institution. The management of its affairs was conducted in a creditable

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way. In the matter of passing examinations, no mortals were so thoroughly examined as engineers, who, when in practice, were continually being examined on one subject or another; the engineer being obliged in consequence to keep well in touch with every branch of engineering. The institution was indebted to the hon. secretary (Mr. Dunn) for the able management of its affairs—to him all credit was due.

Mr. DUNN briefly responded, giving it as his opinion that with the hearty co-operation of every member no limit to the ultimate extension of the institution existed. With the working up and faithful carrying out of the objects of the institution the honorary members had heartily assisted, and a great deal of the success in organisation imputed to him had really been due to the valuable assistance rendered by Mr. Binnie himself.

We may mention that the proceedings were enlivened with music between each toast, and a further programme of music after the speech-making wound up a very enjoyable evening.

THE FARADAY HOUSE DINNER.

The old students' dinner in connection with the Electrical Standardising, Testing, and Training Institution, took place on Wednesday last at the Imperial Institute. Lord Castletown, of Upper Ossory, presided, and the large company included Sir Courtenay Boyle, Sir Henry Mance, Mr. R. Hammond, Mr. C. E. Spagnoletti, Profs. Carey Foster, Meldola, Perry, Hudson Beare, Vernon Boys, Mr. H. Edmunds, Mr. Sydney Morse, Mr. C. H. Wordingham, Mr. F. Ince, Mr. J. Swinburne, Mr. E. Garcke, Mr. A. Wright, and many other prominent electrical engineers. After a well-served dinner the toast list was attacked with vigour.

The CHAIRMAN, in proposing the toast of "The Queen," said that during her unique reign, with the assistance of steam and electricity, the machinery of the world's commerce had been evolved.

Sir H. MANCE proposed "The Electrical Standardising, Testing, and Training Institution," and congratulated the past and present students on the advantages which they enjoyed as compared with those which their predecessors had had afforded to them. He remembered the time when Culley's book was practically the only guide the young man had. While praising the Faraday House training, he regretted not to see more prominence given to telegraphy and submarine work. He paraphrased the old saying, "the man who makes two blades of grass grow where one grew before is a benefactor to mankind," to the electrical engineer who makes a cable transmit two words where it transmitted one before deserved well of the shareholders. He referred to the vagaries of a certain electric meter, and thought there was ample scope for work in this direction. After some amusing whale stories, he cautioned the students against despondency if a good appointment was not at once obtained after leaving the school, as all professions were equally difficult to gain a remunerative footing in.

Mr. R. HAMMOND replied, and gave figures to illustrate the rapid growth of the industry. He said that Faraday House was maintained without Government aid, without endowment, and without returning interest to those who had subscribed the necessary capital to start it.

The CHAIRMAN then proposed the toast, "The Past and Present Students." To show the remarkable success of the school he read a list of old students and of their careers after leaving the parent institution. One of these has invented an arc lamp, but we were disappointed to hear no mention of a commutatorless direct-current dynamo.

Messrs. C. D. TAITE and R. G. F. DUMARESQ responded.

Mr. FRANCIS INCE proposed "The Visitors," which toast there were few to drink, nearly the whole company being the guests of the Board of Control.

Sir COURTENAY BOYLE, in reply, said that the past year had not been marked by any great strides, but rather by the steady, uninterrupted progress of the industry. Applications for 50 per cent. more provisional orders had been received. He traced the changes in nomenclature which had first in 1883 replaced the expression "electric fluid" by "electricity," and since this term by "electric energy." He warned the students, past and present, that neither theory or practice without energy would get a man on.

The other toasts were: "The Board of Control and Staff," proposed by Prof. G. CAREY FOSTER, and responded to by the CHAIRMAN and Mr. HUGH ERAT HARRISON, and "The Chairman," proposed by Mr. W. CURLING ANDERSON, and responded to by the CHAIRMAN.

INSTITUTION OF ELECTRICAL ENGINEERS, Jan. 28

At last night's meeting of the Institution the following paper was read:

ELECTRIC INTERLOCKING THE BLOCK AND MECHANICAL SIGNALS ON RAILWAYS.

BY F. T. HOLLINS (MEMBER).

So far as I am aware, there has not been a paper read before the Institution for a number of years (if at all) dealing with the general question of block signalling and electric interlocking on railways. This fact, and the importance of the subject, the improvements in the systems in use, the various arrangements for special purposes, the constant extensions of the application of electricity for expediting and more safely controlling the traffic on our railways, is, I trust, a sufficient apology for bringing the subject forward on the present occasion.

It is obviously impossible within the limits of this paper to give minute and detailed descriptions of all systems of block and interlocking apparatus, but, so far as I am in a position to do so, I will briefly describe those systems of electric interlocking in practical use on other railways, and deal more in detail with the system (Sykes's) of which, being responsible for its adoption, construction, and maintenance on the Great Eastern Railway, I am naturally in a better position to speak with some authority. I trust that those members who are more closely associated with other systems will give the Institution the benefit of their better knowledge and experience by adding such details and other information during the discussion as may seem to them to bring out the advantages, or otherwise, of such systems. I take this opportunity of heartily thanking my colleagues (the Railway Telegraph Engineers) who have been good enough to afford me so much information with regard to these systems.

A little prefatory explanation may be desirable for members unacquainted with railway work. For the purpose of controlling the traffic passing over a railway it is necessary to divide up the line into short sections, varying in length in proportion to the traffic, the point of division being indicated by the provision of a signal-box, having fixed outdoor signals. The signals are usually a distant signal and a home signal, with at busier places a starting signal, and at very busy posts an advanced starting signal for each road, and for sidings, junctions, and cross-over roads there are additional signals for the protection of these connections. These are manipulated by the signalman, so as to indicate to the drivers of trains if they may pass the point where such signals are fixed. The distant signal is merely a caution signal to advise the driver (if it is at danger) that the next signal—that is, the home signal (which is a stop signal)—may be also at danger, and that he must be prepared to stop; but if the distant is "off," he knows that the stop signal is also "off." The mechanical locking ensures this. Prior to the invention of the telegraph (and, I am afraid, for some time afterwards) the running of trains was merely regulated by a time interval. Later on, a system of electric bells was established, to indicate when a train might be allowed to enter a section, and when it had passed through that section. In 1840, an arrangement of electric signalling of trains was first used on the opening of the Blackwall line, between Minories and Blackwall; and at about the same time a needle block was made use of on the Midland Railway through Clay Cross Tunnel. In 1842, a slightly different arrangement was brought into use on the Great Eastern Railway (each instrument showing all the sections) for the whole line between Norwich and Yarmouth, and in 1853 a perhaps more efficient system of needle block and bell was introduced by Mr. Edwin Clark on the London and North-Western Railway. The term "electric block signalling" is generally applied to a combination of electrical apparatus, which, by means of an acoustic and visual signal, gives such indications to the signalman as enables him by a proper manipulation of his outdoor signals to prevent two or more trains getting into one block section upon the same line of rails.

The block systems in general use may practically be divided into two separate groups—those operated by, and the indicators

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held in position by, a constant current on the line (the single-needle, semaphore, or disc instrument) to either indicate in accordance with the polarity of the current, "Line clear," or "Train on line," and normally (by gravity) "Line blocked," and those systems (principally Tyer's), the apparatus of which is operated to indicate "Line clear" or "Train on line" by momentary currents, and the indicators of which are held in that position by the residual magnetism remaining after the cessation of the current which actuates the needles and reverses the polarity of the magnets. There are several variations of both systems; but for the constant-current, three-line wires (one for the up line, one for the down line, and one for the bells), are generally made use of; and for Tyer's apparatus only one wire is required for the up and down line and the bell communication also. The term "electric interlocking"—that is, interlocking the outdoor signals with the indoor block signals—is generally applied to a combination of electrical and mechanical apparatus, which compels the signalman to work his outdoor signals absolutely in accordance with his electrical block signals (both of which are electrically under the control of the signalman at the box in advance), and with the most complete systems so controlling the signalman at the box in advance that neither the block apparatus nor the outdoor signals at the rear box can be operated to admit a following train until the preceding train is absolutely clear of the section. Next to the Sykes system there is no doubt Mr. Spagnoletti's has been the most largely adopted. It is in use throughout the Metropolitan Railway; at perhaps a dozen important places on the Great Western Railway; at the junctions of the Great Northern and Midland Railways with the Metropolitan Railway; and several other points.

Spagnoletti's Electric Interlocking. — The transmitting or accepting instrument is provided with a plunger, two movable discs, and one fixed disc, together with an electromagnet. The outward appearance of the apparatus is shown in Fig. 1, and Fig. 2 is the lock indicator. The three discs in the indicating instrument respectively indicate "Train arrived at" (a fixed disc), "Line clear sent,"

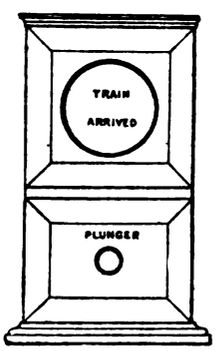

FIG. 1.

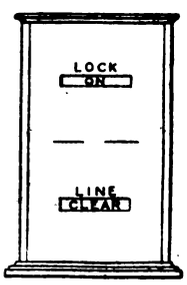

FIG. 2.

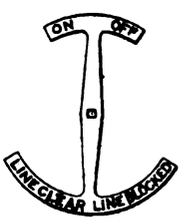

FIG. 3.

and "Train on line coming." The lock-indicating instrument has two discs carried upon the needle of an ordinary single-needle coil, as shown in Fig. 3. The indications are "Lock on" and "Line blocked," given by gravity, and "Lock off" and "Line clear" by a current, and are made to appear before the two apertures in the screen, in accordance with the position of the lock. The coil giving this indication is merely in a local circuit of which the lock acts as a relay. Whilst the lever is in the "off" position a train cannot be accepted, and at junctions of conflicting roads of any kind it is arranged that, having plunged to accept a train from one road, it is impossible to plunge to accept one from the other until the train accepted has arrived and the signal is put to danger. The operation is this: "A" has a train for "B," and gives the "Is line clear" signal on the bell. "B" responds (if the line is clear) by plunging on his accepting instrument (Fig. 1) and his plunger is locked, giving to himself the indication, mechanically (but held by the current electrically), "Line clear sent." This takes out the lock of the section signal at "A," and indicates "Lock off" and "Line clear." When the signal has been taken off, the train passes into section A B, and, after clearing the signal, it actuates a rail contact, which indicates on "A's" instrument "Train arrived," unlocks his plunger for the rear section, and shows "Train on line coming" at "B" by interrupting the current on the line, and causing the "Line clear sent" disc to rise from before it. On the train arriving at "B," and passing over his rail contact into section B C, the "Train arrived" disc is disclosed—the "Train on line coming" disc having been released, and moved by gravity from before it by the same current and coils that unlock the plunger to allow a following train to be accepted. The electric lock is really upon the trigger of the lever, and not upon the lever, or a tappet of the lever, itself. The lock therefore controls the trigger, and the trigger controls the lever. The system described, I am told, is not quite the same as that on the Metropolitan, or the Great Western Railway, but the arrangement described is, as it is recommended by Mr. Spagnoletti, for lines to be fitted with entirely new apparatus. The arrangement at present in use has been adapted to the existing form of block. If I might presume to suggest, I should say that the coils for giving the block indications "Line clear" and "Line blocked" ought to be in the line circuit, and quite independent of the indications of the "lock," for several reasons.

Langdon's Electric Interlocking.—On the Midland Railway Mr. Langdon has in work, I believe, over some 12 or 14 block sections, an arrangement of electric interlocking which was devised by him for use in combination with the single-needle block apparatus, so that the system of block working should remain unaltered. Instead of the usual pin, or locking trigger, to peg over the handle to "Line clear" or "Line blocked," a small pedal on either side of the handle is provided. To give "Line clear," the pedal to hold the handle over in the right direction switches in an additional battery sufficient to operate the lock of the controlling signal in the rear as well as the needle of the block instrument, the two coils being in series. On the "Train entering section" signal being given the pedal pressed down to hold the handle to "Line clear" is released and the opposite pedal depressed to lock over the handle to give "Line blocked" to the rear. In pressing this pedal down the handle or commutator is locked over into this position, and can only be released by the action of an electromagnet which is in circuit with a rail contact fixed a suitable distance ahead of the controlling signal for the section in advance. The transmitting instrument therefore remains locked up, giving the "Line blocked" indication, until the train actually arrives and passes over a Siemens mercury rail contact. The signal must be put to danger behind the train (when it is automatically relocked), or the circuit arrangements in the instrument remain such that "Line clear" cannot again be given. The electric lock consists of a sliding bar or tappet fixed in a slot and suitably attached to the tail-piece of the signal lever. A notch across the sliding bar and the slot serves to receive a small steel bolt (engaging in both bar and slot) carried by a light lever. At the opposite end of this is an armature to be operated by a non-induced electromagnet suitably wound so that the ordinary current of four cells used for the block indications alone will not operate it, the additional battery switched in by the "Line clear" pegging pedal being necessary.

Evans's Electric Interlocking.—On the Manchester, Sheffield, and Lincolnshire Railway there is a modified system of electric interlocking on trial, which is designed to allow of either "absolute" or "permissive" block working. The starting signals are duplicated (both locked), one for the "absolute" and the other for the "permissive," to indicate to the driver if he may proceed under the permission of "absolute" or "permissive" block working. Either signal, as required, can be worked by the same lever. Constant-current needle instruments are employed, and a switch is turned which indicates to the operator whether a train has been accepted from the rear on the "permissive" or "absolute" block system. This switch controls the working, and when it is in one position the "absolute" signal only is released; when in the reverse position, the "permissive" signal only is released. The switch in the instrument at the box in advance being turned to either "permissive" or "absolute," and the handle being pegged to indicate "Line clear," a current is transmitted to the rear box which, by means of a relay in the line, and three pairs of electromagnets acting as an electrical selector and lock, releases either one or other of the signals as required. The man in advance lowers his home signal; the train arrives, and is protected by that signal; and the back motion of the lever locks up the block instrument, and is itself locked until the starting signal has been lowered for the train to proceed, and is again put to danger. Instead of a rail contact, by which the train alone can free and clear the section in its rear, the back motion of the starting signal lever is the final motion permitting another train to be accepted up to that signal. Under ordinary arrangements, so long as the "Line clear" signal is appearing, the lock would stand released, but a special device is provided to break down the lock circuit immediately it is unlocked, and it is only joined up when "Line blocked" is given from the station in advance. This ensures the signal only being used once with the one "Line clear" current, and compels the sending of "Train on line," an excellent arrangement simply effected. On the Caledonian Railway a modified system of electric interlocking has been adopted over about 50 sections of their new city and suburban lines in connection with the ordinary Tyer's three-plunger block instrument, with the addition of a plunger lock, a polarised relay, an electric lock on the starting signal, a Sykes's signal reverser, and a rail contact. The "Line clear" plunger can only be used once to free the section signal in the rear when it becomes electrically locked, and this lock can only be taken off when the train arrives and passes over the rail contact in the section in advance. The same rail contact that clears the "Line clear" plunger to accept another train from the rear box, also, by means of the Sykes's signal reverser,

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puts the signal to danger behind the train as it enters the next section. This apparatus was designed, I understand, so as to allow of the old system of block working being strictly adhered to. The method of dealing with sidings, junctions, and cross-over roads would, I am sure, be interesting, and I invite Mr. Dunn, the company's telegraph engineer, to give us some information on this point.

Tyer's Electric Interlocking. — Mr. Tyer has completed a combination of block and electric interlocking which is (as might have been expected) of considerable merit. The outward appearance of the best form of his old block is retained, and there is every indication of all the different motions that could be desired, using a signal reverser to automatically put the signal to danger, and a rail contact to clear the rear section by unlocking the "Line clear" plunger. The lock is on the trigger of the signal lever, and is a very neat and simple arrangement. The signalman in advance may very effectually block back after accepting a train in case of emergency, and even after the signal at the rear box is off; in fact, he may give "Line blocked" and put the signal to danger too.

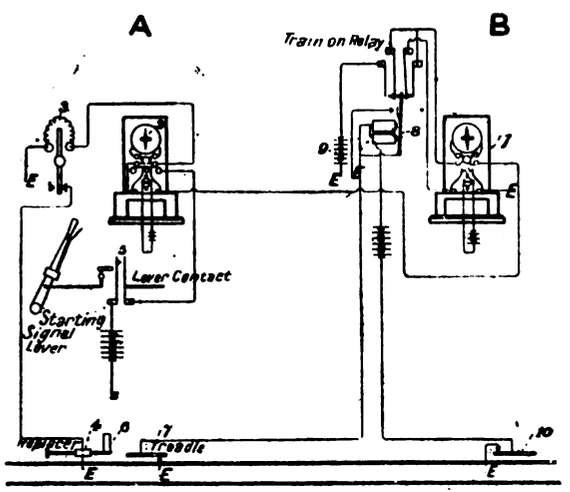

FIG. 4.

Blakey and O'Donnell's Electric Interlocking.—On the Great Northern Railway, Blakey and O'Donnell's electric lock and block is on trial over, I believe, two sections near London. The apparatus, which is as under, seems to be mostly "Sykes's," applied to the single-needle block. There is a Sykes's signal reverser normally discharged, so that the rod does not engage with the arm until the current is received; a lever contact for closing the circuit to the reverser; a polarised relay in circuit, with the block instrument at the rear end of the section; a relay in connection with the block instrument at the advance end of the section; and Sykes's rail contacts or treadles. Diagram Fig. 4 shows the connections.

When the advance station "B" pegs the block instrument to "Line clear," this actuates the block needle, 2, and the polarised relay, 3, at "A," and partially completes a local circuit through the signal reverser, 4, on the starting signal. The signalman at "A" in pulling the signal lever joins up the lever contact, 5. This completes the local circuit; the reverser is geared, and the signal arm, 6, lowered. It will be seen that without this current the lever, if pulled, would not lower the signal. The train passing into the section actuates the rail contact or treadle, 7, and the relay, 8, attached to the block instrument at "B," disconnects the commutator of the block instrument and joins up the battery, 9, which brings the needles of both block instruments to "Train on line." This reverses the tongue of the polarised relay, 3, at "A," and the local circuit being disconnected the signal reverser puts the starting signal to danger behind the train. This state of things remains until the train reaches the second rail contact or treadle, 10, at "B," which, momentarily disconnecting the circuit of the relay at "B," restores the block needles to zero, and the apparatus is ready for accepting another train from "A." The Great Northern Railway Company have also at King's Cross tunnel an interesting arrangement of electric interlocking, utilising the rails as conductors in such a manner as to ensure that any engine with its train occupying the lines shall be fully protected by the signals, and such signals shall not be capable of being lowered until the line is clear. (There is a somewhat similar arrangement to this, minus the signal reverser, on the London, Chatham, and Dover Railway, at St. Paul's.) Diagram Fig. 5 shows the arrangement. Sykes's signal reversers are here again made use of. At King's Cross West the lever working the "main" and the "main to goods" advance signals (either signals worked with one lever as geared), is normally electrically locked, such lock being connected with a polarised relay attached to the block instrument. The signals named are fitted with Sykes's reverser, actuated by commutators at the north end of the tunnel. The rails of the down main line through the tunnel are insulated, as a separate section from the adjoining rails, at each end, and at the north end both rails are in circuit with a low resistance and low E.M.F. battery, as shown; and at the south end the circuit is completed by a relay, the armature of which forms the earth connection of the lever lock and signal reverser. Assuming the down main line to be clear through the tunnel, when King's Cross West gives "Be ready" to Belle Isle down (the signal-box at the north end of the tunnel), the latter pegs his block instrument to "Line clear;" the polarised relay attached to the block instrument at King's Cross West is actuated, and the lever contact released. Belle Isle next either lowers the "down main" or "main to goods" home signal, and the commutator on such signal then earths one pole of the battery. The centre of this battery is connected by wire through the tunnel to a polarised relay in connection with the electric slots on King's Cross West down advance signal, one of which is actuated, and admits of the corresponding arm being lowered. On a down train passing into the tunnel the wheels and axles of the engine short-circuit the battery connected to the rails; the armature of the relay in connection therewith at King's Cross West, being no longer held by the current, moves from the poles of the electromagnet, and thus disconnects the lever lock and signal reverser circuits, causing the signal arm to go to danger, and the lever lock to fall in position to lock the lever when put back. The contact spring in connection with the signal lever disconnects the lever lock circuit when the lever is pulled over. So long as the engine, therefore, remains on the section of line shown, the signal is locked in the danger position to protect it.

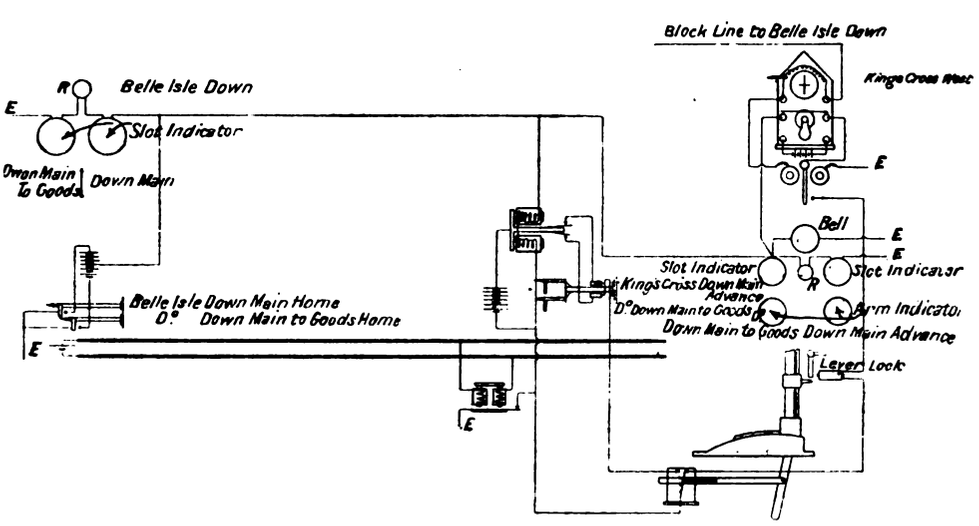

FIG. 5.

Single Lines.—The traffic capacity of single lines of railway has been so largely increased, and the otherwise unavoidable doubling of such lines for some long time deferred, by the adoption of Tyer's tablet system and the Webb and Thompson electric train staff (which is the same thing in another form, but so far as I can see, minus the block), together with the arrangement for interlocking the same with the signals, is well worth consideration. Formerly, each section of a line had its exclusive "train staff," which, delivered

into the hands of a driver, was, except the ticket for the same direction, the sole authority for entering that section of line. If several trains were known, however, to be passing consecutively in one direction, the person holding the staff could obtain from a box, locked up by the staff, a ticket to give to following trains and the staff to the last. If the staff happened to be at the opposite end to a train requiring to pass through, there was nothing for it but to send for the staff and wait. Tyer's tablet instrument is, so to speak, a combination of the block telegraph and the train staff and ticket, the last two being combined as a metal tablet, controlled by and its use controlling the block, the indications of which are given at both ends of the section. A tablet once obtained, the block indications cannot be altered until it is restored to one or other of the instruments controlling the section. Although there may be as many as

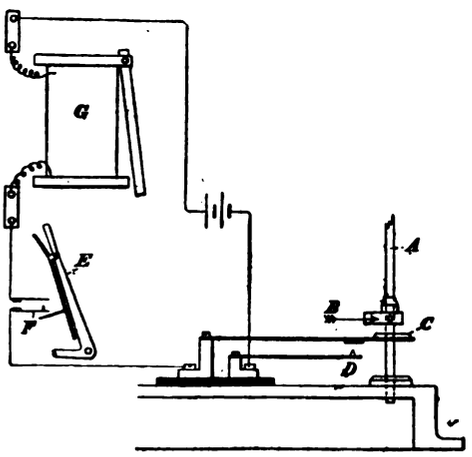

FIG. 6.

30 tablets for the section (half at each end), only one tablet can be obtained at one time ; and this requires the concurrent action of both signalmen. But, as a tablet can be obtained at either one end or the other so long as all are in the instruments, there is no avoidable delay in passing trains through the section. The capacity of the line to carry traffic is then only restricted by the length of the section and the speed of the trains. Having effectually and safely combined the staff or tablet always ready at either end of the section with the block telegraph, it only remained, in order to give the maximum of safety, to electrically interlock this apparatus with the outdoor signals controlling the entrance to the section at both ends to ensure that they could never be contrary the one to the other, and so that the starting signals at each end could never both be off at the same time. The Tyer's No. 6 tablet instrument is too well known to need description or illustration. Suffice it to say, before obtaining a tablet for a train the usual "Is line clear" signal

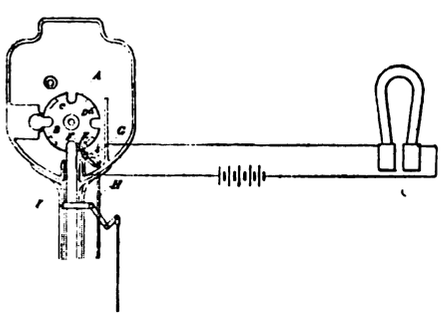

FIG. 7.

is given on the bell, to which, if clear, the signalman at the other end replies by pressing in the plunger of his tablet instrument to release the opposite end commutator, and the signalman offering the train turns the commutator of his instrument, which also unlocks the drawer, and he obtains the tablet. It is the turning of this commutator in the position to obtain a tablet which also releases, by a momentary current, the Sykes's lock on the starting signal. This contact (it is a knuckle-jointed contact) is not made by the back motion of the commutator, but only by the front motion, to obtain the tablet. Mr. Tyer, however, with his signal lever lock, prefers a constant current, with a key (it may be a lever trigger contact) to close the circuit when the lever is wanted. Fig. 6 shows this. The act of turning the commutator to obtain a tablet causes the rod, A, to be pressed down, and the pin, B, then presses into contact battery springs, C, D, which, when the trigger of the signal lever, E, is pressed to pull over the lever, joins the battery by springs, F, to the lock, G, and thus releases the signal. As a tablet can only be obtained at one end, the starting signal can only be taken off at that end of the section where the tablet is obtained. With the Webb and Thompson train staff apparatus the locking is effected by a Sykes locking instrument, applied as shown in Fig. 7. The upper portion of the staff instrument only is shown. The disc, A, is moved round a notch each time a staff is obtained. The small pins, B, C, D, E, on the disc, A, are for the purpose of engaging with the small contact lever, F, as the disc is moved round from right to left in getting out the staff ; and this lever, F, then makes contact with G, closing the local circuit, operating the Sykes instrument, and thus unlocking the lever. Putting a staff into the instrument turns the disc from left to right, and this moves the small contact lever, F, in the opposite direction without making contact with G. When, however, the lock has been discharged and the lever is free, the staff cannot be put in because the rod, H, would prevent the small contact lever, F, being moved by one of the pins, B, C, D, E, on the disc, A. If the starting signal were left off, a staff could not be obtained, as the bolt, I, geared to the signal lever, blocks the passage of the slot in the staff instrument so long as the signal is in the "off" position.

(To be continued.)

The following were the candidates balloted for :

Members.—J. H. Barker, Electric Supply Company, Limited, Cambridge ; E. A. Claremont, Electron, Chorlton-cum-Hardy ; R. Cotton, Capetown Electric Lighting Syndicate, South Africa ; C. H. Gadsby, 102, Park-road, Loughborough ; J. Moss, 37, Arbery-road, Bow, E.; A. C. O'Bryen, 145, Holland-road, Kensington.

Associates.—J. W. Boucher, 12, Dawson-street, Dublin ; A. K. T. Clarke, St. Helens Corporation Electricity Works, St. Helens ; C. Furness, 40, Havelock-street, Sheffield ; W. Gore, 52, Foreign-street, Camberwell, S.E. ; H. Gray, 71, Linnæus-street, Hull ; J. M. Guttridge, Carrville, Alexandra Park, Redland, Bristol ; B. B. Heaviside, 31, Culmington-road, Ealing, W.; A. J. Hodgson, Arc Works, Chelmsford ; W. J. Larke, Homesdale, Mottingham, Kent ; E. D. Long, 20, Queen Anne's-road, York ; G. A. Maquay, 1, Whittingstall-road, Fulham ; S. J. A. Mills, 41, Inverine-road, Charlton ; H. C. Newton, Electric Light Company, Durban, Natal ; E W. Sawyer, 118, High Cross-road, Tottenham, N.; M. Short, Newcastle upon-Tyne Electric Supply Company, Pandon Dene, Newcastle-upon-Tyne ; S. Smith, care of George Findlay and Co , 21, Adderley-street, Capetown ; C. W. Speirs, 21, Sinclair-road, Kensington, W. ; J. C. A. Ward, The Retreat, Haverstock Hill, N.W.; D. Watson, 3, Clifton-crescent, Peckham, S.E.; C. West, Cross Cheaping, Coventry.

Student.—C. W. Fourniss, 2, Rainton-terrace, Rainton-road, Charlton.

FORTHCOMING EVENTS.

The following are some of the announcements for forthcoming week :

TO-DAY (FRIDAY).—Royal Institution (Prof. J. C. Bose on "The Polarisation of the Electric Ray"), 9.—Electro-Harmonic Concert, Regent-street, 8.

TO-MORROW (SATURDAY).—Royal Institution (Mr. Carl Ambruster's second lecture), 3 p.m.

MONDAY, FEBRUARY 1.—Society of Arts (third Cantor Lecture on Pottery), 8 p.m.—Society of Engineers' meeting, United Service Institution, 7.30.—Royal Institution (general monthly meeting), 5 p.m.

TUESDAY, FEBRUARY 2.—Institution of Civil Engineers, 8 p.m. (discussion of the Periyar papers and paper on "Cold Storage at the Docks").—Royal Institution (Dr. Waller on "Animal Electricity"), 3 p.m.—Willans and Robinson Company's meeting, Cannon-street Hotel, 2.30 p.m.—St. James's and Pall Mall Company's meeting, Carnaby-street, W., 12.30 p.m.—Junior Engineers (Mr. Nixon on "Dynamo Design"), Westminster Palace Hotel, 8 p.m.—Society of Arts (Sir C. Dilke), 8 p.m.

WEDNESDAY, FEBRUARY 3 —Society of Arts, 8 p.m. (Right Hon. Horace Plunkett, "Industrial Progress of Ireland").—Also at Liverpool (Mr. T. M. Bigley on "Electric Tramways"), Liverpool Engineering Society.

THURSDAY, FEBRUARY 4.—Annual general meeting of the Institution of Mechanical Engineers at 25, Great George-street (and on Friday).—Central London Railway Company's meeting, Cannon-street Hotel, 3 p m.—Institution of Civil Engineers (students' visit to Messrs. Elliott's works), 2 p.m.—Royal Institution (Prof. Miers on "Crystals"), 3 p.m —Society of Arts, Howard lecture (Prof. Ewing on "The Production of Cold"), 8 p.m.—Also at Dundee, Institute meeting.

FRIDAY, FEBRUARY 5 —Royal Institution (the Bishop of London on "The Picturesque in History"), 9.—Anglo-American Telegraph Company's meeting.—The Prince of Wales distributes the certificates to the scholars and exhibitioners of the Technical Education Board of the London County Council at the Queen's Hall —Institution of Civil Engineers' students' meeting ("Pelton Water-Wheels"), 8 p.m.—Dinner to Dr. Nansen by the Royal Societies' Club, 7 p.m —Also at Paris, meeting of the French Society of Civil Engineers.

SATURDAY, FEBRUARY 6.—Royal Institution (Mr. Ambruster's third lecture).

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TO CORRESPONDENTS.

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All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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INSURANCE.

The paper of Councillor G. Pearson, of Bristol, read yesterday before the Municipal Electrical Association, raises a question of great importance. We are compelled to write in advance of the discussion, but it seems to us that such a discussion, though interesting, must be purely academic. A somewhat intimate acquaintance for many years with the insurance world leads us to believe that profits so far as fire risks are concerned are not so large as dividends paid warrant one to believe. There was a time when fire insurance risks proved greatly profitable, funds accumulated and were well invested, so that in some cases the results of past working greatly assist the balance-sheet of to-day. We do not mean to say that fire risks are or have been unprofitable, but simply to insist upon what we believe to be the fact, that the profits are not so great as the general public imagine. One other view of the case would lead to the same conclusion. It is that, though numerous attempts have been made of late years to float competing companies, most of these attempts have ended in absolute failure. Then, again, the earnings of some of the companies mentioned are mostly from life risks and not from fire risks. The dividends paid are not paid fractionally so much from the fire risk profits and so much from the life risk profits, but in the lump, and the recipients do not know which branch of the business pays most, nor do the public. The exact state of affairs is only known to the offices' officials. Before, then, any combination for mutual insurance can take place it becomes necessary to know a great deal about risks, and the experience of the different risks is in the hands of the companies. The present premiums are based upon the experience of many years of business, and the proper premiums for any class of risk is a troublesome thing to ascertain. No doubt, however, Councillor Pearson is perfectly correct in describing "municipal risks, as a rule, are good." There is no reason why their buildings should not be of the best material, well constructed, their appliances to meet any sudden outbreak of the best, in good order, and in the hands of men trained and exercised in their use. Perhaps the suggestion will be scouted, but nevertheless it may be a fact that for the most part corporation property is woefully under-insured. A price cannot well be put upon ancient buildings, upon municipal records, upon pictures, plate, glass, and a hundred other things of the heirloom type. Only the greatest care and diligence will ensure these treasures being handed down to future generations. Even when we consider the merely modern portion of municipal enterprise, that connected with dock work, with gas, water, and electric light enterprises, with model dwelling-houses and similar buildings, the question of insurance is not easy. Many shipowners do partly or wholly insure their own vessels, and we might be prepared to agree that on the whole self-insurance is a paying game, yet confidence and wealth are required before undertaking the risk. Experience proves that a certain percentage of risks will be a loss; the doubtful point is, which risks out

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of the hundred will cause the loss. There is no municipality in this country that would dare to contemplate self-insurance, as they would feel that the proverbial uncertainty would end in a probable certainty and a disastrous loss.

When we come to consider merely the insurance of central stations, Mr. Pearson evolves a somewhat novel idea. It must be remembered that municipalities generally borrow the money and pay it back by instalments over a term of years. We assume the station pays. Then, out of revenue, the annual or semi-annual instalments to repay capital have to be found, all costs of production, distribution, and maintenance, and, of course, insurance premiums. The balance after these payments is profit, and how such profit is to be used is a question to be settled by each authority. Some maintain that if the profit is sufficient, the charge per unit to the citizens should be lowered. Others decide against too low a price, and prefer to diminish the rates by the surplus. To us, the former seems to be the proper plan, otherwise a portion of the community—viz., those using the lights in their houses—contribute something to the benefit of those who do not use the light and yet are ratepayers. However, Mr. Pearson's idea is to doubly insure for a time—once in the ordinary way, and, secondly, by starting a reserve insurance fund out of the available surplus. Surely the present generation of ratepayers have enough to do in presenting their descendants with a central station in full working order at a cost of nothing, and it is hardly fair to saddle them still further with an insurance fund for the possible benefit of future ratepayers. The present ratepayers may well say, "We find the money to build and equip—borrowed, it is true—but repay gradually, so that twenty or thirty years hence there will be no outstanding capital, yet there should be a station almost or quite as good as new; for a station must, to be of service, be kept in the highest state of efficiency. Hence, those who succeed to the estate ought not to grumble, but be quite ready to pay insurance without us having to provide this for them also." However, as we say, the whole question is very interesting, and it is well it has been brought forward.

Writing after the discussion is finished, we regret that some attention was not paid to the well-known causes of the increase in the rates and to the best means of reducing the fire risks from the electrical engineer's point of view.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

BIRKENHEAD ELECTRICITY WORKS.

SIR,—We notice in your issue of to-day that in the account you give of the Birkenhead electricity works you state, respecting the accumulators, that "upon the concrete and surrounding slabs is placed a layer of roofing felt, and then a layer of bitumen." We therefore take the liberty of informing you that the material employed is our "anti-sulphuric enamel,"* which has been used upon nearly all the electric light stations working with accumulators. Under the principle of "give the devil his due," we trust you will favour us by inserting this slight correction in your next issue.—Yours, etc., GRIFFITHS BROS. AND CO.

Aquol Works, Macks-road, Bermondsey, January 15, 1897.

[* Our correspondents do not say where the enamel is used, and we doubt the statement that anti-sulphuric enamel is either roofing felt or bitumen.—ED. *E. E.*]

CRYSTAL PALACE ELECTRIC SUPPLY COMPANY.

SIR,—With reference to the report of an alleged fire at this company's sub-station at Westow-hill, Upper Norwood, which appeared in your last week's issue, I write to inform you that the account furnished to you was inaccurate. The facts were, two coils in the armature of one of the motor-dynamos gave out, and the resulting smoke gave colour to the fact that there was a fire. No damage whatever was done to other parts of the machine, as is shown by the fact that, with a new armature fixed, it was working in the supply well within 24 hours of the mishap. There was no interference in the supply of the district, and not a trace of fire in the building.

I shall feel obliged if you will give the same publicity to this letter as you did to the report under notice.—Yours, etc., HERBERT J. BUXTON, Secretary.

Upper Sydenham, S.E., January 26, 1897.

FIRE RISKS AT ELECTRICITY WORKS.

MEETING OF THE MUNICIPAL ELECTRICAL ASSOCIATION.

A special general meeting of the Municipal Electrical Association was held yesterday (Thursday) morning at the Westminster Palace Hotel, to consider the question of fire risks at electricity works. There was a fair attendance of members, and the chair was taken by the president, Mr. C. E. Wordingham, of Birmingham.

The PRESIDENT, in opening the meeting, said: Gentlemen,—As you all know, the fire insurance offices recently have seen fit to raise to a very material extent the rate of premium demanded for electrical lighting stations and accessories connected with them. This action on their part has very naturally given rise to a feeling very near akin to indignation on the part of electric lighting undertakers, because they don't see why this action should have been taken, and taken, moreover, quite irrespective of the particular conditions pertaining in each station. In view of the great public interest which this has given rise to, it seemed good to the committee of this association to call together a special meeting, so that the matter might be thoroughly discussed, and so that the chairman of committees and engineers of towns could exchange their ideas on the subject. One of our members—Councillor Pearson—has been good enough to prepare a paper on the subject to read at this meeting, and that will form the groundwork on which the whole matter may be discussed. I think it is well that I should point out before we begin the discussion what is the scope of this meeting. As a body we are not in a position to take any action in the matter. What we have to do is to lay down what is the general feeling of engineers and committees throughout the country so far as we represent them on this subject. We can then say, "this is our united opinion," and that will form a guide to each corporation or municipality in dealing with the matter. It is, of course, a complicated matter, and in many cases can only be dealt with by the individual corporation, so that, I take it, after the discussion is over, a resolution will be moved to the effect that we consider—or, rather, this meeting considers—that such and such line of action is desirable, but not in any way committing the members here to take that line of action. It is merely an expression of opinion, and that, I think, is really the extent to which we can go. I should like to say that, through an unfortunate mistake in one of the technical papers, this meeting has been announced to take place in the afternoon instead of the morning. It is no mistake of their

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secretary, but simply, I suppose, due to the carelessness of the "printers' devil." I think that will account for the attendance being a good deal smaller than it otherwise would have been, but it is curious that this is the second time that the mistake has been made by the same paper about this very meeting. You will remember that at the convention last year all the papers were read in abstract, but as we have only one paper to-day I think it will be better in all ways if I ask Councillor Pearson to read the paper *in extenso*.

Municipal Insurance.

BY G. PEARSON.

When I was first requested to write this paper I entertained considerable doubt as to whether it would not be desirable to confine the discussion to the subject of the insurance of municipal power stations only, and not to discuss the general question of the insurances of the general properties belonging to municipalities, but on consideration I think it will be best to discuss the whole question rather than to confine my remarks to power stations alone. No one doubts but that the business of an ordinary well-managed insurance company is exceedingly profitable, but if proof is wanted it will be found in the figures given

COUNCILLOR G. PEARSON.

in the table below, which show the value of the shares in a few good insurance offices :

Company.	Amount originally paid per share.	Prices per share.	Dividend paid per share Per cent.
Atlas	£6 0 0	£21 10 0	17
Caledonian	5 0 0	30 0 0	23½
Commercial Union	5 0 0	32 0 0	25
Liverpool and London and Globe	2 0 0	46 10 0	75
London Assurance Corporation.....	12 10 0	51 0 0	20
London and Lancashire.....	2 10 0	16 10 0	20
Manchester	2 0 0	8 10 0	12½
North British & Mercantile	6 5 0	36 0 0	16
Northern	10 0 0	63 0 0	22½
Norwich Union	12 0 0	95 15 0	37½
Royal.....	3 0 0	47 0 0	57½

From these figures it will be seen that the premiums paid cover all risks, and leave a considerable margin of profit for the investors in this class of shares.

It may assist the discussion if I explain the position of the city with which I am best acquainted—viz., Bristol—in the hope that others may thereby be induced to give us the benefit of their knowledge of the position of other towns, as by these means accurate information may be obtained as to the position of many towns throughout the country, and we shall be thereby freed from the risk of generalising on too narrow a basis. Bristol, like many other towns, received a notice from the company with which its power station was insured of a great increase in the rate of premium—viz., from 5s. to 10s. 6d. A sub-committee was appointed to consider the question and to report. The committee met and received information as to the insurance of the various civic properties, from which it appeared that the docks property was insured for £339,535, at a premium of £1,085. These risks were taken by the company subject to the fire offices tariff. The property is insured through the Hand-in-Hand Office, and has the advantage of that company's bonus return system on the portion retained by them, which provides that in cases where no claims are made the premium is returned once in every five years, a reduction of about 20 per cent. The properties in the hands of the sanitary department are insured for £33,199 in the Yorkshire Office, at a premium of £36. 5s., equal to 2s. 2d. per cent. In this policy there is the average clause, which protects the office against under insurance by the Corporation. There are other smaller policies at special rates, such as hospitals, port hospital ship, steam launch, road-roller, boilers, etc., making a total insurance of £58,199, at a premium of £152. 13s. 7d. The city properties in the hands of the Finance Committee are insured for £318,264, at a premium of £265. 10s. 8d. The electric light station and plant are insured for £14,000, at a premium of £74. 0s. 6d., less £15 per cent. commission. The aggregate amount of the municipal insurances in Bristol is £730,098, and the premiums amount to £1,577. 4s. 9d. From these figures it will be seen how various are the properties owned and insured by the Council of the city of Bristol, and how various are the natures of the risks.

After considering the foregoing and other information, the sub-committee reported to the Electrical Committee recommending the committee to reinsure for the year at the increased premium, and asking instructions as to any further consideration of the matter. The sub-committee were requested to further consider the question and to report. After having further considered the question the sub-committee recommended the committee to approach the Fire Insurance Tariff Committee in May or June, 1897, when they would have had further experience in Corporation central-station risks, and the committee would have plenty of time before their policy expired to make other arrangements in the event of no satisfactory terms being made by the insurance company. We shall doubtless at no distant date reconsider the question, and I trust the discussion of to-day will assist the future deliberations of the Bristol Electrical Committee. I will now proceed to consider some of the suggestions from time to time made for solving the problem of municipal insurance.

First.—Shall we abandon insurance altogether? This in Bristol is a subject of considerable magnitude, and, being in the hands of four committees, unanimity would be difficult to obtain, and in the absence of any nucleus of an insurance fund would be one of grave risk. Indeed, so grave a risk that I can scarcely believe the Docks Committee would feel justified in running it. Personally, I believe it would in the end pay, but the risks would fall on the ratepayer of to-day, who would first have to take the risk of an absolute loss by a big fire, and in addition would have to contribute a payment to a fund to provide the ratepayer of the future against the risk he of to-day is taking. I think these reasons would weigh very heavily on the Council in the event of any discussion taking place having for its object the proposal for a general abandonment of insurance by various insurance offices, and the suggestion that the Council should assume that responsibility itself.

Secondly.—Shall we insure partially? A suggestion has been made by a gentleman having considerable experience in the insurance against marine risks that the Council should begin by becoming its own insurers for one-half of the value of its properties. This suggestion appears to meet some of the difficulties of the former suggestion. The ratepayer of to-day would not assume such serious responsibilities, and the half-premium saved from the insurance company would in course of time form the nucleus of an insurance fund, which may ultimately induce the ratepayer of the future to assume the whole responsibility of a total abandonment of insurance by means of insurance companies. The large profits made by all well-managed insurance companies, as appears from the foregoing figures, would seem to show that the average premiums more than cover average risks, and the action of the Tariff Committee in the matter of the insurance of electric light stations would appear to show that in the absence of any alternative proposals there is very little chance of any material reduction in the charges now made by them, and which their complete system of combination enables them to extort from the insuring public.

Thirdly.—Shall the electrical committees of all municipalities abandon the insurance of their stations? To this question, so long as the present rate of premium exists, I have no hesitation in answering, yes. The premiums extorted by the Tariff Committee by means of the combination to which I have before alluded are in excess of what is required to cover the risks, and have in my opinion been increased, not on account of fires at electric light stations, but on account of fires at electric appliance manufactories. But the first question that arises is not who shall "bell the cat"—we are all ready to do that—but "How shall we bell the cat?" The difficulty I have before pointed out as to starting an insurance fund exists here, but to a smaller extent. The risk is not very large, but there may be difficulties in inducing a town council to face it, small though it is, especially when the natural fears of a councillor are increased by the active canvass of interested insurance agents. But I see one way out of the difficulty. There are few towns

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which are not by this time either making a profit or fast approaching that much-desired time when they will, and I would suggest, as a means of cutting the knot which we find it impossible to untie, that electrical committees should ask their councils to allow them to use the first profits made for forming an insurance fund—say in Bristol of £4,000 or £5,000, other towns forming such funds as they think the size of their stations demand. The interest on this fund, plus a very small annual payment, would in a few years place each electrical committee absolutely out of the reach of fire risks without the intervention of a profit-earning company, and without any appreciable call on the ratepayers. This would remove the one great difficulty in starting an insurance fund—viz., the necessity of appealing to the rates to raise it in the first instance. Personally, I should scarcely feel justified in allowing a municipal electric lighting undertaking with which I was connected to remain uninsured without any fund in hand to meet a possible loss without making a serious call on the rates for the half-year in which the fire occurred.

Suggestions have been made for a mutual insurance fund to be formed by municipalities for general insurance. This has, at first sight much to recommend it. The municipal risks are, as a rule, good. The credit of the parties concerned is unquestionable, and these characteristics would appear to promise an ultimate success. But on further consideration, difficulties suggest themselves.

First.—Have corporations the necessary power to join together and mutually guarantee each others risks? Personally, I cannot say that I think they have. But this difficulty can be removed by legislation, supposing a case to be made out for the change. But assuming this to be done and power to be obtained, on closer consideration are the risks so simple and so uniform in character as they at first sight appear? Let us examine my own town—Bristol. We do the whole of our scavenging by means of men in our employ, and by means of our own horses and plant. We should therefore require stabling for 200 horses, with the necessary plant, carts, harness, and also the accompanying workshops for the production of carts and harness, to be covered, and in addition we have a dock undertaking to be covered to the extent of between £300,000 to £400,000, with risks greatly varying in degree, to say nothing of the electric light undertaking itself. It appears to me to be too much to hope that an ordinary town council employing contractors for its scavenging, having no trading undertaking such as our Bristol docks, in fact having only municipal buildings and possibly municipal estates to cover, would be prepared to join a town situated as Bristol is at this moment, and make a mutual insurance of such very varying risks. If this is so, then we are driven to differentiate our respective risks and charge increased premium for one risk as against another in different towns. Then we get to the position of an ordinary insurance company with varying premium, and should, I am afraid, ultimately find ourselves quarrelling as to rates precisely as we are now, the only difference being that now we quarrel with the insurance companies, and then we shall be quarrelling amongst ourselves. A further suggestion has been made for the formation of a mutual fund for the insurance of municipal electric lighting stations alone, but the same difficulties present themselves in a slightly modified form. The electric risks of various towns may not vary to the extent I have pointed out in the case of general risks, but I think few will deny that the risks would vary very much, and in seeking to correct these variations we should find ourselves driven back again to a varying premium, with the endless possibilities for disputes as to amounts. In the face of these difficulties I cannot see any reasonable hope of forming a mutual fund for general municipal insurances, or even for the insurance of electric lighting stations alone, and I must await the evolution of a workable scheme by some man of greater experience than myself.

Having looked at this question from various points of view, I am driven to the conclusion that the best arrangement is for each town to seek to become its own insurer.

First.—As to general risk. By becoming, in the first instance, its own insurer in part only, accumulating the premium saved to form the nucleus of an insurance fund, and setting aside half-yearly a small additional sum from the rates to aid in the formation of the insurance fund, and by these means a fund may be raised in a few years of sufficient size to justify the abandonment of ordinary insurance altogether, the period of total abandonment depending greatly on the freedom from fire losses in respect of the corporation properties.

Second.—As to its electrical risk. In this case the difficulties are not so great, as I have said before there are few installations in existence which are not fairly well built, and where profit is not already being made, or will be made at no very distant date. Nothing would be easier, in my opinion, than to obtain leave from the council to set aside a fund equal to the profits of the electric light installation for a few years to form an insurance fund; and even if the council declined to set aside a sum equal to the whole profits they may be induced, at any rate, to set aside a portion of the profits; in which case the day when ordinary insurances could be abandoned would only be delayed a short time longer, and failing the adoption of either of these courses the only other alternative I see is to assist in the formation of several non-tariff offices. One would be of no use, as it would be boycotted by the tariff offices, and therefore incapable of reinsuring. This last suggestion I look upon as a last resort in the event of the previous suggestions failing to meet with the approval of town councils generally, and not to be seriously entertained until the other proposals have either failed to obtain a trial, or have failed after having obtained it.

Discussion.

Councillor F. Longbottom (Huddersfield) said he was not there to give advice, but to get information. An idea had struck him since reading the paper, and that was that so far as his knowledge went he should be in favour of corporations being their own insurers. From what he had seen of different electrical stations, he found that some of them were in a very dangerous state as regards fire risk. They appeared to him to be just ready with the least touch to blaze away and be destroyed directly. Others, again, were so constructed that it was almost impossible for them to take fire. If a mutual corporation insurance company were formed, he thought they would have to adopt some sort of sliding scale of premiums according to the risks. By insuring the whole of their property, corporations could get a fund together that would meet all emergencies. He knew that many years ago some of the great shipping companies in London dropped their insurances, and through doing that were able to build a ship every year out of the insurance money they saved.

Alderman Higginbottom (Manchester) thought that the discussion would have taken the form of the insurance of electric lighting stations instead of a general discussion on the disadvantages of insuring municipal buildings as a whole. He agreed with the writer of the paper that he could not see how municipal corporations could form themselves into a combined association with a view of insuring each town under one insurance company, taking the varying risks of each town. In fact, they had no power to do any such thing. Special legislation would be necessary, and some of them knew very well what that meant. They would have to wait a very long time, in his opinion, before legislation would interfere to enable one corporation to pay a certain amount of money per year towards the risk of fire in another town, over which it had no control, except virtually the control of a committee which would have to be formed. The varying risks would be such that it would take the whole time of assessors to assess them, and the varying rates and premiums which would have to be paid accordingly. Therefore he put on one side entirely the practicability of making a mutual insurance fund among corporations for general purposes; and he thought these reasons applied equally well to municipal electric lighting stations. He had never come across such a dangerous station as mentioned by the last speaker, but they, as electrical engineers, must know that there was a great difference of risk between one station and another, where one was high tension and the other low tension, and so on. In Manchester the public buildings were insured for £689,000, though that, of course, did not represent anything like their real value, and on that account they paid £800 or £900 in premiums every year. It would take a good many years' premiums if they were to set the whole of the premiums on one side to form a fund to cover their general risks, before such a such a fund could be formed as would cover such large risks as were incurred in the city of Manchester. There were 13 committees who insured, and during the last 20 years they had paid £12,500 in premiums, and had drawn out £3,611, of which £2,670 was taken by one committee—the Cleansing Committee—whose department included the stabling and provender. With regard to the electric lighting, that was a very different matter. If they were a profit-making committee, they should set apart a portion of that profit as a reserve fund for fire insurance. In Manchester they had set aside in two years £16,000 as a renewals and contingency fund—and fire was a contingency. But if they were not making a profit, they would find it very difficult to ask their Council to increase that loss by setting an additional sum aside for insurance.

Mr. C. S. Vesey-Brown (electrical engineer, Lincoln) saw no reason why an electric light station need be insured against fire from the point of view of engineering plant, but he saw great reason why it should be insured against extraordinary risks, which most electric light stations in this country were surrounded by. The site at Lincoln was between a flourmill and a sawmill, and it seemed to him they had to insure simply to protect themselves against careless accidents which their neighbours might bring about. The station itself consisted of concrete and brickwork with iron roofs, and there was absolutely no reason why it should be insured except because of its proximity to its neighbours. He thought that the towns which would most benefit by the municipal insurance scheme would be the small towns such as Lincoln, because he took it that in large towns a ½d. or ¼d. rate would cover any damage done by fire, but in the smaller towns it would mean a very heavy pull on the ratepayer's pocket.

Alderman Ellis (Portsmouth) said at their station they had fire appliances in every possible position. There were 4in. standards on the staircases, in the offices, engine-room, boiler-house, and in every conceivable position, besides hose and all the necessary appliances. They also drilled their men, and had a telephone direct to the fire brigade station. There were no buildings absolutely adjoining them, so they were free from external

possibilities of fire. He thought it was very desirable they should put aside some portion of their profits to form a renewals and contingency fund, for he agreed with a previous speaker that fire was a contingency.

Mr. H. L. P. Boot (of Tunbridge Wells) believed in the mutual insurance company. He suggested that a working committee of one from each town should manage the affairs, and that the rates should be fixed by averages for each class of risk. These men, called X for some reason, should meet twice a year, having travelling expenses only paid. A good assessor and secretary only would be wanted on the paid staff, but these should be paid at higher rates than borough electrical engineers, as good men were wanted for this work. He did not believe in applying profit to any insurance fund, but rather would use it to relieve the rates.

Alderman Porter (of Taunton) described the trouble he had had over the insurance question at Taunton. They paid originally 4s. per £100 on the generating station, and 5s. on the sub-stations, which were in his opinion far less risks. Now an increase in the rates had been demanded, rising them 7s. 6d. to 10s. 6d. per cent. He claimed that Taunton was the first town in England to take up electric lighting of the public streets.

Alderman Calvert (Huddersfield) said corporations had no power to form insurance companies among themselves. There was nothing to prevent them becoming their own insurers, but he was afraid until they got a special Act of Parliament they had no power to join with any other corporation to effect insurances on corporation property. The insurance companies had treated the electric lighting undertakings in a very high-handed manner. In Huddersfield their insurance was raised from 2s. per cent. to 7s. 6d. per cent., so the committee decided to withhold the premiums, and at present they were not insured at all.

Mr. Ram (electrical engineer, Coventry) spoke as to the general ignorance of insurance inspectors. He had taken many and many of them round electric lighting works, and had never found one who knew anything at all about the subject. They saw hydrants here and hydrants there, and took all sorts of notes and measurements, when perhaps all the while there was a resistance frame placed against the matchboarding, which was badly scorched in consequence.

Mr. Arthur Wright (electrical engineer, Brighton, ex-president) said he should just like to help his brother electrical engineers by showing what could be done by kicking. At Brighton, when they had a wooden station with a wooden switchboard and no fire appliances, they were charged 2s. 6d. per cent. In two years' time they put in fire hydrants, removed the wooden switchboard, and then their premium was raised to 5s. Next year they borrowed £1,000 for fireproofing their roof and removing all combustible material, and the result was that the charge was raised to 10s. 6d. Then the committee could stand it no longer, and decided to refuse to pay it. That brought the outside companies to them, and they accepted an offer of 5s. per cent. for the purpose of breaking up the ring.

Councillor Willoughby (of Plymouth) said that small towns could not afford to take the risk of being uninsured. He thought that their object should be to break up the ring of insurance companies. They should arrange to insure in non-tariff offices which are backed by underwriting associations, such as Lloyd's.

Mr. A. E. Pycraft (the clerk of the St. Pancras Vestry) said that mutual insurance was hardly feasible without special legislation. The debate had been rather too general, and he thought it would be more useful to collect details of the total value insured and the total premiums paid by all electric light stations. At St. Pancras they commenced by paying 2s. 10d per £100 on their first station; two years afterwards this was raised to 4s. 6d., and then one year later to 7s. 6d. Hence he made enquiries before insuring the new station, and had got the Fine Arts and General Insurance Company to do it for 2s. 6d. per cent.

Alderman Woodhead (of Halifax) thought that the topic for solution was not sufficiently definite. He noticed that Bristol insured up to the hilt. Even their steam-roller was protected against fire. He believed that with a mutual arrangement the premiums could be reduced by 50 per cent.

Mr. W. L. Madgen was glad to hear the excellent paper Councillor Pearson had read. He should, however, like to hear the insurance companies' side of the question. It behoved the electrical engineers to put their houses in order to prevent recurrence of fires. The fires at Sardinia-street and at Chelmsford had given the companies a fright, which had, he thought, caused the increase in rates.

Councillor Phythian (of Manchester) considered the companies to be perfect brigands. His Council were taking up the matter, and were, he thought, likely to go in for self-insurance. Thus he noticed that their premiums for boiler insurance amounted to £240 per annum, which would provide a new boiler per annum. He thought that the present charges could be reduced by 75 per cent. If the Corporation were to put by now an amount equivalent to 10 years' premiums, this would form a nucleus which, assisted by the annual payment, would give a safe insurance.

Mr. J. H. Rider (of Plymouth) suggested that the corporation should cease insuring one property at a time, dropping more policies as their fund increased. He would commence by ceasing to insure with the electric light works as the most safe.

Mr. Albert Gay (of Islington) did not think that mutual insurance of corporation property would take, as each body liked to manage its own affairs independently. It was, in his opinion, too risky a course to give up insurance altogether, and he thought the companies should be pressed to grant a sliding scale in proportion to the safety of the buildings.

Mr. H. W. Cousens (of Taunton) said that small towns could not follow the lead of large towns in self-insuring their property. He thought that even those companies outside the tariff ring were growing shy of insuring electric light property. We were suffering in this respect from the faults of a previous generation.

Mr. W. J. Searl (the chairman of the Electric Light Committee of Hammersmith) considered that all small towns must insure. A rise in the rates similar to that now complained of had been experienced in the printing trades due to a few bad fires.

Mr. H. Faraday Proctor (the engineer at Bristol) agreed with the chairman on most points. He considered the present rates for different municipal property most unfair; thus a library full of inflammable material was charged at much lower rates than the electric light station. He advised that the change to self-insurance should be made gradually, the premiums on the non-combustible portions of the stations being dropped first. He thought that sub-stations under the streets were practically safe. An interview with representatives of the fire insurance company to discuss the matter might do good.

Mr. C. Wordingham, the president, closed the debate. He agreed with the proposal to establish an insurance fund out of profit. Those corporations which were not in a position to do this at present should continue to insure in non-tariff offices.

Alderman Calvert (of Huddersfield) then moved the first resolution as follows: "That, in the opinion of this association, the action of the insurance offices in raising the rates of premiums for the insurance of electric generating stations is quite unjustifiable, and in their opinion some joint action on the part of municipalities is called for in consequence."

Mr. G. H. Cottam (the electrical engineer to the Hampstead Vestry) seconded the motion. He had had a good deal to do with fire office inspectors, and while he liked them personally he thought few had any idea of what to look for when inspecting. He was called in the private house of an inspector whose fuse had gone, and who claimed the whole of the arrangements as his own. Mr Cottam found that the simplest rules had been ignored, and he doubted if in the case of fire that house would have "risen like a phœnix from the ashes." One inspector going over his station demanded a fireproof door between the boiler-house and engine-room. The speaker advocated that the practice of insuring such parts of the station as the boiler-room should be discontinued. He had pleasure in seconding the motion.

The motion was then put, and carried unanimously.

Alderman Higginbottom moved the second resolution, as follows: "That, in the opinion of this association, the most feasible method of providing against risk for fire in electric generating stations is for each municipality to set aside each year from the gross profits a certain sum to form a fund for the purpose of meeting such risks; and where the profits do not admit of such sum being set aside, it is desirable to insure in those offices which are willing to investigate each risk on its own merits."

Mr. Arthur Wright seconded, and the resolution was carried.

Mr. Vesey-Brown proposed: "That, in the opinion of this meeting, it is desirable for the committee of this association to ascertain the capital insured in electric lighting stations (excluding the cost of mains and the capital involved in the laying of mains), the premiums paid, and, if possible, the bases of assessment made by the insurance companies, and to report the result of their investigations at the annual convention."

Mr. Mountain seconded the resolution, and it was carried.

Mr. Pearson having replied to the discussion, describing his personal experiences with the insurance companies and their officials, a vote of thanks was passed to him for his valuable paper.

A vote of thanks was also passed to the president for taking the chair.

RADIATION.*

BY C. M. DORMAN.

(Continued from page 118.)

Now let us bend our lath and let it fly back—in electrical language, charge the condenser and discharge it. The force with which it starts to fly back will, for a given amount of bending—electrical displacement—depend not only on the shortness and thinness (geometrical dimensions) of the lath, but also on the pliability of the material of which it is composed. Connect the plates, A B (Fig. 3), of a charged condenser by means of a piece of copper wire, C C C. The potential energy will immediately commence to become kinetic, and a current will flow round the circuit, accompanied, of course, by the usual magnetic field. The energy necessary for the production of this field is analogous to that required to endow mass with velocity, and the mass in question is the inductance of the circuit, C C C. By the time the plates, A and B, have arrived at the same potential, the energy of the system, which is now entirely kinetic, will cause the change of potential to continue until the condenser is again charged, but with the polarity of the plates reversed. At this point the energy is all potential again. Our bent lath has now flown back and overshot its centre mark until it has come to rest on the other side of the centre. The energy of the charged condenser, like that of the vibrating lath, will continue to oscillate backwards and forwards, now potential, now kinetic, until at last it comes to rest in the centre. The time occupied by a complete oscillation of the condenser depends on three things: (1) capacity which is com-

* Presidential address, delivered January 11, 1897, before the Northern Society of Electrical Engineers.

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parable to length, thinness, and pliability in the vibrating lath; (2) inductance of discharging circuit, which may be represented by loading the free end of the lath with a pendulum bob; (3) the resistance of the discharging circuit, which may be compared with the viscosity of the medium in which the lath vibrates—discharging the condenser through a piece of wet string being like immersing the lath in a bath of treacle. To obtain a very low swing or periodicity the capacity must be great, and large plates very close together must be used. If in the plate condenser shown in the figure glass be used as the dielectric between them instead of air, the capacity will be increased sixfold. For great slowness, in addition to making our lath long and thin, we must load it well. To increase the inductance of the circuit, we must make the circuit longer and increase the magnetic permeability of the space occupied by it. Filling the space bounded by the wire, C C C, with iron will do this, although for very high periodicities its presence does not increase the permeability.

It should here be pointed out that the discharge of a condenser is not always of an oscillatory nature. When the resistance bears a certain definite proportion to the inductance and capacity the discharge is dead beat. This condition may be pictured by imagining the length and thickness of the lath, the weight with which it is loaded and the viscosity of the treacle in which it is immersed, to be so mutually related that when it is allowed to fly back, after bending, the whole of its energy is absorbed by friction by the time it has reached its middle position. There is, therefore, none left to carry it over the centre and it is dead beat. The periodicity of the alternations accompanying the spark discharge of a large condenser such as a battery of Leyden jars can be roughly estimated by a sound produced. By using a large number of jars in parallel, and discharging them through a circuit of great inductance, such as the secondary of a large induction coil, the periodicity may be so much slowed down that a musical note accompanies the spark. In fact, Dr. Oliver Lodge suggested a keyboard for altering the capacity and self-induction in such a manner that a kind of Leyden-jar organ would be the result. "What are the wild waves saying?" played on such an instrument would create rather a sensation at a Royal Society soirée.

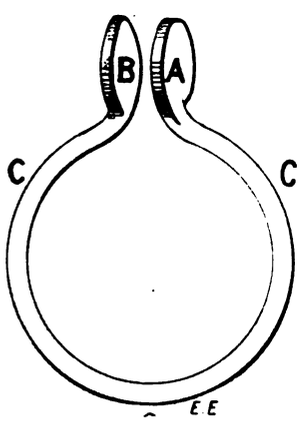

FIG. 3.

With such a machine under proper conditions, we should find that by quadrupling the number of jars, or by quadrupling the amount of self-induction, the number of vibrations would be halved and the lower octave of the note produced. Very few oscillations, each of decreasing amplitude, take place before the jar is completely discharged. How is this, since the energy is not all fritted away into heat? The answer to this question is found in the fact that the vibration of the ether in the neighbourhood of the spark is transmitted to the surrounding ether, and waves move out in every direction just as waves of sound are sent out from a vibrating tuning-fork whose prongs become quickly damped in consequence. The velocity with which these waves travel through space obeys the same old law which has served us in the case of indiarubber tubes. This fact had long been predicted by Clerk Maxwell and Lord Kelvin, but it remained for Hertz to rig up the actual tackle for measuring it with a 2ft. rule.

We shall be in a better position to comprehend the beauty of the experiments of Hertz after a short survey of the principles which underlie the undulatory theory of light. This, of course, requires as its basis a plenum or universal sea of ether, in which the entire creation is immersed. The energy of the sun is transmitted to the earth in a very similar manner to that in which the pulses travelled up our stretched indiarubber tube, in the form, that is to say, of waves occasioned by vibrations taking place at right angles to the waves' progressive direction. Mathematicians have satisfied themselves for years past that light and radiant heat are waves of the same nature, produced by transverse vibrations in the same elastic medium, and latterly radiant electricity has been drawn into the same fold. Practical physicists have now shown without doubt that their reasoning was correct. The tendency of the advance of knowledge in this branch of science has been to emphasise the fact that the difference between various kinds of rays of energy may be entirely accounted for by variations in their periodicities and wave-lengths, and modifications in the direction and amplitude of the waves' vibrations. They all experience reflection, and are effected by interference in a very similar manner to the waves which ran up and down the indiarubber tubes. To facilitate our reasoning, we pictured in that case the individual molecules vibrating up and down in straight lines in the same plane as that of the paper and all at right angles to the direction of the ray. Such a ray is, in the language of opticians, plane polarised, and all the waves of which representations have been presented to you to-night have been of this character. This, however, is a peculiar and not a normal characteristic of an ether wave. In trying to form a mental picture of a ray the particles which before agitation occupied the straight line, which is the ray's direction, should alone be considered. Looking up or down the direction of an ordinary unpolarised ray we should, were the motions of the particles visible, not see all of them vibrating in the same plane. At one part of the ray they might be plane polarised, and vibrating up and down in an azimuth, which we may designate as north and south. At a little distance up or down the ray this azimuth would probably be different—say, east and west. Further along the ray the vibrations might not take place in straight lines at all, but in an elliptical path, whose major and minor axes crossed on the ray's centre line. Somewhere else this ellipse might take the form of a circle, with its centre also on the direction line. To fix our ideas, we may imagine a ray passing through a closed book at right angles to the planes in which its leaves lie. The motion of the ether at any point in the direction of the ray may be sketched with a pencil on the page of the book which passes through that point. The paths of vibration of the particles will all be ellipses, but as mathematicians we must include in this category a straight line whose minor axis is zero, and a circle whose major and minor axes are equal. Now, if during the progress of the ray through the book we found for a hundred pages that the path of the successive particles were of a similar ellipse—that is to say, if the pencilled paths exactly overlapped as though they were all traced off the same drawing—we should say that the ray was polarised throughout that distance of its direction. Were the tracings all straight lines of the same azimuth it would be plane polarised; if the inscriptions were all ellipses, with their major and minor axes superposed, it would be elliptically polarised; whereas, if a hundred concentric circles were inscribed on a hundred consecutive pages, the ray throughout that distance would be circularly polarised. A ray, then, is said to be polarised when the motion of its successive particles are in similar paths; but we must not lose sight of the fact that each successive particle down the ray is in phase a little behind the one behind it. In circular polarisation the particles which originally lay in a straight line occupy a spiral position like a corkscrew; in elliptical polarisation their position would be like the same corkscrew squeezed in a copying press until its elevation was elliptical instead of circular; while plane polarisation would be represented by the corkscrew squeezed quite flat until the wire was all in one plane. These three states can easily be imitated on the stretched tube. If a sharp tap be given to the tube at right angles to its length a plane polarised ray will travel up it; if the end held in the hand be made to describe a circle in a plane at right angles to its length, a circularly polarised ray will be the result, and the tube will assume a spiral form, while if the original agitation be in an ellipse instead of a circle, the resulting tubular spiral will be correspondingly flattened as in elliptical polarisation. Circular and elliptical polarisation may be either right or left handed according to the nature of the spiral.

Possessing now at least a crude idea of the nature of the motions of an ether wave, we can follow it until it encounters gross matter. A ray of light, for instance, coming to us from the sun, will travel through the intervening ether at a speed measured by the square root of the quotient of its elasticity and density. We can neither measure the ether's elasticity nor density, but we know the speed, and so can estimate that quotient. The mean result of the best terrestrial and celestial observation is thirty thousand million centimetres, or 186,000 miles a second. This enormous velocity shows the possession by ether of great elasticity and a very small density. The ray, on entering the earth's atmosphere, will be gradually slowed down, but hardly appreciably, as its speed when it arrives at the earth's surface will only be some 55 miles a second less than it was *in vacuo*. Now let it come into contact with matter still more dense than air. The ray will either be reflected, absorbed, or transmitted, or perhaps experience all three to a certain extent. This will certainly be the case if it is incident to the surface of a thick plate of glass. Let the initial ray, A (Fig. 4), make a certain angle with the normal to the reflecting surface; after striking the surface it will rebound at an equal angle on the other side of the normal, and the two rays and the

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normal will all three lie on the same plane. The reflected ray, B, will, however, possess very different qualities from A. Whereas the latter is unpolarised, and composed of all sorts of vibrations in planes normal to its direction, some of them being up and down through the paper, as shown by dots, and others at right angles to them in the paper, as shown by cross lines, it is found that in the reflected ray the majority of the vibrations take place in planes parallel to the reflecting surface, up and down through the paper, as shown by dots. The amount of this polarisation varies as the angle of incidence and reflection is altered. Only part of the ray is reflected, another part becomes absorbed by the partial opacity of the glass, and a third part becomes transmitted as the ray C. This transmitted ray is also found to be partially polarised, but in an opposite direction to B. Here the majority of the vibrations lie in the plane of the paper. What is known to opticians as the plane

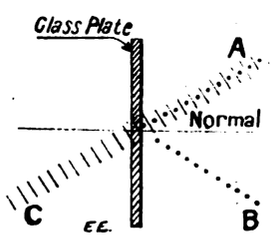

FIG. 4.

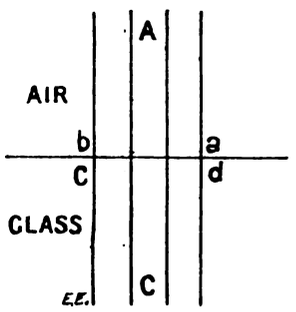

FIG. 5.

polarisation is the plane containing both the reflected polarised ray and the normal to the reflecting surface—in this case the plane of the paper—hence it is seen that in a plane polarised ray the vibrations take place at right angles to the so-called plane of polarisation. We have delayed for a moment the analysis of the changes which take place when the ray enters the solid glass itself, and this must now claim our attention. To render this clearer I have constructed a model which you now see projected on the screen. A ray of light is in cross-section practically only a point, so we will now deal with a beam consisting of a number of parallel rays. The incident beam, A (Fig. 5), is now normal to the bounding surface of the air and glass. On entering the glass the velocity of the wave is retarded from 186,000 to 124,000 miles a second. The $\sqrt{\frac{\text{Elasticity}}{\text{Density}}}$ is less in glass than air, and the velocity is consequently correspondingly reduced. The ratio of the speed in air (or, to be more correct, *in vacuo*) to the speed in glass is called the index of refraction of glass for the ray considered. In this case it is $\frac{186,000}{124,000} = 1{\cdot}5$. The position of the incident wave is now moved so that it is inclined to the separating surface (Fig. 6). You now see that the beam is bent out of its course or refracted on entering the denser medium, and as I go on increasing the angle made by the incident beam with the normal, the refraction increases more and more. This is easily explained. Let $a\,b$ be the wave-front—that is to say, in this instance, a cross-section of

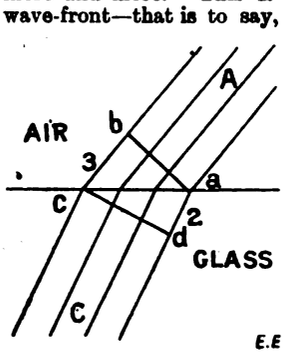

FIG. 6.

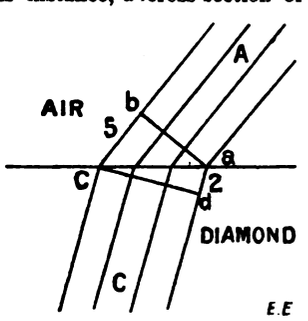

FIG. 7.

the beam. The vibrations of the particles of the individual rays are all in the same phase and are all moving in similar directions in the wave-front. When the ray a has just commenced to enter the glass, the ray b has the distance $b\,c$ to travel in air before it can enter the glass. During the time taken in traversing the distance $b\,c$, a will have proceeded a certain distance into the glass dependent on its refractive index. In this case this distance will be two-thirds of $b\,c$, since the relative velocities in air and glass are 3 to 2 for a refractive index of 1·5. By the time the complete beam has just entered the glass its new wave-front, $c\,d$, will have veered round as shown, and the new beam, which, of course, is at right angles to its wave-front, is consequently bent out of the old one's course. To show this more distinctly, the model is so arranged that the refractive index can be altered. Clamping the incident beam in the same position as before I make the refractive index 2·5, that of a diamond. In this case $a\,d$ (Fig. 7) is only two-fifths of $b\,c$, and you see the new wave-front in the diamond is veered round still more, and the beam still more bent out of its course. With the index still set for the diamond, the beam is moved back until it is normal with the bounding surface. There is now, as might be predicted, no refraction, since the wave-front $a\,b$ and $c\,d$ are coincident, as shown in Fig. 5. The model also shows beautifully the gradual widening of the beam as its new wave-front veers round. The index of refraction varies for the same media with the wave-length of the ray. In the case of a luminous beam the long slow red waves are not nearly so refrangible as the short quick violet ones. This fact is, of course, manifest in the prismatic spectrum where red rays are the least bent out of their original course.

It is impossible to form any concrete notion of the manner in which ether is bound or trammelled by the presence of gross matter. It is difficult to conceive of matter as an anchorage for ether, since we know that the earth in its journey round the sun does not plough through and displace it, and experiences even less retardation from its presence than a wide meshed sieve does when waved in the air. Why, then, are its vibrations so wonderfully affected? There is plenty of food for contemplation here, although year by year more light is being thrown on the subject. In the short sketch of the nature of refraction just given it was assumed that the medium into which the beam passed from the air was isotropic. In such a case the speed of an ether wave through it is quite independent of its direction. This is so in air, annealed glass, water, and all substances which, to use a familiar expression, have no grain. In substances like ice, crystals with one or more axes, and in organic bodies like quill or thin sections of bone, the molecules are generally so arranged that the action on the ether in which they are immersed causes a ray to suffer greater retardation in some directions than in others. They have, in fact, two indices of refraction, and in such a case it is easy to see that when the incident ray is not normal to the surface of separation, there

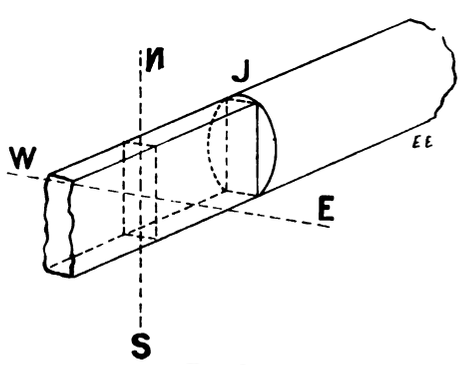

FIG. 8.

will be two refracted rays, one bent more out of its course than the other. A moment or two spent in considering the behaviour of a natural crystal of Iceland spar will render this clear. In all crystals their molecules are symmetrically arranged round certain directions called their axes. Even in an uniaxial crystal there are really an infinite number of axes all parallel to one another, although any one of these directions is spoken of as the axis of the crystal. Imagine the elasticity-density quotient to be different along the axis to what it is in every direction at right angles to it. Bearing in mind that the elasticity measured at right angles to the direction of a ray governs its velocity, it is easy to see that when travelling through a crystal plate cut parallel to the axis, it will be affected in a peculiar manner. Let this paper represent a crystal plate, with the axis in it and vertical. The elasticity of the bound ether in a vertical direction—that is, parallel with the axis—is greater than that measured across the axis—that is, horizontally. The ray on entering the plate immediately becomes polarised in two planes, its vibrations occurring some in the axis (vertically) and some across it (horizontally). It in fact becomes divided into two rays—the one, whose vibrations are taking place in the axis, being less retarded than that which is agitating the ether horizontally. Two rays polarised in planes normal to one another is the result, one of them lagging in phase behind the other by an amount depending on the distance they have travelled through the plate. On the other hand, when a ray travels through the Iceland spar in the direction of its axis, there is no tendency for the vibrations to take place in any particular azimuth, since the ether is symmetrically bound in all planes normal to that axis, and consequently there is no polarisation and no double refraction. As a mechanical analogue showing the manner of polarisation of a ray on entering a double refracting medium like a plate of spar cut parallel with its axis, consider a long cylindrical bar of any elastic material whose section is at J (Fig. 8) suddenly changed from a circle to a rectangle longer in the vertical than in the horizontal diameter,

(To be continued.)

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SUPER-REFINEMENTS!

"There is a pleasing absence of many of the super-refinements that have been much affected in central stations."—Extract from article on the St. Helens central station in the *Electrical Review*, January 23, 1897.

They're leaving thee, Simplicitas; our hearts are racked with pain
To know that traitors hold thy reign is o'er,
Iconoclast' inventors, with an eye to worldly gain,
Are threat'ning thine existence more and more.
The slaves to high efficiency, and lusters after "div.'s,"
The cranks who have devices on the brain,
Have left thy beaten track, that has served for ages back,
And will never tread its peaceful path again.

In the good old times gone by, when the Thumb King ruled on high,
And when measurements were so much "full" or "bare";
Then, a boiler (in the yard) and an engine (*sans* a card)
Were the only things for which we had to care.
Now, with boilers most complex, and with engines made to vex,
And with steam-pipes like a blooming Gordian knot,
And a heap of fads patent (each one saving ten per cent.);
To oust Simplicitas it's all a plot.

But still thou art not dead; the great *E. R.* hath said
(With kind congratulation in the tone)
That St. Helens loves thee yet, and hath cast aside the net
Of super-refinations not thine own.
It will have no tricky plant; its stokers—let them pant:
The money saved on fads can go in coal.
And the moral here is clear: to Simplicitas adhere,
And hang so-called improvements on the whole.

January 24, 1897. J. H. C. B.

A FEW PRACTICAL NOTES ON ALTERNATE-CURRENT SWITCH-GEAR.*

BY MR. L. ANDREWS.

During recent years several papers have been read before different societies on alternating-current working, dealing with the generation, transformation, distribution, and regulation of the current. To-night I wish to draw your special attention to what, I think, may justly be termed the heart of the work—namely, the switchboard, or, as it is now more correctly termed, the switch-gear. This is the centre from which all other important parts of the work are controlled, and a slight mistake here often causes a complete interruption of the whole supply. That these total interruptions do sometimes occur even in modern stations must, I am afraid, still be admitted. But from what I have been able to learn about them it appears to me they might nearly all have been prevented if more attention had been paid to the design of the switch-gear. Is there not a tendency to rely too much upon experienced attendants? Of course, I do not wish to under-rate the advantage of a skilled switchboard attendant, but I think the switch-gear should be so designed that an average man can control it if necessary. The most careful man may sometimes make a mistake. Besides, he is always liable to break down, and a small station cannot always afford to keep an equally efficient spare.

We often see inserted in advertisements for alternating-current switch-gear attendants a clause stating that applicants must be able to synchronise. This need of such a special qualification for alternate-current work has often appeared to me to be a weak point about this system of electricity supply. If a man knows that his character as an efficient switchboard attendant depends upon his always synchronising at exactly the right moment he is far more likely to make the lights jump than he would be if he felt that it was not possible for him to make a mistake. The effect it has upon the men appears to be much the same as I am told an average person experiences in looking over a precipice. If a rail makes it impossible for him to fall he does not feel any tendency to do so. But if he knows that his life depends upon his keeping a steady head he is far more likely to lose it. Mr. Faraday Proctor, of Bristol, appears to have recognised this in 1894, for in the *Electrical Review* of March 9 in that year, he explained that at Bristol instead of switching directly on to the 'bus bars through the main switches they first switched on to the circuit through a very light fuse. If the machines were badly out of phase the fuse prevented a big rush of current passing. This appeared to us at Hastings to be a move in the right direction, and we determined to imitate it. But we thought a magnetic cut-out would be better than a fuse, because it would be quicker in its action and would be more easily reset. During the past two years we have always used a safety device of this description, and although it is now only on very rare occasions that it cut out, we are satisfied that the very fact of its being there enables the men to synchronise very much better than they would do without it.

A diagrammatic sketch of this arrangement is shown in Fig. 1. The current from the generator passes through the solenoid to the outer 'bus bar, through the lamps to the inner 'bus bar, and back to the generator through the switch contacts. To switch this generator on to the 'bus bars the handle is brought down to its lowest position, thus setting the weight, W, behind the catch above, and closing the contacts, C_2. It will be noticed that the circuit is still interrupted at C. The handle is then returned to a nearly vertical position, thus leaving the weight, W, free to fall when it is released by the catch. As soon as the synchroniser voltmeter shows the machine to be approximately in parallel, the handle is pushed home, thus finally connecting the generator on to the omnibus bars. If it is at all out of phase, the current from the 'bus bars rushes into the generator *vid* the solenoid, thus lifting the core and releasing the catch and weight, W. The latter falls freely through an angle of about 45deg., increasing in momentum on its journey. It then strikes the arm connecting the two contacts, C_2, and carries this round through an angle of about 90deg., so interrupting the circuit at this point. (The contacts, C_2, are immersed in water.) The series of operations is then repeated, and an attempt made to catch the next phase. To switch machines out of parallel the handle is pulled out of the contacts, C, but before the circuit is interrupted at this point, the pin in the handle engages in the

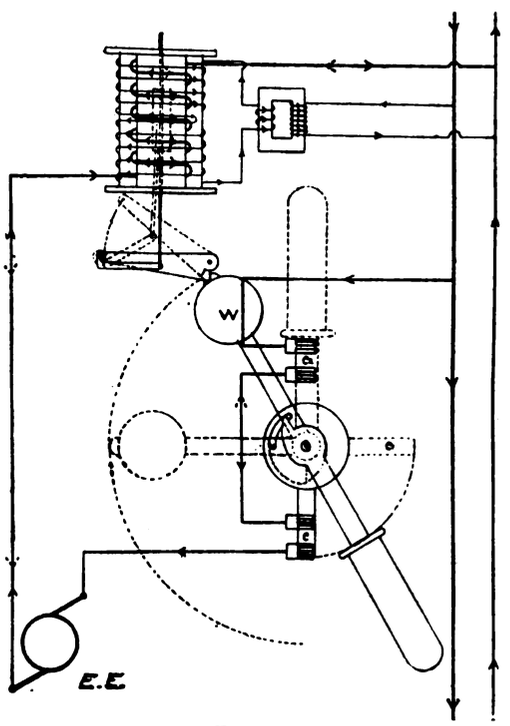

FIG. 1.

catch, thus releasing the weight and breaking the circuit at the contacts, C_2. We have noticed in using this arrangement that a long steady phase is not necessarily the best for synchronising. If we let the machines get over the steady phase and let the needle begin to pulsate quickly again, they always go into parallel without the slightest flicker. If we wish to get machines in quickly we don't wait for a steady phase, but have shots at any appearance of a correct phase. I have no hesitation in letting anyone who has never seen machines parallel before synchronise with this arrangement.

Nearly all the complete interruptions that have occurred during recent years have been originated by the failure of some portion of a set of plant working in parallel with others. I suppose we shall never get running machinery so perfect as to be able to depend upon its never breaking down, but we can arrange it so that the failure of one set shall not affect others working with it. In continuous-current stations the return current or zero cut-out serves for this purpose, and it is probably this device which has enabled these stations to gain the reputation of being more reliable than their alternating contemporaries. Zero cut-outs have been suggested for alternating-current work, but immediately the alternator fails in short-circuits a very much higher difference of potential than a continuous-current generator would do, and it also has comparatively very little self-induction, consequently, although the current momentarily falls to zero, it instantly rushes up to a very much higher current in an opposite direction, and therefore it would not allow a zero cut-out time to be affected. I believe Mr. Raworth, of the Brush Company, was the first engineer to design a cut-out that would discrimi-

* Paper read before the Northern Society of Electrical Engineers, January 25, 1897.

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nate between a generating and motoring alternating current. The ingenious way in which Mr. Raworth persuaded the generating current to avoid the fuse and travel round by the shunt, and the motoring current to select the fused conductor, is probably familiar to you all. It occurred to me about two years ago that although it was impossible with alternating currents (that naturally reversed their direction a hundred times a second) to employ a magnetic cut-out that released, when its poles were reversed, relatively to a constant polarity, yet it might be possible to construct a somewhat similar device having its poles excited from two distinct sources, and connected up so that it would release only in the event of the direction of the current from the one source being reversed relatively to the other. For this purpose I wound a number of turns comparatively fine wire on the series coils of the magnetic cut-out described just now. This winding was connected as a shunt across any transformer excited off the main omnibus bars, and was arranged so that the direction of the current in the shunt winding was opposite to that in the series so long as the dynamo to which it was connected was generating current.

(To be continued.)

BRISTOL CORPORATION ELECTRICITY WORKS.

The accounts have been issued of the working of the electric light station of the Bristol Corporation during the year ended December 31, 1896. The expenditure during the past year reached £12,173. 16s. 6d., and the total expenditure to December 31, 1896, has amounted to £109,968. 8s. 4d. Below are given the revenue account and balance-sheet, together with a statement of electricity generated, sold, etc.:

GENERAL BALANCE-SHEET.

Liabilities.	£	s.	d.
Capital account—amount received	110,000	0	0
Sundry creditors	1,619	7	3
Net revenue account—balance	2,274	3	11
Suspense account—balance	253	0	0
Deposits as security	122	0	0
Cash account—amount overdrawn at bank, £2,428. 18s. 1d.; less cash in hand, £218. 5s. 8d.	2,210	12	5
	£116,479	3	7

Assets.	£	s.	d.
Capital account—amount expended for works	109,968	8	4
Stores on hand December 31, 1896: coal, £42. 10s.; oils, waste, etc., £41. 14s. 7d.; genoral, £192. 6s.	276	10	7
Sundry debtors for current supplied to December 31, 1896	6,008	17	0
Other debtors	225	7	8
	£116,479	3	7

REVENUE ACCOUNT, YEAR ENDING DEC. 31, 1896.

Dr. A.—To Generation of Electricity.		£	s.	d.
Coal or other fuel, including dues, carriage, unloading, storing, and all expenses of placing the same on the works	£2,067 17 7			
Oil, waste, water, and engine-room stores	214 0 0			
Wages at generating station	1,279 10 3			
Repairs and maintenance as follows: buildings, £34. 6s. 5d.; engines, boilers, etc., £208. 0s. 6d.; dynamos, exciters, etc, £14. 0s. 5d.; condensers, other machinery, instruments and tools, £91. 7s. 4d.; accumulators and accessories, £25. 13s. 6d.	373 8 2			
		3,934	16	0
B.—To Distribution of Electricity.				
Wages and other remuneration to linesmen, fitters, labourers	163 5 0			
Repairs, maintenance, and renewals of mains of all classes, including materials and laying same, £332. 7s. 1d.; less amounts chargeable to contractors, £54. 9s. 6d.	277 17 7			
Repairs, maintenance, and renewals of transformers, meters, switches, fuses, and other apparatus on consumers' premises, together with cost of lamps sold, as *per contra*	78 6 8			
Repairs, maintenance, and renewals of apparatus at distributing stations	61 15 11			
		581	5	2
C.—To Public Lamps.				
Attending and repairs	399 5 5			
Carbons and renewals of lamps	145 4 10			
		544	10	3
E.—To Rents, Rates, and Taxes.				
Rents payable	474 18 6			
Rates and taxes	582 9 4			
		1,057	7	10
F.—To Management Expenses.				
Salaries—Engineer's department	534 2 8			
Secretary and clerical staff	412 19 10			
Stationery and printing	91 7 8			
General establishment charges	209 11 1			
		1,248	1	3
G.—To Law and Parliamentary Charges.				
Law expenses		2	2	0
H.—To Special Charges.				
Fire and boiler insurance, employer's liability, and fidelity guarantee premiums	88 0 7			
Costs of canvassing for new customers	1 14 8			
Interest on deposits	0 17 7			
		90	12	10
Total expenditure		£7,458	15	4
Amount carried to net revenue account		7,590	11	2
		£15,049	6	6

Cr.	£	s.	d.
Sale of current, per meter, £11,267. 9s. 7d.; less discounts, £541. 9s 2d.	10,726	0	5
Rental of meters on consumers' premises	486	17	7
	11,212	18	0
Less bad debts	47	6	10
	11,165	11	2
Public lighting—Electricity supplied to public lamps, £3,135. 11s. 8d; and attendance and repairs of public lamps, carbons, etc., as *per contra*, £544. 10s. 3d.	3,680	1	11
Incidents	10	11	3
Improvers, premiums—amount transferred from suspense account	61	0	0
Sale of incandescent lamps	86	11	2
Charge for preparing contract	5	5	0
Fees for insulation tests	2	2	0
Rents receivable	38	4	0
	£15,049	6	6

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units		861,165
Quantity sold—		
Public lamps	167,231	650,758
Private consumers by meter	483,527	
Quantity used on works		196,746
Total quantity accounted for		847,504
Quantity not accounted for		13,661
Number of public lamps		105
Total maximum supply demanded (kilowatts)		766
Total maximum possible demand (kilowatts)		1,149

COMPANIES' MEETINGS AND REPORTS.

DIRECT UNITED STATES CABLE COMPANY.

The ordinary half-yearly general meeting of the Direct United States Cable Company, Limited, was held on Tuesday at Winchester House.

Mr. E. M. Underdown presided, and, in proposing the adoption of the report and accounts to December 31, reminded the shareholders that this was the first half of the financial year, when the arrangements as to dividend could not be considered. Their prospects for the current year were most encouraging, and they might become so prosperous in the current half of the year that they might find themselves in a position to offer something additional to the proprietors. On the whole the position of the Company was not unfavourable. The revenue, after deducting payments, amounted to £47,600, and the working and other expenses, exclusive of cost of repairs of cables, to £19,815, leaving a balance of £27,785 as the net profit, making, with £4,235 brought forward, a total of £32,021, which would be appropriated to the payment of two interim dividends of 2s. 6d. each, which would absorb £15,177, and after placing £12,000 to reserve, the balance of £4,843 would be carried forward. The increase in the revenue during the half-year, as compared with 1895, amounted to £3,663, or more than 8 per cent. Most of the items in the accounts remained pretty much the same as they were last half-year. The general improvement in business had made itself felt in Atlantic telegraphy, while the cost of cable repairs had only been £529. The investments had been increased by £18,166 since June, their present market value being about £58,000 more than the figure at which they stood in the accounts. During the period under review they had not been untroubled by external events. They would be very glad indeed if they and their companions in the pool could be the proprietors of the only cable across the Atlantic, but they were being perpetually threatened by additions to the number of cables at the bottom of the sea.

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As they were aware, this Company had arrangements with certain other companies, one of which, the Anglo-American, was at present working the German traffic from Emden to Valencia and from Valencia across the Atlantic. The agreement under which this traffic was conducted would, however, expire in a short time. If the German Government took steps to establish for itself a cable or cables there was no doubt that the pool would be the losers, as a minimum, of the amount of the guaranteed traffic, which now went to the pooling companies. They had recently heard that a cable had been completed from Emden to the coast of Spain, and they were also aware that there was a cable which reached from the Azores. The pooling companies had had under their consideration whether this Company or the pooling companies should deal with the extension from the Azores to the American coast. They felt the very great importance of coupling up the European system with the Atlantic, but they had come to the conclusion that in the conditions under which the matter had been so far presented to them, they were not justified in taking up the scheme, which he believed had not been taken up in other quarters to which it had been presented. Of course, they would be all the happier if they thought that no further steps were to be taken about this matter, but he feared that they could not feel altogether safe on this point. They must always be prepared to meet with the possibility of their cable becoming unavailable for traffic. In his address to them last year he stated that their reserve fund was actually not so large as it was 12 years ago. A few months since their cable was broken by a ship in the harbour of Ballinskelligs, and last week they heard that their short section between Halifax and the United States was not working satisfactorily. The two repairs, however, had been effected. He thought he had given them reasons sufficient to show them why their reserve fund should be increased to an amount which would make them absolutely safe in the event of any possible accident happening to their cable.

Mr. James Pender, M.P., seconded the motion, which was carried unanimously.

A resolution was also passed authorising the contribution by the Company of £250 to the submarine telegraph memorial to the late Sir John Pender.

CITY AND SOUTH LONDON RAILWAY COMPANY.

The twenty-fifth ordinary general meeting of this Company was held at Winchester House yesterday (Thursday).

The **Chairman** (Mr. C. G. Mott), in moving the adoption of the report, stated that the past half-year had been more successful than any previous one. The tender of Messrs. J. Mowlem and Co. for the construction of tunnels and stations had been accepted, and they had commenced work. In consequence of Mr. Greathead's death it had been necessary to appoint another engineer to carry out the works now in progress, and Sir Benjamin Baker has consented to undertake the work. The new condensing plant is completed and working satisfactorily.

A dividend of 1¾ per cent. per annum is to be paid on consolidated ordinary stock.

Messrs. Sampson Hanbury and Spencer Barclay Heward were re-elected directors, and Messrs. Turquand, Youngs, Bishop, and Clarke wore re-elected directors.

The shareholders' sanction was given to issue, when required, the 5,000 5 per cent. preference shares, the balance of the preference capital already created on June 30, 1891, and also to create the small amount of additional ordinary share and loan capital authorised by the Act of 1895, in consequence of the proposed extensions to Clapham.

CENTRAL LONDON RAILWAY COMPANY.

The report of the directors of this Company for the half-year ended December 31 states that the expenditure during the half-year has amounted to £365,228, which, added to the amount previously expended, makes a total outlay of £807,326. In view of the payments which will become due on account of the contract during the next few months, a further call on the shareholders of £2 per share, payable on 1st prox., has been made. The negotiations in connection with the station at Davies-street and the street improvements there, conditionally authorised by the Central London Act of 1891, not having been successful, a Bill to authorise a slight alteration in the position of that station, and the acquisition of a new site on the north side of Oxford-street, between the two branches of Marylebone-lane, has been deposited in Parliament. This Bill will be submitted to the shareholders for their consideration at the special meeting to be held at the conclusion of the half-yearly meeting. In their last half-yearly report the directors expressed a hope in connection with the extension to Liverpool-street that an agreement satisfactory to the Great Eastern and Central London Companies would soon be completed. This anticipation not having been realised, the directors, after giving the most careful consideration to the whole subject, have determined—for the present, at least—to discontinue the negotiations with the Great Eastern Company respecting the station and works at Liverpool-street, and as a further consequence the arrangements proposed to be made with the North London Company have not been proceeded with. The report of the engineers states that good progress has been made with the works. Tunnelling operations are in full progress, and the subway at the Bank Station, and the work of sinking shafts, where that has not already been done, is being proceeded with in a satisfactory manner. The shareholders' meeting is on February 4 at Cannon-street Hotel.

ST. JAMES'S AND PALL MALL ELECTRIC LIGHT COMPANY, LIMITED.

Directors: Eustace J. A. Balfour, Esq., chairman; Latimer Clark, Esq., F.R.S., vice-chairman; Sir John H. Morris, K.C.S.I.; Bennett Fitch, Esq., M.I.C.E.; Walter Leaf, Esq. General manager and secretary: Frederic J. Walker. Chief engineer: S. T. Dobson, A.M.I.C.E., M.I.E.E.

Report of the directors and statement of accounts to be presented to the shareholders at the annual general meeting to be held at the offices of the Company, Carnaby-street Central Station, Golden square, W., on Tuesday, February 2, at 12.30 p.m.:

The directors in submitting their report for 1896, with accounts as certified by the Company's auditors, are pleased to state that the business and prospects of the Company have steadily improved. A further extension of buildings and plant is required for the winter season of 1897-8, and orders for material have already been placed. The Mason's-yard station has been completely refitted with new machinery, and in conjunction with the Carnaby-street station has taken its share of the general supply. The whole plant and machinery has been working satisfactorily throughout the year, and has been fully maintained. A still further reduction has been effected in the cost of the unit. An order has been placed with the Company by the Vestry of St. James's for the lighting of the principal streets of the parish by electricity, and this work will shortly be in operation. After consultation with the auditor appointed by the Board of Trade, and in accordance with his wishes, the directors have debited to revenue account the management and other outlay relating to supervision of the works during construction. In accordance with recent decisions in the case of tramway companies, the directors have charged to capital expenditure the costs of obtaining license and provisional order, etc., amounting to £1,458. 18s. 8d. The net earnings of the Company during the past year have amounted to £21,369. 9s. 5d. Of this sum £5,997. 10s. was distributed in August last in payment of an interim dividend at the rate of 5 per cent. per annum for the half-year ending June 30, 1896, on the ordinary shares, and of 7 per cent. per annum on the preference shares The balance, £15,371. 19s. 5d., together with the undivided profit of £135. 6s. 4d. from year's account, leaves £15,507. 5s. 9d. now to be dealt with. The directors propose to divide the amount as follows:

(*a*) By payment of a dividend at the rate of 7 per cent. per annum on the preference shares for the second half of the year	£3,500	0	0
(*b*) By payment of a dividend on the ordinary shares for the second half-year of 8s. per share, making, with the interim dividend paid on August 1 last, a total distribution of 10½ per cent. for the year	7,992	0	0
(*c*) By payment of a dividend of £36. 17s. 6d. per share on the founders' shares	3,687	10	0
(*d*) Amount to be carried forward to ordinary shareholders' undivided profit account	326	8	0
(*e*) Amount to be carried forward to founders' undivided profit account	1	7	9
	£15,507	5	9

The chairman, Mr. Eustace J. A. Balfour, and the vice-chairman, Mr. Latimer Clark, F.R.S., are the directors who retire by rotation under Clause 79 of the articles of association, and, being eligible, offer themselves for re-election. The auditors, Messrs. Deloitte, Dever, Griffiths, and Co., also retire, and, being eligible, offer themselves for re-election.

Dr. REVENUE ACCOUNT, YEAR ENDING DEC. 31, 1896.

	£	s.	d.	£	s.	d.
A.—To Generation and Distribution of Electricity.						
Coal, including dues, carriage, etc. ..	£5,024	1	1			
Oil, waste, water, engine-room stores	818	6	5			
Salaries of engineers and officers	1,040	9	9			
Wages at generating and distributing stations	3,664	4	8			
Repairs and maintenance as follows: buildings (including alterations), £649. 17s. 5d.; engines and boilers, £779. 18s. 3d.; dynamos, £153. 7s. 5d.; other machinery, instruments, and tools, £212. 19s. 8d.; accumulators, £69. 18s. 6d.; lamps (at stations), £46. 2s.	1,912	3	3			
Attending and repairing public lamps	59	9	0			
Repairs and maintenance of mains ...	914	9	3			
Miscellaneous expenses	89	1	7			
				13,522	5	0
B.—To Rents, Rates, and Taxes.						
Rents payable	215	0	0			
Rates and taxes	2,500	10	9			
				2,715	10	9
C.—To Management Expenses.						
Directors' remuneration	2,374	7	9			
Salaries of manager and secretary, engineer, clerks, canvasser, etc.	2,942	19	1			
Stationery, printing, and advertising.	236	11	11			
General establishment charges	289	15	11			
Auditors of Company	78	15	0			
Trustee for debenture stockholders ...	52	10	0			
				5,974	19	8

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D.—To Law Expenses.	£	s.	d.
Law expenses	137	11	7
E.—To Special Charges.			
Insurance	425 4 8		
Expenses obtaining Stock Exchange quotations for debenture stock	26 13 9		
Expenses in abating nuisances	31 10 0		
Fees for testing meters	8 7 1		
Board of Trade audit	54 10 0		
Expenses, *re* rating assessment	42 4 3		
	588	9	9
F.—To Depreciation.			
Depreciation on buildings	416 13 11		
,, plant, machinery, etc.	5,557 19 7		
	5,974	13	6
	28,913	10	3
Net loss on sales of old plant	1,686	17	7
Balance carried to net revenue account	25,339	6	11
	£55,939	14	9

Cr.	£	s.	d.
Sale of current, after deducting provision for bad and doubtful debts (at 6d. per unit less rebates)	52,941	3	2
Ditto under contract	917	19	3
Public lighting	108	1	0
	53,967	3	5
Rental of meters on consumers' premises	1,274	8	1
Rents receivable, less repairs to houses	476	4	11
Transfer fees	39	17	6
Discounts on purchases	77	8	2
Sale of old materials, stores, etc.	1	13	11
Sundry fees, shareholders' lists sold, etc.	2	18	9
Rent of machinery let on hire	100	0	0
	£55,939	14	9

Dr. GENERAL BALANCE-SHEET, DEC. 31, 1896.	£	s.	d.
Capital account—amount received	250,000	0	0
Sundry tradesmen and others, due on construction of plant and machinery, fuel, stores, etc.	1,884	19	9
Sundry creditors on open accounts	2,640	15	5
Debenture stockholders, for interest accrued, less tax, payable January 1, 1896	966	13	4
Unclaimed dividends	8	9	8
Capital reserve fund	15,000	0	0
Liability under bills discounted	550	6	0
Net revenue account—balance at credit thereof, £21,504. 15s. 9d.; less interim dividends paid on preference and ordinary shares, £5,997. 10s.	15,507	5	9
	£286,008	3	11

Cr.	£	s.	d.
Capital account—amount expended for works, less depreciation to date	241,327	19	1
Stores on hand—coal, £179. 3s. 9d.; lamps, £30. 0s. 5d.; meters and switches, £1,207. 4s. 2d.; general, including oil, waste, etc., £1,855. 13s. 9d.	3,277	2	1
Sundry debtors for current supplied, £14,746. 3s. 1d.; other debtors, £600. 1s. 4d.	15,346	4	5
Temporary investments, value at December 31, 1896—New Zealand 3½ per cent. inscribed stock, £4,816. 9s. 3d; Queensland 3½ per cent. inscribed stock, £4,821. 19s. 10d.	9,638	9	1
Cash at bankers (Lloyds Bank, Limited), £1,360. 17s. 2d.; cash in hand, £57. 12s. 1d.	1,418	9	3
Capital reserve fund investments, cost of Canada 3 per cent., Cape 3½ per cent., and India 3 per cent. stock	15,000	0	0
	£286,008	3	11

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC., YEAR ENDED DECEMBER 31, 1896.

Board of Trade units generated		2,687,968
Quantity utilised—		
Sold to consumers	2,401,431	
Used on works	28,682	2,430,113
Quantity expended in distribution—		
In batteries	6,888	
In feeder	198,553	205,441
Quantity accounted for		2,635,554
Quantity unaccounted for		52,414
Number of lamps on circuit, December 31, 1896		108,803

WOLVERHAMPTON TRAMWAYS COMPANY.

The annual general meeting of this Company was held in Old Jewry on Monday, but the Press were not admitted.

Tynemouth.—The Parliamentary Committee reported at the Town Council meeting that the town clerk had been instructed to obtain information from Sunderland and South Shields as to the position of the Corporation with respect to public lamps and electric lighting.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Marienwerder (Germany).—Tenders for 600 telegraph poles will be received at the office of the Baurath Löwe up to February 6. Particulars 30 pfg. (4d).

Oberwesel (Germany).—It is proposed to erect electricity and water works at Oberwesel (Rhein). Proposals from undertakers should be in the hands of the Burgermeister by February 10.

Cannes.—Tenders will be received on February 20, at the Mairie at Cannes (Alpes-Maritimes), for the erection of a postal, telegraph, and telephone building. There are five separate contracts.

Bredow (Germany).—The local authority of the commune (gemeinde) of Bredow-a-M. will receive plans, estimates, and offers, up to February 10, for the establishment of an electrical supply works for the commune.

Fareham.—The Urban District Council are inviting tenders for high-tension and low-tension cables, earthenware conduits, and laying. The date is February 15, and particulars will be found among our advertisements.

Visé (Belgium).—The authorities (l'administration communale) of the town of Visé desire propositions from companies and others for town electric lighting. The proposal is an open one, both as to method and date, and offers or enquiries should be made to the Collège echevinal, Visé.

Hanover.—Tenders are wanted by the Prussian State Railways for 32,600 telegraph insulators, with and without screwed attachments; 260 tons of wire (not line wire), 2½ tons of insulated wire, and 1¼ ton of wire rope. Particulars for one mark from the Railway Authorities (Königliche Eisenbahn Direktion), Hanover, Joachimstrasse 7.

Berlin.—The Prussian State Railway Authorities will receive tenders up to February 6 for the supply of a quantity of glass cells and stoppers, 37,000 battery zincs, 27,300 coppers, 5,200 connections, a quantity of sulphate of copper, and other battery essentials. Particulars for 50 pfg. from Die Königliche Eisenbahn Direktion, Berlin W., Schöneberger Ufer, 1.

Cologne.—The State Railway Department will receive tenders up to February 6 for 171 tons of galvanised-iron telegraph wire, 6 tons bronze wire, 3 tons of insulated wire, 265,000 porcelain insulators, 7,700 screwed insulator pins, and a quantity of other accessories. Particulars for 90 pfg. (11d.) from the office of the Königl. Eisenbahn Direktion, Domhof 28, Köln.

Hull.—The Corporation invite tenders for a lease of the tramways authorised to be constructed by the Tramways Orders Confirmation (No. 1) Act, 1896. Tenders to be delivered by February 1, endorsed "Tramway Tender," at the office of Mr. R. Hill Dawe, town clerk, Town Hall, Hull, from whom all particulars and conditions of tender may be obtained.

Derby.—The Corporation require tenders for the wiring, fittings, etc., for electric light during the building of the Municipal Technical College, Green-hill. Specification and form of tender, containing plans, schedule of rooms, etc., may be had on deposit of £1. 1s. (which will be returned on receipt of a bona fide tender), from Mr. J. E. Stewart, engineer, Electric Lighting Station, Derby. Tenders, endorsed "Wiring, etc., of College," to be sent to Mr. H. F. Gadsby, town clerk, Town Hall, Derby, by 12 noon on February 6.

Hastings.—The Corporation require tenders for alterations and additions to an engine and boiler house in Waterworks-road. Drawings may be seen and forms of tender and specifications obtained at the office of Mr. Philip H. Palmer, A.M.I.C.E., borough engineer, Town Hall, Hastings, between 10 a.m. and 5 p.m. Tenders, under cover, endorsed "Tenders for Electric Lighting Engine-House," must be delivered at the office of Mr. Ben. F. Meadows, town clerk, Town Hall, Hastings, by 12 noon on February 3.

Harrogate.—Tenders are invited for wiring the Queen Hotel, Harrogate, and for electrical fittings for same. Specifications and forms of tender can be obtained from the Electrical Engineer, 12, Dragon-view, Harrogate, on deposit of £2. 2s., which deposit will be returned on receipt of a bona fide tender. The hotel can be inspected on application to the manager. Tenders, sealed, and marked "Tender for Electric Lighting," must be addressed to Mr. Geo. Wilkinson, M.I.E.E., consulting engineer, and delivered by February 3.

Wallasey.—The Urban District Council are prepared to receive tenders for the supply and erection of a 200-kilowatt alternator, with engine combined, and for the requisite switchboard extensions. Copies of the specification may be obtained on application to the engineer, Mr. J. H. Crowther, at his office at the Great Float, near Birkenhead, on payment of the sum of £2. 2s., which be returned on receipt of a bona fide tender. Sealed tenders, on the form provided for the purpose, addressed to the Chairman of the Gas and Water Committee, and endorsed "Tender for Steam Alternator, etc.," to be delivered to Mr. W. Danger, clerk to the Council, Public Offices, Egremont, Cheshire, not later than 4 o'clock in the afternoon of Thursday, February 18, 1897. The contractor will be required to enter into a bond with approved sureties for the due performance of the contract.

RESULTS OF TENDERS.

Chester.—The Town Council have accepted a tender for wiring and fitting the library with electric light, for the sum of £162.

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Halifax.—The Town Council have accepted the tender of the Electric Construction Company, Limited, for the supply of an engine and dynamo for £3,610.

Hampstead —The Vestry have accepted the tender of Messrs. Siemens Bros. and Co., Limited, of Queen Anne's-gate, for the supply and erection of an additional exciter at the station, at the price of £625, and also that of Messrs. S Z de Ferranti, Limited, of Charterhouse-square, for the supply and erection of an additional alternator at the station, at the price of £3,348.

Hanover.—The tenders for the supply of telegraphic materials to the Prussian State Railways have been published. To reproduce them would take about two columns. The firm that heads the list for insulators is G. Richter, and for wire the Dusseldorf Eisen und Draht Industrie. It is not usual to state formally to which firm the tender is given, and there is no "lowest tender," as the prices vary according to description and place of delivery.

Milton (Portsmouth).—The Guardians of Portsea Island Union have received the following tenders for electric lighting work at the new infirmary buildings at the union house, Milton:

New and Mayne, Bridge-street, Westminster (accepted) .	£248	0	0
C. Forbes and Co., 37, Sloane-square, London, N.W.....	319	11	0
J. R. Penning, Elm-grove, Southsea	359	12	0
Williams and Sons, London-street Ironworks, Reading ...	367	0	0
S. Grossmith, Daniel-street, Portsea	389	0	0
Pearson and Co., Milsom-street, Bath	389	14	6
Walker and Co., Queen-street, Portsea	397	0	0
Wenham and Waters, Vicarage-road, Croydon	402	10	0
Smeeton and Page, 63, Queen Victoria-street London	453	7	6
H. F. Joel and Co., 31, Wilson-street, Finsbury-square ...	514	0	0
T. J. Anderson, Royal Insurance Buildings, Sheffield	530	0	0
Mallet and Co., Suffolk House, London, E.C.	621	0	0

BUSINESS NOTES.

Carlisle.—The Corporation have practically decided to adopt the electric light.

National Telephone Company.—Sir James Fergusson, Bart., M.P., has joined the Board of this Company.

Birmingham Tramways.—The committee will report in favour of the Town Council assenting to the local Tramways Bill.

Eastbourne.—The electric light was used very effectively in decorating the town hall for the children's fancy dress ball given by the Mayor last week.

Vestry Loan.—The London County Council have decided, upon the recommendation of the Finance Committee, to lend the St. James's Vestry £3,850 for electric lighting purposes.

Radcliffe.—The District Council have resolved to apply to the Local Government Board for borrowing powers for £1,100 for the purchase of land upon which to erect electric lighting premises.

Coventry Tramways.—The annual meeting of the Coventry Tramways Company was called on Monday at Coventry, but owing to the absence of the necessary quorum was adjourned for a week.

Chiswick.—The Urban District Council have decided to purchase two steam motorcarts, built from designs by Mr. J. I. Thorneycroft, to be employed for the purpose of dust collection within their district.

Rhodesia.—The absolute dearth of animal traction owing to rinderpest in Rhodesia continues, and at Umtali it is intended to construct a light tramway to meet the pressing needs of town transport.

Personal.—Mr. W. Wyld was recently appointed assistant at the Salford Corporation electricity works, and has commenced his duties. He came from Blackpool station, where he had been for the last two years.

Germany.—Of the central electric power stations erected or commenced in Germany during the year 1896, 40 per cent. have been on the three-phase or alternating systems, and 60 per cent. employ continuous current.

Canterbury.—The adoption of the electric light continues to be the chief topic of discussion in the city, and the action of the Town Council in deciding to proceed with the undertaking has been very generally approved.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended January 24 amounted to £1,217, as compared with £1,043 in the corresponding week of the previous year, being an increase of £174

Appointment Vacant.—Applications for the post of medical electrician to the London Homœopathic Hospital, Bloomsbury, W.C., should be sent in to Mr. G. A. Cross, secretary superintendent, not later than March 1.

Hampstead.—The Vestry have decided that red Ruabon tiles, 9in. by 9in., be laid on the floor of the new engine-room at the station at a cost of 5s. per yard laid, in lieu of the wood-block flooring specified in the contract.

Western and Brazilian Telegraph Company.—The receipts for the week ending January 22, after deducting 17 per cent. of the gross receipts, payable to the London Platino-Brazilian Telegraph Company, amounted to £2,758.

Bristol Tramways and Carriage Company, Limited.—The traffic returns for the week ended January 22 were £1,727. 1s. 5d., compared with £1,786. 12s. 7d. for the corresponding period of last year, being a decrease of £59. 11s. 2d.

Aluminium Supply Company, Limited.—This Company has been registered, with a capital of £1,000 in £1 shares, to carry on the business of manufacturers of and dealers in aluminium and alloys and metals, machinists, metallurgists, etc.

Manchester Telephones.—At a public meeting held at the Chamber of Commerce it has been resolved to establish a local telephone company in competition with the National Company. Nearly 500 subscribers have been already promised.

Caen (Normandy).—Application has been made to the local authority for a concession for an electric tramway in Caen. The promoters are a local c mpany working in connection with the Chalons sur-Marne Compagnie des Tramways électriques.

Epstein Electric Accumulator Company.—Upon the reorganisation of the staff of this Company, Mr. L Broekman and Mr. Percy W. Northey, A.I.E.E., have been appointed joint managers, and Mr. Northey will also act in the capacity of secretary.

The West Suburban Railway.—The Guardians have decided to ask the Vestry to petition and stongly protest against the West Suburban Railway scheme on account of the annoyance and discomfort it would cause to the sick in the infirmary and workhouse.

Appointment Vacant.—The School Board of London want an engineer-fitter at 35s. per week for the Bowling-green stores. "He must have a sufficient knowledge of electrical apparatus to enable him to attend to the electrical installation in the event of small repairs being required."

Aberdeen.—In connection with the erection of five electric lamps for street lighting in George-street, Bailie Lyon said at the Town Council meeting that the experiment had given great satisfaction, and he hoped it would lead the Council to put up similar lamps in many other parts of the city.

City and South London Railway.—The returns for the week ended January 24 were £1,115, compared with £994 for the corresponding period of last year, being an increase of £121. The total receipts for the half-year 1897 were £4,388, compared with £4,035 last year, being an increase of £353.

Paddington —A resolution is to be moved at the Vestry meeting asking for the appointment of a committee to report on the question of erecting a town hall, and as to whether the Metropolitan Electric Supply Company, Limited, and other companies would be prepared to rent offices there.

Newhaven (Sussex).—At the Rural District Council meeting it was decided to adhere to the Council's decision to oppose the granting of a provisional order to the Rottingdean Electric Lighting and Power Company. Limited, the grounds of opposition being that it was undesirable to grant a monopoly.

Winchester Electric Light and Power Company, Limited.—This Company has been registered, with a capital of £25,000 in £5 shares, to carry on the business of an electric light and power company, electricians, mechanical engineers, suppliers of electricity, and electrical apparatus manufacturers.

Partnership Arrangement.—Messrs. Wheatley Kirk, Price, and Goulty, of London and Manchester, have just admitted Mr. Ernest Sherley-Price into partnership. The firm now consists of the following members: Mr. Hy. Sherley-Price, Mr. W. R. Goulty, Mr. S. Sherley-Price, and Mr. E. Sherley-Price.

Eastern Extension, Australasia, and China Telegraph Company, Limited.—The Company announce that the interest on the 4 per cent. mortgage debenture stock for the half-year ended January 31 will be paid by warrant on February 1 next. The stock register will be closed to the 30th inst. inclusive.

Guildford —The Town Council have again been discussing the question of the pavements, which had been relaid by Messrs. Sharp and Kent after laying distributing mains. This has been the cause of a good deal of friction between the two parties, but the Council have now decided to let the matter drop and lay the pavement themselves.

Messrs. Babcock and Wilcox.—The directors of Babcock and Wilcox, Limited, have declared an interim dividend for the six months ended December 31 at the rate of 6 per cent. per annum on the preference shares, less income tax, and 10 per cent. per annum on the ordinary shares, free of income tax, payable on February 12.

Electrophone, Limited.—A Company has been registered under this title, with a capital of £20,000 in £1 shares, to acquire the business of a company of the same name, and to manufacture, construct, erect, maintain, lay down, carry out, buy, sell and deal in telephones and all apparatus, appliances, and things connected with telephonic communication or with electricity.

Proposed Glasgow Exhibition.—The Parks and Galleries Committee of the Glasgow Corporation have decided to recommend to the next meeting of the Town Council that an exhibition be held in Glasgow in 1901. The exhibition will be international in character, and as it will follow the Paris Exhibition in 1900 it is intended to secure as many exhibits from the French capital as possible.

Newington.—The Vestry Clerk reported at the last meeting that he had had a letter from the Board of Trade notifying the receipt of three petitions against the granting of the electric lighting order to the Vestry—one from the Newington and Walworth Ratepayers' Association, the second from a body of ratepayers, and the third from the Brush Company. The matter was referred to the Electric Lighting Committee.

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Toronto.—According to a telegram published in some of the daily papers, the electric light company's building was set on fire last week by a spark, with the result that the dynamos and the entire lighting plant were destroyed. The city was accordingly in darkness, and several factories had to be temporarily closed. Dynamos have been ordered from other towns, and sent on from Chicago and Cleveland by special trains.

Stowmarket.—At a meeting of the East Stow Rural District Council notice was given by the clerk that the firm of Messrs. N. Prentice and Peddar, electricians, Stowmarket, had offered to supply the Council with motive power and electricity for working the sewage scheme, which, if accepted, would be a great initial saving to the Council, thus doing away with the necessity for purchasing plant. The matter was not discussed.

Maxim Motor Company, Limited.—A company has been registered under this title, with a capital of £7 in £1 shares, to adopt an agreement with H. Maxim, and to manufacture, sell, and deal in motors, cycles, carts, wagons, ships, boats, launches, flying machines, and carriages. The directors are to be appointed by the subscribers. Qualification, £100. Remuneration as fixed by the Company. Registered office: 8, Princes-street, W.C.

Lee.—The General Purposes Committee reported at the meeting of the District Board of Works that they had considered the notice of the Blackheath and Greenwich District Electric Lighting Company as to the provisional order, and recommended that the Board approve of the electric light throughout the district. Several members having spoken in favour of an engineer being appointed, the recommendation of the committee was agreed to.

Belfast.—Lord and Lady Kelvin paid a visit last week to the Corporation's electrical station in Marquis-street, where they were met by Sir Samuel Black, town clerk; Councillor George Andrews, J.P., chairman of the Electric Committee; Councillor Otto Jaffé, J.P., vice-chairman; and Mr. V. A. H. M Cowen, electrical engineer. The principal portions of the plant were inspected, and his Lordship expressed himself pleased with the efficiency of the station.

Bournemouth.—The Town Clerk explained at the Town Council meeting that, in accordance with the instructions of the Council, he had communicated with the electric light company on the question of whether, and on what terms, they would be disposed to sell their undertaking to the Council, and he had received a reply stating their willingness to enter into negotiations on the subject. It was resolved to refer the matter to the General Purposes Committee.

Sir Joseph Whitworth and Co., Limited.—At an extraordinary meeting, held at Manchester on Saturday, it was resolved that the directors be empowered to amalgamate with Sir W. G. Armstrong, Mitchell, and Co., Limited, the combined firms in future to be known as Sir William Armstrong, Whitworth, and Co., Limited. The shareholders in Sir Joseph Whitworth and Co. will receive £7. 10s. in cash for each £10 share and three £1 shares in the new company, valued at £2. 10s. each.

Southampton.—The Works Committee of the Harbour Board reported at the last meeting of that body that the 11 tenders received for additional electric cranes having been referred to the sub-committee, it was unanimously resolved that the committee be asked to recommend the Board to accept the tender of Messrs. Stothert and Pitt, at £7,228, being the lowest complete tender for these cranes and alterations. Messrs. Siemens and Co. have been selected for the electrical part of the work.

Willans and Robinson, Limited.—An extraordinary general meeting of the Company will be held at the City Terminus Hotel, Cannon-street, London, E.C., on Tuesday, February 2, 1897, at 2 30 p.m., for the purpose of considering, and, if approved, of passing the following resolution—viz.: "That the directors be authorised to issue, upon such terms and conditions as they may determine, the unissued balance of the capital of the Company, amounting to 7,500 preference and 7,500 ordinary shares."

Sheffield.—The Sheffield Electric Light and Power Company, Limited, have decided to reduce the price of current from 6d. to 5d. per unit. This reduction, which is equivalent to 16⅔ per cent., is to take effect as from January 1, 1897. The use of the electric light has so largely increased in Sheffield that the facilities for production are being greatly increased. Orders have already been placed for the delivery of more than 2,000 h.p. of new machinery and the laying down of new supply cables in the city and suburbs.

Liverpool Overhead Railway.—The report of the directors for the past half-year to be presented to the shareholders' meeting on February 9 shows that 3,919,134 passengers have been carried during the half-year, with traffic receipts amounting to £32,227. 2s. 3d., and total receipts to £32,782. 18s The working expenses were £21,093. 5s. 5d. There is available for dividend £12,177. 5s., which includes £2,897. 12s. 5d. brought forward. The dividend proposed is 5 per cent. on preference and 3 per cent. on ordinary shares.

Heaton (Newcastle).—A fatal accident occurred about 6 a.m. on Saturday to a young man named Leslie Brown Jamieson, residing in Balmoral-terrace, Heaton. The deceased was employed at Messrs. Hawthorn, Leslie, and Co.'s works, at St. Peter's, and on Saturday morning, whilst following his employment, he accidentally came in contact with some electric plant. He received so serious a shock that medical assistance was at once sent for, but before the arrival of Dr. Ogg the unfortunate young man expired.

Birmingham.—A meeting of the employés of the City of Birmingham Tramways Company was held on Sunday morning, under the presidency of Mr. Favell, to consider the question of the hours of labour and wages. Memorials for presentation to the Board of directors were adopted, asking for the hours of labour to be reduced to 10 per day, or 60 per week, all time over to be paid for at the rate of time and a quarter; and for an alteration of the rate of wages in accordance with a scale which was included in the memorials.

Horfield.—At the meeting of the District Council Mr. J. P. Hartnell said that he should like to say that in his reply to Mr. Phillips, at a previous meeting, when that gentleman said that he had heard that the Bristol Electric Lighting Committee had made a profit of 6 per cent., he (Mr. Hartnell) stated that they might have made a profit of 6 per cent. or they might have made a loss of £15,000—he did not know. He wished now to congratulate the city on the very satisfactory way in which they had conducted the electric lighting during the past year.

Hull.—The new steam yacht built by Messrs. Earle for the Niger Coast Protectorate has arrived at her destination. The yacht is ventilated with a view to meeting the special requirements of the service for which she is designed. For this purpose an electric fan is fitted in connection with trunks for exhausting the vitiated air from the cabins and berths, while numerous cowls and ventilating-shafts are introduced for the supply of fresh air to all the spaces. A complete system of electric lighting is established, and an electric search-light projector is fitted.

Worcester.—The Streets Committee of the City Council having considered the terms of the provisional order which the tramways company are about to apply for have decided to recommend the Council not to sanction the extension of the tramways along High-street in view of its narrowness, but to sanction the proposed extensions to Red-hill, Cherry-orchard, and Rainbow-hill. The committee also recommend the adoption of numerous conditions, one of which is that if electricity is used as the motive power the current shall be obtained from the Corporation works.

Anglo-American Telegraph Company, Limited.—At a meeting of the Board of directors on January 22, it was resolved, after placing the sum of £12,000 to the credit of the renewal fund, to recommend to the proprietors at the next ordinary general meeting of the Company, to be held on February 5 next, the declaration of a dividend of 17s. per cent. upon the ordinary consolidated stock for the year ending December 31, 1896, and a dividend of £1. 14s. per cent. upon the preferred stock for the same period. There will be a balance of about £360 to be carried forward to the next account.

Islington.—At the meeting of the Vestry the Electric Lighting Committee submitted a report recommending that certain property in Eden-grove be purchased in order that the electric lighting station might be developed. It was proposed to purchase the freeholds of Nos. 44, 46, and 48, Eden-grove, and 1, Burnard-place, for £1,400. On the motion of Mr. Lambert, seconded by Mr. Littlewood, the report was unanimously adopted. Mr. Lambert, in reply to questions, said the acquisition of the property would give the Vestry uninterrupted frontages along Eden-grove and Burnard-place.

Halifax.—The Markets Committee have been discussing the question as to how the markets could be best lighted. They agreed to take two electric arc lamps from the arcades, and place from four to six more in the markets proper. The present electric arc lamps will be removed to more suitable positions. A sub-committee, consisting of the chairman (Councillor Hebden), Councillor Fawthrop, and Alderman Braithwaite, was appointed to see to the carrying out of the work. The Gasworks Committee propose to erect an arc lamp at the Russell street entrance to the markets in place of the present gas lamp.

The London Tramways.—The Parliamentary Committee of the London County Council recommended at the last meeting that the question of obtaining statutory authority for tramway companies generally to take leases of tramway undertakings purchased by the Council or the local authorities adjacent to the county of London should be referred back to the Highways Committee for further consideration. The committee stated that they had consulted the parliamentary agent on the matter, who reported that he was of opinion that the Act of 1870 was sufficiently clear on the subject. The recommendation was agreed to.

Huddersfield.—The Electric Lighting Committee reported at the Town Council meeting that in January, 1896, the number of consumers was 280, and the number of lamps connected was 20,889; now there are 385 consumers and 28,983 lamps. The units metered in 1895 were 237,800 and in 1896 317,648, or an increase of 25 per cent. The borough electrical engineer has been instructed to report upon the schemes of the Electric Lighting Extension Syndicate, Limited, and the Electric Free Wiring Syndicate, Limited, for the supply of energy by the Corporation to premises supplied with fittings by a syndicate.

Meter Testing.—The Commissioners of Sewers of the City of London have issued notice that they have appointed an electrical inspector and have provided a well equipped laboratory to enable him to carry out the duties required under the city of London electric lighting orders. Persons wishing to have their electricity meters tested, or desiring to know the pressure of the electric supply, or otherwise requiring the services of the electrical inspector, as prescribed by the above-mentioned orders should apply to that officer, at the electrical laboratory of the Commissioners in the Wool Exchange, Basinghall-street, E.C.

Rochdale.—The Tramways Sub-Committee of the Paving Committee having visited Walsall and Bristol for the purpose of inspecting the overhead system of electric traction which is used

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in connection with the tramways in those towns. The sub-committee consisted of Alderman James Cheetham (chairman of the committee), Alderman Schofield, and Councillors Bottomley, Butterworth, Duncan, Dunning, Howarth, Starkie, Jas. Taylor, and S. Turner. Councillor Howarth was, however, unable to leave Rochdale. The deputy town clerk (Mr. James Leach) and the borough surveyor (Mr. S. S. Platt) also accompanied the deputation.

City and South London Extension.—The County Council have considered an application made on behalf of the City and South London Railway Company for the Council's sanction to a plan showing a slight modification of the plan approved by the Council on October 20 last of the arrangements for entrance and exit for the proposed London Bridge station at the corner of Denman-street and Railway-approach. It is now proposed that the shaft will be placed more to the west, and so increase the space available on the entrance side of the lifts. This, in the opinion of the committee, is an improvement on the original proposal, and the modification has been sanctioned.

Liverpool.—A meeting of the owners and ratepayers has been held to consider the proposal of the City Council to apply to Parliament for the passing of three Bills in the ensuing session of Parliament. The Lord Mayor moved:—"That this meeting consents to the promotion by the Council of a Bill to authorise the Corporation to purchase by agreement or compulsorily the undertaking of the Liverpool United Tramways and Omnibus Company or any part thereof, and to contain all necessary provisions to enable the purchase to be carried out and consequent thereon, and that the expenses of promoting such Bill be paid out of the general rate." Alderman Radcliffe seconded the motion, which was carried without discussion.

Claim for Electric Fittings.—In the Westminster County Court on Tuesday, his Honour Judge Lumley Smith, Q.C., had before him the case of Allen *v.* Farnley, in which the plaintiffs, a firm of West-end electrical engineers, sought to recover payment of an account in respect of electrical fittings supplied to the order of the defendant, a restaurant-keeper carrying on business at Beak-street, Regent-street. The Defendant was called, and said he knew nothing about the plaintiffs' claim, as the goods were supplied at a time when his son was in possession of the business, and was carrying it on for his own benefit. After hearing other evidence, his Honour gave judgment for the plaintiffs for the amount claimed, the judgment to go against the son.

London Local Extensions.—The County of London and Brush Provincial Electric Lighting Company have given notice, under Electric Lighting Acts and Orders, that they intend to lay high and low tension mains in North-street and York-road, etc., Wandsworth; the London Electric Supply Corporation have given notice of intention to lay distributing mains in Hills place and Marlborough-mews, Westminster; the House-to House Electric Light Supply Company notice of intention to lay low-tension mains on the north side of West Cromwell-road; and the Vestry of St. Pancras have given notice of their intention to lay mains along the south side of Euston-road. The notices were passed by the committee of the County Council with the usual conditions.

Dover.—Councillor Ayres asked at the Town Council meeting if they could determine the position of the electric lights in Biggin-street. Mr. Bagshaw had informed him that the lamp-posts had arrived, but the positions had not been fixed. Councillor G. Mowll said he had yet to learn the reason for approaching the Castle Ward Lighting Committee for work to be done in the Town Ward. They were quite prepared to fix the sites. Two alternative plans had been prepared, and the Town Ward Lighting Committee were prepared to meet the engineer of the electric light company and the surveyor, and he fully understood that it was decided that a week before the arrival of the posts Mr. Whitlock would give them notice so that a decision could be arrived at and the work at once got on with.

Aberdeen District Tramways Company.—The report of the directors recommends a dividend for the half-year at the rate of 5 per cent. and a bonus of 1s. per share, carrying to contingent account a further sum of £1,500 towards meeting expenses of the litigation with Mr. James Ogston, who was successful in the House of Lords, and £204 forward. The directors state that in August last the directors of the Great North of Scotland Railway made an offer of £16 per share for the undertaking, in addition to the cost of doubling the line in Albyn-place and of the extension to Bay View. The directors agreed to recommend their shareholders to accept this offer, but, owing to the Town Council's declining to consent to the transfer of the undertaking, the negotiations have not gone further in the meantime.

Kilburn.—A public meeting has been held to discuss the subject of public lighting in the High-road. The following resolution was carried unanimously: "That this meeting of Willesden and Hampstead ratepayers, called to consider the question of the public lighting of the High-road, Kilburn, views with great satisfaction the offer of the Hampstead Vestry to place 24 arc lamp standards along the centre of the High-road free of all cost of installation to the Willesden District Council charging them a rental of £15 per annum per lamp, and would strongly urge the Willesden District Council to accept the proposal, and so assist in carrying out a much-needed and long-required public improvement." A resolution was also passed asking the Willesden District Council to request the Hampstead Vestry to supply the electric light to shopkeepers on the Willesden side of the road on the same terms as to the shopkeepers on the Hampstead side.

Wimbledon.—It was reported at the Urban District Council meeting that the clerk had received notice of objection to the application of the District Council for an electric lighting provisional order from the Mitcham and Wimbledon Gas Company, and requests for alterations or additional clauses from the Lambeth Water Company, the Surrey County Council, and the London and South-Western Railway Company. The Clerk, in answer to Mr. Crimp, stated that the gas company based their objection on the ground that they were large ratepayers in Wimbledon, and the proposed installation of the electric light would mean a heavy increase in the rates. The objections emanating from the other parties were merely of a formal character. He had also received notice of an objection which had been made by Mr. Alfred Ward, who sent it in the first instance to the Board of Trade.

St. Pancras.—The Vestry at their last meeting agreed to supply electric energy at 2d. per unit to a public company which is about to put electric motorcars on the streets. At the same meeting Mr. Cox informed the Vestry that a claim had been received from Messrs. Henley's Telegraph Works, Limited, for the sum of £2,419. 7s. 8d., extras over their contract of £17,000 for laying electric mains. The committee acknowledged extras to the amount of £582. 15s. 3d., but had a letter from Messrs. Henley's solicitors claiming £2,743. 11s. 8d., stating their instructions were to take proceedings for recovery at the expiration of a month. The committee recommended, on the advice of the Vestry's solicitors, Messrs. Cunliffes and Davenport, to apply at once to stay the action under the Arbitration Act, 1889, and to make a tender to Messrs. Henley of £582. 15s. 3d. This was agreed to.

London.—It will be remembered that at the Court of the Commissioners of Sewers the contractors for the Central London Railway asked the members to reconsider their decision as to their refusal to permit an opening to be made at the west door of the Mansion House for the purposes of the sinking of a shaft at that point. The clerk read a letter at the last meeting stating that the contractors wished to withdraw their application, as they did not know that Sir Benjamin Baker had been in communication with the Commission, and that the views he expressed were inconsistent with what they had stated. The Chairman thought the letter was, under the circumstances, a satisfactory one. An application from Messrs. Galbraith and Kennedy to sink a shaft in Queen Victoria street in connection with the Waterloo and City Railway was referred to the Streets Committee for consideration, and with power to act.

Wolverhampton and District Tramways Scheme.—Further details have been disclosed respecting the tramway scheme affecting South Staffordshire, which will come before Parliament under the Birmingham, Wolverhampton, and District Tramways Bill. Under the Bill any kind of propelling power may be adopted, but as a matter of fact it is the intention of the syndicate to use electricity. The central station is to be erected at Dudley Port, and the current will be conveyed by overhead wires. The gauge will be 3ft. 6in. Along the various new lines there will be no less than 74 narrow places. The most difficult is Rookery-street, Wednesfield, and the Urban District Council at that place were at first bitterly opposed to a tramway being laid down in that thoroughfare. In fact, the chairman stated in an interview with the engineer (Mr. Sellon) that should the syndicate put down rails along that street it would become practically a death trap, but the Wednesfield Council have accepted the assurances of Mr. Sellon on the subject.

Cologne.—A report of the working of the Cologne central station for the year ending March 31, 1896, is published in the *Elektrotechnischer Anzeiger*. The cost of production is stated to be as low as 1·44d. per kilowatt-hour—not including interest and sinking fund. The total capital invested in the station amounts at present to £112,700, of which £25,700 has already been written off—including £9,100 during the past year—leaving a book value of £87.000. The total consumption during the year is divided chiefly as follows: private lighting, 81·18 per cent.; private motors, 6·99 per cent.; public lighting, 7·43 per cent. Each lamp installed burnt on an average 463 hours during the year, the maximum demand being during the month of December. The total number of incandescent lamps connected to the network was on March 31, 1896, 26,263 50-watt lamps, or their equivalent. In addition to this there were 454 arc lamps and 150 h.p., represented by 35 motors. This brings the total lamp and motor connection to 1,701,410 watts, or an equivalent to 34,028 50-watt lamps.

Folkestone.—A meeting of the Corporation in committee has been held to consider the matter of electric light and the agreement with Mr. Hopkins, which was under consideration last week and adjourned. After a very long discussion the matter was again adjourned. The chief points in the agreement as printed are that the company shall pay the Corporation all the expenses, not to exceed £600, light the streets effectually for seven years at an agreed price per lamp, and all standards to be provided and fixed by the Corporation. At the expiration of 42 years the company's undertaking may be taken over by the Corporation at its then value, and upon certain terms, at the expiration of 15 years, and any subsequent seven years, the price to be a sum equal to the amount of money properly expended by the company on capital account, and so certified by the auditor of the Board of Trade, with certain specified additions. It is understood that the chief item of contention is the provision of lamp standards, which will involve an outlay of £2,000, and which Mr. Hopkins asks the Corporation to bear the cost of, whereas originally it was arranged that the company should bear it.

Frankfurt-a.-Maine.—Respecting the manufacture of telegraph wire and electric cables the annual report of the Chamber of Commerce of Frankfurt says, in substance: "This comparatively new

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industry gains ground from year to year, and embraces constantly new fields, so that its various branches are continually employed. It is to be regretted that the prices of raw materials have risen and the sales prices fallen to such an extent that the rentability of a business requiring such accuracy in manufacture and such careful selection of material is a matter of doubt Although the main factor, copper, has advanced on the English exchanges, the advance placed on copper wire by the manufacturers is out of all proportion, made possible only by a convention. Rubber and cotton, which enter largely into the manufacture of these goods, have also advanced considerably, so that the cost of production is materially higher than formerly. It is true that in August, 1895, an advance was made in prices, but through strong competition this has crumbled away, so that at the time of this report the position is exactly the same as before the advance. This industry has been much simplified by the establishment of uniform diameters and insulations."

Fulham.—The Electric Lighting and Dust Destructor Committee reported at the Vestry meeting as follows: "We have received the following report from the deputation appointed to visit the Leyton dust destructor, and recommend that it be adopted—viz.: "We beg to report that, on Friday, the 8th inst, accompanied by the medical officer of health and the surveyor, we visited the Beaman and Deas dust and sludge destructor at Leyton. We found that there were four cells in working, driving two engines, and after a careful inspection of the installation in operation, we are of opinion that a destructor of this type is capable of destroying all the refuse of Fulham and of producing power to generate electricity, but to what extent we are not at this stage in a position to state. We recommend that the surveyor be instructed to obtain what further information he can and report same to the committee as soon as he is in a position to do so We further recommend that samples of our own refuse should, if possible, be sent to the dust destructors in operation at Warrington, Oldham, and Cambridge, and that a deputation be appointed to visit these destructors to see how our own dust is destroyed and the amount of steam produced."

Littleborough.—Last week a deputation from the Rochdale Tramways Company waited upon the General Purposes Committee of the District Council with a view to laying before the members information as to the desire of the tramway company to use electric traction for the cars between Rochdale and Littleborough. They also explained that the company wished the local authorities in whose respective districts the lines run—Rochdale, Littleborough, and Wardle—to give an undertaking that they will not enforce their rights to compulsorily acquire the plant of the company for a period of 21 years, after 1902, which is the time when right of compulsory purchase becomes operative under the Tramways Act of 1870. A conversation took place between the members of the committee and the deputation as to the details of the scheme, and several suggestions were made as to the working of the lines in future. The situation of the present terminus in Church-street, the principal thoroughfare of the village, has always been objected to and some of the members suggested the advisability of making the terminus at some other place. The extension of the lines to Summit was also mentioned as a much felt need. The proposals laid before the committee by the directors as to the electric traction on the existing lines will be considered at a future meeting, and the result brought before the District Council.

Glasgow Tramway and Omnibus Company, Limited.—The report of the directors for the half year to December 31, to be submitted to the half-yearly meeting to be held at Glasgow on 1st prox., states that the revenue account shows a balance at its credit of £1,825, which, added to the balance of £168 brought forward from last half-year, makes a sum of £1,993 available for distribution, and out of which the directors propose to declare a dividend at the rate of 1s. per share, free of income tax, which will absorb a sum of £1,750, leaving a balance of £243 to be carried forward. During the half-year communication took place between the directors and the Corporation of Glasgow, which resulted in a sale to the latter of a stable in Pollokshaws and the lease of the Govan and Ibrox tramways on terms favourable to the Company. The horses, cars, and all other plant used in connection with the working of these tramways were also sold to the Corporation at a valuation as a going concern. Some time ago an action was raised in the Court of Session against the Corporation of Glasgow for various sums, amounting in all to £14,246 of owners' taxes paid by the Company on the Glasgow tramway lines during the currency of the lease. On the other hand, a counteraction for £2,775 was raised by the Corporation against the Company for interest, sinking fund, and mileage for the period from May 15 till June 30, 1894. The Lord Ordinary has given a decision in favour of the Company in their action against the Corporation, but has decided against them in the Corporation's counter action His decisions are under appeal.

Deane.—At the meeting of the Parish Council the following communication was received from the town clerk in reference to the proposed extension of the Bolton tramways to Deane: "Application has been made to the Bolton District Council for their consent to the proposal of the Corporation for the extension of their tramways into the townships of Lostock, Deane, Over Hulton, Middle Hulton, Great Lever, and Tonge, and I am apprehensive that, notwithstanding the approval of the ratepayers of those districts of such proposal, as expressed by resolution of their Parish Councils, the Rural District Council will withhold their assent, and so prevent the proposed extension being carried out. To obviate this result, I venture to suggest that you, as chairman of one of the Parish Councils concerned, should use your influence with the members of the District Council elected for your township to induce them to vote for the required consent being given. As the proposed extension would also conduce to the convenience of the ratepayers of Bradshaw, Breightmet, and Harwood, their support might also be asked for through the district councillors of their township" It was decided that Mr. Brocklehurst be asked to use his influence with the District Council, of which he is a member, in favour of the proposed extension. The clerk to the County Council wrote, on behalf of the Parliamentary Committee of that body, asking whether the Deane Parish Council approved of the proposal contained in the Bolton Tramways Improvement Bill for laying tramways within the Deane district. A reply was ordered to be sent stating that the Parish Council was entirely in favour of the extension as proposed.

Kingston-on-Thames.—The Lighting Committee reported at the Town Council meeting that the consulting engineer (Mr. Preece) had submitted a statement of the expenditure and liabilities in respect of works of electric lighting on capital account. The amount of expenditure and liabilities was £29,497. 8s., and the loans at present authorised and received amounted to £23,772, leaving the sum of £5,725 required to be borrowed. The borough electrical engineer had also submitted an approximate estimate for the extension of buildings and plant at the central station, and the extension of mains, the total amount required to be expended under these headings being £14,242. 10s., which brought the proposed estimated expenditure up to a total of £19,967. 18s. The committee recommended the Council, through the General Purposes and Finance Committee, to authorise application to be made to the Local Government Board for sanction to the borrowing of a further sum of £20,000 for electric lighting purposes. It was also recommended that the borough electrical engineer (Mr. J. E. Edgcome) be the consulting engineer in regard to the carrying out of the proposed work. Subject to the Council's approval, the committee had decided to extend the electric mains along Richmond-road and along Albany-park-road, at an estimated cost of £880; and also to lay an electric cable to St. Raphael's Church, Portsmouth-road. Councillor J. Collings, in moving the adoption of the report, said the committee felt that they had arrived at a stage when the lamps they already had connected left practically no spare power, and it was absolutely necessary to provide additional capital if they were to proceed with any success. The report was adopted. The Lighting Committee's annual report has been issued, and we hope to deal with it shortly.

Swansea.—The Electric Lighting and Tramways Committee reported at the Town Council meeting as follows: "Resolved, that a sub-committee, consisting of the mayor, the ex-mayor, the chairman and vice-chairman of the Finance Committee, Aldermen D. Harris, J. V. Leeder, J. M. Mayne, G. Morgan, and M. Tutton, and Councillors T. Freeman, R. S. Lindley, R. Martin, R. Thomas, and W. P. Wearne be appointed with full power to make the necessary arrangements for taking the poll of owners and ratepayers in connection with the Swansea Corporation Tramways Bill, the cost of such poll not to exceed £300. Resolved, that Mr. George Hopkins, of Parliament-street, Westminster, be instructed to report upon the proposed purchase of the tramways, the cost of such report not to exceed £100. A deputation of ratepayers from St. Thomas attended and discussed with the committee the provisions of the Tramways Bill relative to the east side of the borough. The Town Clerk submitted a copy of the Bill intended to be promoted in the next session of Parliament by the Swansea Improvement and Tramways Company to authorise them to equip their tramways for electrical traction, and it was resolved that the Town Council do lodge a petition against the Bill, and that the mayor be authorised to affix the corporate common seal to such petition." Mr. Martin moved the adoption of the minutes. This was seconded. Mr. R. S Lindley said it had been stated that sufficient time had not been given to enable owners to make their claims of ownership. He should therefore like to ask the town clerk what notice the Act required to be given. It was an important matter, and it was desirable that they should have the vote of everyone entitled to vote. The Deputy Town Clerk said that under the Public Health Act they had to give 14 days' notice to the owners to send in their claims. On January 4 they issued 500 copies of a poster to be posted on churches and chapels and all hoardings.

Blackrock.—At the meeting of the Commissioners Mr. Hayes moved that a letter be written to the tramway company pointing out that the existing agreement for wayleave through the township will expire next year, and that it would be desirable and for the interest of the tramway company and the Commissioners that a permanent arrangement should be made; and that, having regard to the wayleave which the company agreed to pay to their townships for less profitable thoroughfares, the Commissioners thought that £200 a mile per annum would be a fair rent, and they would be prepared to agree to the company putting in a clause in the Bill which was coming before Parliament in the ensuing session for a lease for 21 years, and that the roadway from kerb to kerb be paved from Blackrock House to the cross at Blackrock. Mr. Canning seconded the motion. Mr. Hartigan moved as an amendment that the matter be allowed to rest for the present. He thought the tramway company had been very liberal in the arrangement with the Commissioners and had treated the public in a very handsome manner. Mr. Wilkinson seconded the amendment. Mr. Kelly said he was in favour of getting the best terms they could from the tramway company for leave to run over the township road. Mr. Marchbank thought they should not try to increase the sum charged for wayleave, as by doing so the tramway company might increase the fares charged on the line. The Board should remember that the paving of the roads by the company had saved the township a considerable sum. In his

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opinion it would be premature to consider the matter before the expiration of the agreement. Mr. Hayes said that the reason he had moved in the matter was that the tramway company were going to Parliament for a Bill. Mr. Wright suggested that a deputation from the Commissioners should wait on the company. After further discussion the amendment was lost, and Mr. Hayes's motion carried by a majority of 10 to 6.

Brighton.—The Lighting Committee reported at the Town Council meeting that they had given instructions for an electricity main to be laid in Rose Hill-terrace at an estimated cost of £65, and that the existing public lamps in that street be lighted by electricity instead of by gas. Councillor Halliwell's request for the improved lighting in Kensington-street was referred to the surveyor to report. Councillor Willett wrote enclosing a memorial from certain inhabitants of Chesham-road, Rock-street, and neighbourhood, requesting that arc lamps might be erected in Chesham-road and Rock-street. It was resolved that the request should receive consideration when the committee have before them the question of the extension of the arc-lighting system. A letter was read from Mr. E. E. Edwards requesting that electricity cables might be laid in Rugby-road, between Southdown-avenue and Stanford-avenue, before the road is made up, but the committee deemed it inexpedient at present to lay an electric cable in the portion of Rugby-road referred to. These proceedings were adopted. The *Sussex Daily News* says: "The very many customers of the Brighton Corporation electricity works will be interested in the latest rumour concerning that undertaking—viz., that it is in contemplation to reduce the price of electricity to long-hour consumers. The policy of encouraging this class of customer has so far met with full reward. It is understood that the one point in doubt is the expediency of making the charge 7d. and 2d. or 7d. and 1·5d. Consumers would very naturally prefer the lower charge and as the interests of the Corporation have so far been best served by a liberal policy, there is no doubt that the lower price would prove the more remunerative. At 1·5d. electricity would compete with gas most favourably for either light or power, and the use of it would thus have every encouragement." The Brighton stipendiary, in his capacity as arbitrator in the matter in dispute between the Postmaster-General and the Brighton Corporation with regard to overhead telephone wires in the borough, has issued a sealed award, which, it is understood, is in favour of the Postmaster-General's application with certain limitations.

Norwich.—At the meeting of the Town Council Mr. Tillett moved, "That the committee be authorised to withhold consent to, and that a petition be presented to Parliament, if necessary, against the Bill promoted by the New General Traction Company, Limited, for the construction of electric tramways in the city; and that the committee be authorised to direct the town clerk to affix the corporate seal to the petition, and to take such action and incur such costs in opposing the Bill as they may consider necessary." This matter had excited a great deal of public interest, and was an important one for the city. The committee were not in a position at the present moment to bring up a report. The committee had had several meetings. As members were aware, this matter was referred to the Law Committee, with the addition of Mr. Alderman Bagshaw and Mr. Alderman Cunnell. There was one thing of which the Council might be quite certain—viz., that no decision would be arrived at without the entire body corporate being consulted. There was no intention on the part of the committee to dictate to the Council. It was simply necessary for them to go into certain details and to see if it were possible to make arrangements by which tramways might be procured. There were two schemes before the city: one might be called the light railways scheme, and the other the tramways scheme proper. The tramway scheme was the bigger and more comprehensive one, and it involved an undertaking of enormous importance. There were delicate matters to consider—such as the power of purchasing the undertaking. At the present juncture all he could say was that the matter had had the earnest and careful consideration of the committee, and they hoped shortly to bring up a report. He ought to say one word as to the procedure, because according to the present motion they asked for power to withhold consent and take necessary steps to present a petition to the House of Commons. He did not wish it to be understood that the asking for these powers necessarily involved a hostile attitude to tramways. All they wanted was power to withhold consent and, if necessary, to petition Parliament in order that they might insist on certain conditions being inserted in the company's Bill with a view to the protection of the citizens. The procedure was somewhat different in the two cases. The tramway company proper must have consent by January 27, or some extended time; if not their scheme was blocked altogether. The consent which it was now proposed to give related merely to the general principles of the scheme, and in no way prevented a petition to Parliament being heard when the Bill came up. As regards the light railway company, the procedure in many respects was different. Instead of proceedings at Westminster before a parliamentary committee there would be a hearing in Norwich before the Railway Commissioners, when any citizen could attend and state his objections. Mr. D. Havers seconded, and the resolution was carried. It was also agreed that the application of the British Electric Traction Company, Limited, to the Light Railway Commissioners for an order authorising light railways in Norwich and district be opposed, and that the committee be authorised to incur such costs, and to direct the town clerk to take such action and to do all such things as may be requisite to oppose the grant of the order, as they may consider necessary.

Cardiff.—A special meeting of the General Purposes Committee of the County Council was held on Monday. The meeting was convened for the special purposes set forth in the agenda, as follow: "To consider the proceedings of the Tramways Committee recommending that the Council purchase the tramway lines and depôts upon certain conditions; and to receive an application from Messrs. Ashurst and Co., solicitors, for consent, under Section 4 of the Tramways Act, 1870, of the Corporation, as the 'local authority" under that Act, to the application of the Cardiff Tramways Company for a provisional order to construct certain new lines of tramway in the borough of Cardiff, and to pass a resolution or resolutions thereon." A letter was read from Mr. J. Glenn, stating that, although the directors of the tramway company were disappointed at the shortening of the lease and the raising of the interest to be paid, they might take it that, with a view of getting the matter definitely settled, the terms as set out in the committee's recommendation offered to the company would be accepted. The Town Clerk followed by reading the recommendations to the Council made by the Tramways Committee, which were the subject of discussion. They were that the tramways, lines, and depôts be purchased upon the following conditions: (1) That the price offered be £61,600 for the existing lines and depôts belonging to the Cardiff Tramways Company, about 9$\frac{5}{8}$ miles in length; (2) that the lines be leased to the Cardiff Tramways Company upon the following terms—viz, for a term of 15 years at a rent of 5½ per cent.; (3) that the existing lines be immediately made equal to new to the satisfaction of the borough engineer, and that where necessary and convenient the lines shall be doubled, and that rentals upon the cost of renewing and doubling, including cost of widening streets to the regulation width of 9ft 6in. from the tram rail, be charged at the same percentage as in condition No. 2; (4) that the cost of repairs, together with 5 per cent for supervision, be paid quarterly to the Corporation by the company; (5) the present fares not to be raised without the consent of the Corporation; (6) the above proposals to be subject to a proper agreement for lease being entered into, such agreement to include, in addition to the usual clauses, clauses to the effect that, when called upon by the Corporation, the company shall use electric current (to be supplied by the Corporation), cable, or other mechanical traction; the company shall work all extensions and newly-constructed tramways upon the same rental basis, until the determination of the first named lease; that the tramways be worked according to by-laws to be framed from time to time by the Corporation, with the approval of the Board of Trade or the Local Government Board; (7) such other clauses and conditions as may be determined by the town clerk. Mr. Tucker and Mr. Waring formally moved and seconded the adoption of the report. Mr. David moved, and Mr. Morgan Morgan seconded: "That clause 1 of paragraph 632 of the proceedings of the committee be amended by the addition of the following words—viz., 'Such sum to include the cost of immediately making equal to new to the satisfaction of the borough engineer the existing lines.'" A long discussion followed on this, but eventually the amendment was declared carried by 17 to 15. A good deal of confusion was caused because Mr. Brain wanted to move another amendment, and no one seemed to be able to say whether he was in order or not. The meeting consequently broke up prematurely, and the second part of the agenda was deferred until the next meeting of the Council.

PROVISIONAL PATENTS, 1897.

JANUARY 18.

1271. **Electric locomotive railroad and self-signalling system.** Hugh McAlpine, 37, Abercorn-street, Glasgow.

1279. **Improvements in and relating to accumulators or storage batteries.** Walter Rowbotham and Charles Levetus, 27, Victoria street, Birmingham.

1319. **Improvements in writing telegraphs.** Oliver Imray, 28, Southampton buildings, Chancery-lane, London. (Leon O. McPherson, United States.)

1337. **Improvements in electrical machines.** Albert Verley, 47, Lincoln's-inn-fields, London.

1344. **Electric signalling apparatus applicable for indicating the rising of dough.** Joseph Best, 322, High Holborn, London.

JANUARY 19.

1361. **Improvements in electric current switches.** Arthur John Wheatley, 8, High-street, Harborne, near Birmingham.

1369. **Improvements in and relating to accumulators or storage batteries.** Walter Rowbotham, 27, Victoria-street, Birmingham.

1381. **Improvements in fittings for electric installations and for bell pulls and the like.** Aldred Edward Gaddum, 17, St. Ann's-square, Manchester.

1430. **Improvements in and connected with electrical storage batteries.** Edward John Wade, 8, Holmewood-road, Brixton-hill, London.

1434. **Improvements in or relating to electric railways.** James Francis McLaughlin, 111, Hatton-garden, London. (Complete specification.)

1437. **Improvements in telephone switches.** Elias Elkan Ries, 97, Newgate-street, London. (Date applied for under Patents, etc., Act, 1883, Sec. 130, June 26, 1896, being date of application in United States.) (Complete specification.)

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1435. Improvements in or relating to electric railways. James Francis McLaughlin, 111, Hatton-garden, London. (Complete specification.)

JANUARY 20.

1521. Improvements in adjustable liquid resistances for starting and regulating electric motors. John Henry Holmes, Portland-road, Newcastle-on-Tyne.

1535. Improvements in the electric precipitation of gold and silver from their cyanide solutions. Alfred James, 121, West George-street, Glasgow. (Complete specification.)

1557. An improved appliance for use in connection with telephone receivers. Charles Alexander Jackson Jellie, 23, Coleman-street, London.

1572. Improvements in electrolytes for the deposition of zinc and for use in secondary batteries. Henry Leitner, 37, Chancery-lane, London.

1574. An improved system of underground current supply with closed conduit for electric railways. William Phillips Thompson, 6, Lord-street, Liverpool. (Charles Devenyns, Belgium.)

1581. Improvements in or relating to electric lampholders, wall sockets, and the like. Henry Bevan Swift, 111, Hatton-garden, London.

1583. Improvements in the manufacture and production of filaments for incandescent electric lamps. Joseph Wilson Swan, 47, Lincoln's-inn-fields, London.

1591. An improvement in incandescent electric lamps. Henry Charles Gover and John Miles Moffat, 28, Southampton-buildings, Chancery-lane, London. (Complete specification.)

1595. Improvements in electrical accumulators. Thomas Hamilton, 4, South-street, Finsbury, London.

JANUARY 21.

1610. An electrical dissolver and slide-changing apparatus for optical lanterns. Horace Seymour Pine and Arthur Elsee, The Green, Castletown, Isle of Man.

1627. Certain improvements in apparatus for the electro-deposition of metals. Alfred Ernest Cook, 128, Colmore-row, Birmingham.

1631. Improvements in apparatus for automatically causing a flow of water or other fluid or making or breaking an electric circuit automatically by the fusion of a suitable joint or connection Handel Beech, 4, St. Ann's-square, Manchester.

1634. An improvement on electric light and heat graduators. William Stevens, Broad-street House, Old Broad-street, London. (Louis Héndlé, France)

1648. Improvements in electric switches and in apparatus for connecting electric circuits. Joseph Devonport Finney Andrews, 45, Fulham-park gardens, London.

1651. Improvements in multiple-contact telephone transmitters and the battery circuit connections relating thereto. Charles Adams Randall, 63, Chancery-lane, London.

1657. An improvement in the electro-deposition of metals and alloys. George Arthur Webb and William Arthur Thoms, 108, St. John's-street-road, London. (Complete specification.)

1680. Improvements in alternating-current motors. Walter Langdon-Davies, 16, Red Lion-street, Clerkenwell, London.

JANUARY 22.

1714. Improvements in and relating to accumulators or storage batteries. Walter Rowbotham, 27, Vittoria-street, Birmingham.

1731. A system of electrical signalling or communication between the occupant or occupants of a cab, carriage, or other road vehicle propelled by horse or other power and the driver or drivers thereof and apparatus therefor. William Perren Maycock, 30, Kemble-road, Croydon.

1754. Improvements in electric arc lamps. Walter Reginald Lambert, 73, St. Stephen's-road, Upton Park, London.

1755. A new or improved arm rest in connection with telephones. Max Byng and Francis George Bell, 73, St. Stephen's-road, Upton Park, London.

1756. Improvements in double-contact switches especially adapted to telephones. Max Byng and Francis George Bell, 73, St. Stephen's-road, Upton Park, London.

1771. Improvements in electrically-driven sheep-shearing or hair-clipping machines. William Baines and William Norris, 18, Southampton-buildings, Chancery-lane, London.

1789. Improvements in electric cables. Willoughby Statham Smith and William Puddicombe Granville, 24, Southampton-buildings, Chancery-lane, London.

JANUARY 23.

1800. An improvement in or connected with electric clock movements to record the time by electricity. William Henry Stockall, 6, Clerkenwell-road, London.

1809. Improvements in high-tension electric switches. Alfred Still and Edward Woodrowe Cowan, Broadheath Engineering Works, Broadheath, Cheshire.

1827. Improvements in and connected with electric motor-cars. William Edwin Heys, 70, Market street, Manchester. (Jean Jacques Heilmann, France.) (Complete specification.)

1849. Improvements in electric railways on the conduit system. Nigel Harington Balfour and Edward Whyte Smith, 66, College-street, Chelsea, London.

1882. Improvements in and connected with electric switches. William Kirkham Partington, 11, Furnival-street, Holborn, London.

1887. Improvements in or connected with incandescent electric lamps. The British Incandescent Electric Lamp Company, Limited, and Herbert Edmund Moul, 47, Lincoln's-inn-fields, London.

SPECIFICATIONS PUBLISHED.

1896.

535. Primary and secondary batteries. Headland.

546. Electric incandescence lamps and adaptor fittings therefor. Bott.

722. Electric arc lamps. Thornycroft and Thornycroft.

1563. Gravity electrical contact makers. Pearson.

2043. Multiple telegraphy. Dixon. (Date applied for under International Convention, September 12, 1895.)

2056. Magneto-electric machines for electrically lighting cycles and other vehicles. Bryan-Haymes, Walcott, Collier, and Bryant.

2074. Construction of lamp and bracket reflectors for electric, gas, and other lights. Parker.

4432. Electrical resistances. Davy.

5491. Means for varying the speed of a synchronous alternate-current motor. Siemens Bros. and Co., Limited. (Siemens and Halske.)

18617. Brushes for dynames. Chaplin.

22156. Duplex electric switch. Simon. (Busch.)

22703. Generation of gas and electricity and apparatus therefor and the application thereof to motive power purposes. Short.

26281. Manufacture of metal sheets or strips by electro-deposition. Klic.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	£	9-9½
Brush Company, Ordinary	£	¾-1¼
—— Non. Cum., 6 per cent. Pref.	£	1½-1¾
—— 4½ per cent. Debenture Stock	100	109-112
—— 4½ per cent. 2nd Debenture Stock	100	94-98
Central London Railway, Ordinary	10	9¾-10¼
——	£	3¾-4
Charing Cross and Strand	£	9¾-10¼
Chelsea Electricity Company	£	8¾-9
—— 4½ per cent. Debentures	100	112-115
City of London, Ordinary	10	15½-16½
—— 6 per cent. Cumulative Pref.	10	16½-17½
—— 5 per cent. Debenture Stock	100	128-132
City and South London Railway, Consolidated Ordinary	100	59-61
—— 4 per cent. Debenture Stock	100	126-128
—— 5 per cent. Pref. Shares	10	15½-16
County of London and Brush Provincial Co., Ordinary	10	8-9½
—— 6 per cent. Cum. Pref.	10	13½-14
—— 4½ per cent. 2nd Debenture Stock	£	9¼-10½
Crompton and Co., 7 per cent. Cum. Pref. Shares	£	1½-2½
—— 5 per cent. Debentures	—	93 98
Edison and Swan United Ordinary	£	1½-2½
—— 5 per cent. Debentures	£	3-4
—— 4½ per cent. Debentures	100	105-110
Electric Construction, Limited	£	1½-1¾
—— 7 per cent. Cumulative Pref.	£	2½-3
Elmore's Copper Depositing	£	⅞-1
Elmore's Wire Company	£	1-1⅛
W. T. Henley's Telegraph Works, Ordinary	10	18-19
—— 7 per cent. Preference	10	18½-19½
—— 4½ per cent. Debentures	100	109-114
House-to-House Company, Ordinary	£	4½-5½
—— 7 per cent. Preference	£	8½-9½
India Rubber and Gutta Percha Works	10	20½-21½
—— 4½ per cent. Debentures	100	106-109
Kensington and Knightsbridge Ordinary	£	9½-10½
—— 6 per cent. Pref.	£	8-8½
London Electric Supply	£	1-1½
Metropolitan Electric Supply	10	13-14
—— 4½ per cent. First Mortgage Debenture Stock	100	119-122
National Telephone, Ordinary	£	7½-8
—— 6 per cent. Cum. First Pref.	10	17-19
—— 6 per cent. Cum. Second Pref.	10	17-19
—— 5 per cent. Non. Cum. Third Pref.	£	6½-7
—— 3½ per cent. Deb. Stock	100	105-108
Notting Hill Company	10	11-12
Oriental, Limited, £1 shares	1	1½-2
—— £5 Shares	£	8¾-9
—— £4½ shares	4½	7½-8
Oriental Telephone and Electric Company	1	11/16-13/16
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	103-105
Southampton Electric Company	£	4½-5½
St. James's and Pall Mall, Ordinary	£	13-14
—— 7 per cent. Pref.	£	9½-10½
Telegraph Construction and Maintenance	12	40-43
—— 5 per cent. Bonds	100	102-105
Waterloo and City Railway, Ordinary	6	7½-8
Westminster Electric Supply, Ordinary	£	11½-12½
Yorkshire House-to-House	£	7½-8

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NOTES.

The Diatto Tram.—It may be worth a note that the Diatto surface contact electric tramway is to be tried at once at Tours. At present the tramways there are run with Serpollet steam tramcars.

Book Received.—We have to acknowledge, from Longmans, Green, and Co., Dr. C. V. Burton's translation of Prof. Ebert's treatise on "Magnetic Fields of Force," which we hope to notice in due course.

Vulcanising Rubber.—Sir M. W. Ridley has stated in the House of Commons that he has decided to certify as "dangerous," under the Act of 1891, the vulcanising of indiarubber by means of bisulphide of carbon, and special rules on the subject are shortly to be issued.

Imperial Institute.—Among the illustrated lectures to be delivered during the month of February at the Imperial Institute on Monday evenings, at 8.30, is one on "Sixty Years of Submarine Telegraphy," by Prof. W. E. Ayrton, F.R.S. On February 15, Mr. W. H. Preece, engineer-in-chief and electrician to the Post Office Telegraphs Department, will take the chair. In connection with the Indian section of the Society of Arts, a paper will be read at the Imperial Institute at 4.30 on Thursday, February 11, by Prof. J. C. Bose, D.Sc., of Calcutta, on "The Progress of Science Teaching in India."

The Cable Conference.—Sir George Baden-Powell having asked the Colonial Secretary in the House of Commons on Friday whether the conference on the telegraph cable to connect the Canadian Dominion with the Australasian Colonies had concluded its labours, and whether any approximate date could be given at which their report could be presented to Parliament, Mr. Chamberlain answered that the committee had made its report, but as that report would be the subject of confidential discussions between her Majesty's Government and the representatives of the Colonial Governments, no date could at present be given for its presentation.

Explosions. — On Monday some rather alarming explosions occurred, due to accumulation of gas in the conduits of the electric lighting installation between the Grande Place, near the Brussels Hôtel de Ville and the Palace of Justice, a distance of over half a mile. In several portions of the route the roadway was torn up, and fragments of the *débris* were projected a considerable distance. There were no fatalities. It will be interesting to see what line the Belgian authorities will take as to who is responsible for the danger from escaped gas—whether the gasworks that lets it loose, or the people to whom its uninvited presence is a serious and expensive nuisance.

Institution of Civil Engineers.—At the ordinary meeting on Tuesday, Mr. J. Wolfe Barry, C.B., F.R.S. (president), in the chair, it was announced that seven associate members had been transferred to the class of members—viz., Messrs. Robert West Holmes, Albert James Humby, Robert Bridges Molesworth, M.A. (Cantab), John Mitchell Moncrieff, Howard Devenish Pearsall, Percy Crosland Tempest, and Beresford Graham Wallis. The monthly ballot resulted in the election of five members—viz., Messrs. Richard Barnsley Sanders, B.E. (Royal) (Parsonstown), Julius Stanke (Sao Paulo Railway), Abraham McCausland Stewart, B.E. (Dublin) (Londonderry), Torquato Xavier Monteiro Tapajos (Rio de Janeiro), and Alexander Basil Wilson (Holywood, Ireland)—and of 36 associate members.

The District Lower Level.—In reference to the proposition to construct an electric express line underneath the present lines on the District Railway, the directors' report says: "The subject of a deep-level line or other improvement of the access into London, though not new, has quite recently been revived and urged upon the Board by a combination of shareholders largely interested in the ordinary stock of the company, and in order that this important question should be dealt with in a business fashion, and its practicability rest upon engineering authority, the Board has concurred in the necessary preliminary measures being taken, with a result that a Bill is lodged for effecting it if the company in special meeting so determine." Meanwhile, a commission has been appointed to enquire what can be done to improve the ventilation on the Metropolitan.

Society of Engineers.—The first ordinary meeting of the Society of Engineers for the present year was held on Monday at the Royal United Service Institution, Whitehall. Mr. Samuel Herbert Cox, the president for 1896, occupied the chair, and presented the premiums awarded for papers read during that year. Mr. Cox introduced the president for the present year, Mr. George Maxwell Lawford, to the meeting, and retired from the chair. The President, in his address, gave a short description of the Zurich waterworks, which he had recently visited, and which are of exceptional interest to engineers by reason of the example they afford of "the conversion of the great sources of power in Nature to the use and service of man," the river flowing from the lake being utilised not only to pump the entire water supply of the town, but to generate both hydraulic power and electricity for lighting, motors, and traction.

Cable Interruptions.—The official list published in the *Journal Télégraphique* gives the interruptions on "international" cables and lines for last month up to the 25th. Omitting failures of more than a year's standing as implying practical abandonment, communication was not restored at the above date over the African land line beyond Mazoe (failure March 11) and the Salisbury and Umtali line (July 11). The others are the Columbian land line from Carthagena to Barranquilla (July 4), the Ste. Croix and Trinidad cable (November 29), the Amazon cable beyond Obidos (December 7), the Ceara-Maranham cable (December 2), the Hong Kong and Macao cable (January 5), and, lastly, the Santa Caterina and Larissa line (December 5), which is still returned as defective. Temporary interruptions include the St. Lucia and St. Vincent cable (November 29 to December 14), the Suakim and Jedda cable (December 5 to January 4), and the Mozambique and Lourenço Marques cable (December 24 to January 4). Several very small interruptions are noted on Siberian, Siamese, and Mexican lines, but a reference to some other land lines has been looked for without result.

The Institution.—In spite of the meeting of the Municipal Electrical Association, there was anything but a large gathering at the Electrical Engineers on Thursday week. There was yet another obituary reference—to Mr. John Aylmer—and then we got to Mr. Hollins's paper. That gentleman had a long run before him, but he went through his paper with the regularity of a Cromer express; the pace was never absolutely breakneck, but there was no remission. After all, however, it was impossible to find time for more than one speaker. Perhaps that was just as well, because the subject was one outside the usual range of most electrical engineers, and though it is not altogether new to those of our readers who have followed Mr. Pigg's articles, it is not possible to be certain of grasping at once all the details of the working of the

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rather complicated mechanism described. It may be added that the date 1842, in the ninth paragraph of the paper, was corrected by Mr. Hollins to 1844. We have received the January issue of the *Journal* of the Institute. It contains Mr. Gavey's paper, and also the proceedings at the general meeting. The report of a portion of these is compressed far beyond the standard adopted by most of the technical Press, while other parts are given absolutely verbatim. One or two of the "abstracts" we hope to refer to in a future note.

Some Societies.—The Northern Society of Electrical Engineers announce a meeting at the Palatine Hotel, Hunt's Bank, Manchester, on Monday, February 8, at 8 p.m., for a paper on "The Supply of Electricity at 230 Volts," by Mr. A. H. Gibbings, of Bradford. Members desiring to take part in the discussion can have a copy of the paper on application to the secretary, at 17, St. Ann's-square, Manchester.—The Institution of Junior Engineers, on Friday, February 12, at 8 p.m. at the Westminster Palace Hotel, have a paper on "The Construction of High-Class Bridge and Girder Work," by Mr. J. A. Macpherson.—We have to acknowledge the receipt of the *Transactions* of the Institution of Engineers and Shipbuilders in Scotland, and also those of the North-East Coast Engineers and Shipbuilders. We have also received the *Bulletin* of the Franklin Institute (Philadelphia). The new president is to be Mr. J. Birkentine.—The North-East Coast Engineers on Wednesday, in the Marine School, Ocean-road, South Shields, at 7 p.m., will have a discussion on Mr. A. E. Sharp's paper, and take a paper on "Liquid Fuel," by Mr. Robert Wallis. The sixth general meeting of the session will be held in the Athenæum, West Hartlepool, on Saturday, March 13, 1897, at 6 p.m., for a paper on "The Machine Cutting of Accurate Bevel and Worm Gears," by Mr. J. H. Gibson. The institution dinner takes place in the Assembly-Rooms, Westgate road, Newcastle-upon-Tyne, on Monday, February 8, 1897, at 7 p.m.

Mr. Bersey's Landau.—Track trials are all very well, or even a run on a quiet road with no one looking, but when the place is that thoroughfare in the city of London which is facetiously called Broad-street, and the time 1 p.m., it must be admitted that so far as threading its way through traffic is concerned the conditions for a motorcart are pretty severe. A representative of the *Electrical Engineer* had the opportunity of trying one there last Friday. He naturally occupied the seat of honour, and confesses that he rather liked it. The motorcar was, of course, an electric one (steam or oil are rightly scorned)—in fact, a landau brought out on the occasion of the meeting of the London Electrical Cab Company. That company's fancy at present are E.P.S. cells and a Johnson-Lundell series-parallel controller. Mr. Bersey drove, and the landau took us smoothly and nicely up to Liverpool-street and so round, and it was evident that there was a clear advantage in getting through the traffic from the fact that there was no "stupid horse sticking out in front." In fact, it seems only to remain for the company to show that they can run their electric cabs more cheaply than with horses, and with that end they have taken large premises for charging, and made a contract with the London Company for current supply. That is all very well for a company which can put down converters and do things on a large scale. So far as the ordinary man is concerned, the possibility of the electric carriage seems to be still a thing that lies in the lap of the gods, or, at any rate, of those great beings who sit on electric lighting committees and the boards of electric supply companies. Already, in most cases, there is a much reduced charge for current for power during the daytime, and it might be argued that it is unfair to make a motorcart pay for the cost of the mains when it comes to the central station to be charged.

Some Notes and Their "Echos."—A contemporary that is believed to be written with a constant care to its own grammar and spelling, and which is known to pay a disproportionate amount of attention to other people's, discusses the question so momentous to engineers, "whether 'interlocking' be a noun or substantive." (It is the title of Mr. Hollins's paper which is impugned, and there is, of course, a third alternative under which the construction can be justified.) But after a whole note on the possible omission of an adverbial termination from a phrase already overloaded with syllables, one must conclude that the omission of the "e" from "echos" in the next column is deliberate, and, at the risk of being accused of hazy notions as to the principle on which the superfluous "e" is inserted in English plurals, to infer that the corrupting influence of dynamos has been at work. It is, of course, not the sea-going pussy-cat sort of that gentleman whose light is not likely to fail for want of indiscriminate admirers that are meant, nor those of the other eminent gentleman of more authority in the profession who (if it is remembered rightly), in his objection to lag, counts a period ahead of the rest of the world, but the (grammatically) exceptionable dynamos of commerce. The pity of it is that to a man unused to the amenities of journalism, and who has done nothing worse than give the Institution a paper of a kind that was urgently asked for, quibbling at his style may cause quite unmerited annoyance; and it certainly does not offer any great inducement to those who have spent their life in doing work, instead of writing about it, to give the benefit of their knowledge to the world at large.

City and Guilds of London Institute.—At Carpenters' Hall last week, the Lord Chancellor distributed the prizes to the successful students of the City and Guilds of London Institute. The Lord Mayor presided, and among others there were Sir F. Bramwell, Sir F. Abel, Sir O. Roberts, Sir R. J. C. Cotton, Sir W. Prideaux, Sir P. Magnus, the Master of the Carpenters' Company, Prof. Ayrton, Prof. Thompson, Prof. Armstrong, Prof. Unwin, Sir R. Cotton, and, of course, Prof. Silvanus P. Thompson. Before the distribution of the awards, the Lord Mayor remarked that the City and Guilds of London Institute were supplying in a most efficient manner a great want, and they were materially assisted in their work by the Corporation of London and the City companies. He hoped that the day might be far distant when either the Corporation or the City companies would turn their backs on anything which would in any way promote education. Mr. John Watney (the hon. secretary) read the report, which stated that the work of the institute had developed in two directions—in providing technical education of a more advanced character in London, and in encouraging and assisting the organisation of technical classes for artisans throughout the country. The awards were then distributed by the Lord Chancellor, who afterwards congratulated the recipients, and remarked in the course of his speech that it was necessary, indeed, that we should bestir ourselves in applying our increased knowledge to trade. As to education, it was its chief function to draw out the faculties of the students in the direction of the occupations for which they were most fitted. Education was inappropriate if not fitted to individual capacity, and was likely to suffer by outbursts in favour of particular branches of study. It was dangerous to undervalue our competitors. Other countries had taken the initiative in teaching their people how to do work, and do it well. As a result, chemical discoveries had been made and patented in

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Germany in great numbers, though there was no reason why they should not have been found out in England as well as in Germany. But in Germany there was extraordinary industrial activity and no sign of standing still.

Royal Society of Edinburgh.—At a meeting of the Royal Society of Edinburgh on Monday, Lord Kelvin delivered a communication on "The Conductive Quality Induced in Air by Röntgen Rays and by Violet Light," by himself, Dr. Beattie, and Dr. Smolan. The paper demonstrated the results of experiments on the electrical effects of Röntgen rays and of ultra-violet light projected on the surface of metals or passing through the air between two metals mutually insulated, and either electrified to begin with, or only electrified, if at all, by the agency of the rays. To investigate the effects of Röntgen rays, a cylinder of unpolished aluminium connected to the electrometer sheaths was used. Along the axis of this a metallic bar was placed, supported by its ends on small blocks of paraffin so situated as not to be reached by the Röntgen rays. This insulated metal was connected by a copper wire to the insulated terminal of the electrometer, and protected from inductive effects. The Röntgen emission tube was placed in a lead cylinder. The rays passed into the tube of aluminium through a window in the cylinder, which could be screened or unscreened at will. The course of the experiment was the same with each insulated metal. The metal was charged first positively, then negatively. The Röntgen rays were then allowed to fall on it through the aluminium cylinder surrounding it, and the electrometer readings taken at fixed intervals until a steady reading on the electrometer was obtained. Calling the point at which the electrometer reading remained steady with the rays acting the ray zero, from the results of the experiment it was found that the difference between the ray zero and the metallic zero was 0·66 of a volt. Some experiments had also been made with ultra-violet light, which were practically of the same nature as those with the Röntgen rays. Prof. D'Arcy Thompson read a paper entitled "A Very Simple Logical Machine," and Lord Kelvin made a second communication on "Crystallisation according to Rule."

More Waves.—Waves, electric or otherwise, are very much in fashion just at present, and Prof. Crookes has been exploiting the subject in his address to the Society for Psychical Research. In general, when the psychicist (the analogue of physicist; pronounce it how you can) starts off on the subject of waves, one may assume that he will talk indefinite nonsense and cease to trouble, but Prof. Crookes is, of course, not as those others. The address is summarised in the *Times*, which, after taking a day or so to consider, has also come out with a leader on the subject. The latter is remarkable in three ways. Firstly, it contains an unwonted blunder in the middle of it; secondly, it throws out the suggestion that some modern Lucretius should clothe with verse (English hexameters ?) the latest results of scientific research as to the ultimate nature of things; and, thirdly, maintains the monstrous proposition that hypotheses of a scientific nature may be fitly clothed in the form of myths. The scientific spirit is to observe and test by comparison with the phenomena, and to do that your hypothesis cannot be too definitely expressed. Assuredly the fairy tale of science has nothing in common with the myths that the later Platonic schools tried to bend into scientific explanations (in general, all wrong). That method leads to nothing but confusion. Lucretius, in spite of the Proœmium, really knew better; his illustrations of the atomic theory (not the modern one, of course) are definite enough. But to return to Mr. Crookes: that gentleman ran through the whole scale of vibrations, both sound (air) and electric (ether), from one to some millions of waves per second, with a view of showing that there were classes of waves which might be capable of doing wonderful things. Now, the limit of the smallest possible sound wave is an interesting problem in the theory of gases. It must be much larger than, for instance, the ordinary light wave. As to electric waves, we have them of all sizes, from those generated by our alternating-current supply companies, which are bigger than the earth itself, down to the smallest measured, beyond the ultra-violet, or even waves which are not measured, but which must be little larger than the molecular distances. It is here and beyond that Mr. Crookes appears to be looking. Was it inconceivable, he said, that intense thought, concentrated (how ?) by one person upon another with whom he was in close sympathy, should induce a telepathic chain along which brain waves should go straight to their goal without loss of energy due to distance ? Apart from the difficulty of "focussing" them, so to say, the difficulty is that the very smallness which (theoretically) gives these waves the power of penetrating anywhere would prevent them being generated by or having any effect on the rather large proteid molecules of which the mechanism which does our thinking is built up. It is a pity; for though it is no good for the purposes of the Psychical Research people, it would be such a pretty explanation of panics and the action of crowds.

The Claret-Vuilleumier Tramway.—A detailed description, with illustrations, of the Claret-Vuilleumier electric tramway system has been begun in the *Revue Industrielle*. The Claret-Vuilleumier is a "closed conduit" system, and differs from the Westinghouse mainly in the fact that instead of a fresh "distributor" being wanted for something under every car length, in the Claret-Vuilleumier conduit there is only one about every 300 yards. (The precise distance is only a question of the most economic distribution of materials.) On the other hand, the distributing arrangement is more complex than the Westinghouse. So far as it is possible to make the matter clear without diagrams and a detailed description, the principle is that the wires from each of the contact points (these are not mere points or knobs, as in the Westinghouse; but that is a detail) are carried to a common distributor, ending there in a number of contact plates arranged in a circle. The supply current comes to the centre of this and feeds by a radial arm which is arranged to advance one division as each point ceases to deliver current. There are cross connections between each pair of distributors. The Claret-Vuilleumier system was first tried at Lyons in 1894, and has now with some modifications been installed on the Paris line from the Place de la Republique to Romainville. The Lyons line was a metre gauge, but the Paris line is of the standard width. The rails are fished and copper bonded. At Lyons the car supply "points" were reversed rails, nearly 10ft. long. These were somewhat of a nuisance, and, moreover, insulation was naturally bad. At Paris cast-steel blocks have been substituted of the same size as the wood or stone blocks of the road paving. These are connected with the distributors by insulated copper wires, laid in wood cases to the distributors under the pavements of the side paths. Some further details have been given in a subsequent issue of the *Revue*. The Lyons tramcars were about 23ft. long, which was inconveniently short for the contact points. The Paris cars, on the other hand, are nearly 30ft. long, and are practically two-storey affairs, the roof seats having a permanent awning. On the front platform of the car a place is provided for the "wattmann,"—which we take to be classic French for the driver or motorman—and a place for

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passengers' luggage. Hillairet-Huguet dynamos and motors are used, but the interest of the line does not lie in this part of the work. As to expense of construction, that of the Lyons line works out about 15s. 6d. per yard, which is considered to be less than an overhead line. Mr. G. Lavergne, who is responsible for the article, has been unable to obtain the figures for the Paris line, and it must be remembered that, as explained above, the Lyons design has been modified in several essential particulars. Moreover, no account is taken of the cost of relaying the pavement. Neither are any details available as to how the line works in practice and the amount of the current loss by leakage in fine and bad weather respectively. One thing, however, is stated, and that is that, so far as Lyons goes, there has been very little trouble owing to the distributor getting out of step with the car owing to a bad or missed contact at a point. If this happens, of course either the car must be run on to the point left "alive" or the distributor must be set right by hand.

Animal Electricity.—When Dr. Waller began his course of lectures at the Royal Institution about a month ago, he raised somewhat of a clamour among electricians by setting up the brand-new words "zincative" and "zincable." It was undoubtedly a mistake, and in the desire to avoid the confusion which is sometimes the result of the retention of the static nomenclature for the galvanic couple would only have provided yet another opportunity of going wrong. Dr. Waller, seeing that they were not approved, promptly expressed his readiness to abandon the new terms if they were not really useful. It remains, however, for his objectors to suggest (which would not be difficult) and to get carried out (which will be quite another thing) some arrangement by which the confusion he deprecated should not occur. Moreover, in a course of lectures on a physiological subject there is at least an excuse for talking the language of the physiologist rather than the engineer, although, as a matter of fact, the latter is the better and more accurate of the two. All this, however, is now happily past. The matters dealt with in the first two lectures have been already referred to. In the third, the action of anæsthetics on the different kinds of protoplasm was dealt with. This is a subject of very great importance, in which the further investigation by the methods Dr. Waller is expounding affords at least a possibility of replacing what is now mainly an empirical knowledge of the differential action of the various anæsthetics (and their occasional abnormal action) upon the firm ground of observed and explained results. As most of our readers are not physiologists, it may be well to explain that, though the death of the commonwealth of cells and nerves that, working together, somehow make up a living animal is a matter to be dated with very approximate accuracy, the death of each element of it is a much slower affair, and experiments can be made with the isolated muscle or nerve which are shown to be due to the same actions as take place in the living body by their conforming strictly to the physiological requirements in the matter of the temperature. In other words, the isolated muscle or nerve remains to all intents and purposes still alive, and its death is a very gradual matter. On Tuesday last Dr. Waller devoted himself at the outset to giving an experimental demonstration of what is usually taken for granted—namely, that the electrical manifestations in the isolated muscle or nerve were a measure of the "vivacity" (in its etymological sense) of the tissue, the stimulus and effect corresponding in a measurable manner. It was also demonstrated that the energy of the muscle was very much greater than that of the stimulus given (Dr. Waller expressed it in ergs, but there are complications which make a definite measurement difficult), and also showed that the response fell off for strong stimulation, the increment diminishing for equal additions of stimulus. This is of course in accordance with a similar law for sensation. On the other hand, a nerve did not observably give out more energy than was put into it, and the effect transmitted appeared to be strictly proportional to the stimulus.

Military Telegraphs in Chitral.—Major F. E. Dempster has an interesting communication in the *Journal* of the Institute of Electrical Engineers on the field telegraph work with the Chitral relief force in 1895. The standard equipment is described and the difficulties of the country. Mountain passes all snow, and tree covered slopes so steep that a man cannot stand on them and where the wire zigzags from tree to tree, come in for mention. Then, for political reasons, after a line had been made, it had to be dismantled. As to maintenance work the following extract is eloquent: "There were altogether 91 interruptions, aggregating 610 hours, and averaging in duration 6·7 hours each. This long duration was due almost entirely to interruptions caused by storms and by the enemy, in which considerable damage was done. Of the 91 interruptions, 56, lasting 457 hours, were due to these two causes. The majority occurred either in the evening or during the night, and consequently nothing could be done till morning. Thirty-eight interruptions occurred in the daytime—that is, between 6 a.m. and 6 p.m.—and their average duration was 4·5 hours, whereas the duration of the 53 that occurred at night was 8·5 hours. The average distance to the fault from the nearest office was six miles, and the repairing party did not as a rule start till an hour after interruption was observed. During the day, therefore, the repairing party travelled six miles and repaired the damage, which was sometimes very considerable, in 3½ hours. During April there were constant interruptions caused by transport animals straying about. A camel always considers a telegraph-post as something put up for him to scratch himself against. Naturally 40lb. posts were not calculated to stand this treatment, and broken posts were common. The camel drivers were, however, speedily given to understand that they were responsible that their camels did not use the telegraph-posts for scratching purposes. Once they realised the unpleasant personal consequences that followed disregard of these orders, interruptions from this cause practically ceased. Next month, however, a far more serious succession of interruptions were caused by the enemy, who night after night cut the wire, pulled down posts, and carried away lengths of wire. The greater number of instances occurred in the Jandol Valley, and the serious effect it had on our traffic may be imagined from the fact that between May 9 and 31—21 days—there were 151 hours', or 6¼ days', total interruption due to wire-cutting alone. Altogether the enemy carried away or destroyed 2½ miles of wire and 38 posts. Speculation was rife as to what they did with the material. At Mundah they were supposed to have made a gun out of a post wound with wire. There was also a legend to the effect that they erected a small line in one of their villages on the advice of one of their mullahs (or priests), who was greatly discredited when it was found the wire did not speak of itself! Storms of great violence visited the line and caused 10 interruptions, aggregating 16 hours. In eight of these interruptions from one to six posts were smashed at a time, and in only one was the wire not broken." Another neat idea was connecting the out-pickets with the guard by telephone. It may be added that the work of the department was specially commended in the commander-in-chief's despatches.

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Royal Institution.—There was a large attendance on Friday to hear Prof. Jagadis Chunder Bose, of Presidency College, Calcutta, lecture on "The Polarisation of the Electric Ray." Sir James Crichton-Browne was in the chair, and among those present were Lord Rayleigh, Sir F. Bramwell, Prof. Dewar, Prof. S. P. Thompson, Prof. Fleming, Prof. Armstrong, and Mr. A. Siemens. Some account of Mr. Bose's lecture is given in another note. Electricians expect every galvanometer to do its duty, but the ladies at Albemarle-street think it is none the worse for a little encouragement, for every time that the spot jumped to the end of the scale was the signal for a round of applause. One can only congratulate those of them whose previous study had been in other directions upon the alertness with which they grasped the somewhat complicated chain of—contact made, series of oscillatory discharges, resultant ether waves blocked in all directions but one by the copper casing of the transmitter, their direction of vibration made uniform by the polarising grating, altered 45deg. by the interposed crystal, and therefore (at least, a fraction of them) able to pass through the analysing grating, disturbance of the receiver giving a diminished electrical resistance, increased current in the galvanometer circuit, and—movement of the spot. On the other hand, the willingness of *Bradshaw's Railway Guide* to oblige in the part of a polariser even when it did the thing ever so much better than the crystals, which may be regarded as professionals at that kind of work, was received with inextinguishable laughter. Afterwards Mr. Bose's apparatus was examined more closely with considerable interest. Downstairs the new rooms were available for moving photographs and Röntgen radiations. In the library was noticed an interesting apparatus for showing correlated motions, exhibited by Prof. Herschel. It was too near 11 o'clock to ascertain its precise object, but it looked the sort of thing that if the latest school of stereo-chemists get hold of there is no telling what they might do with it. On Monday, at the general monthly meeting of the members, Sir James Crichton-Browne, M.D., F.R.S., treasurer and vice-president, presiding, the following were elected members: Mr. Alfred Louis Cohen, Mrs. Delaforce, Sir Charles A. Elliott, K.C.S.I., LL.D., Mr. John Lawson Johnston, Dr. A. Liebmann, Mr. T. George Longstaff, Mr. Howard Marsh, F.R.C.S., the Rev. E. G. C. Parr, M.A., Mr. Charles Rose, and Mr. Edward P. Thomson. The special thanks of the members were returned to Sir Frederick Abel, Bart., K.C.B., for a donation of £50, and to Mr. J. Wolfe Barry, C.B., for a donation of £25 to the fund for the promotion of experimental research at low temperatures. Dr. Waller's lectures on animal electricity are the subject of another note, but it may be mentioned that on Tuesday he showed some interesting experiments on the effect of alcohol on muscles and nerves. Alcohol vapour first of all caused increased sensitivity, which corresponded to the exhilaration of reasonable doses of the substance administered in the usual way, but a very moderate addition reversed the process, and the benumbing effect went on until the muscle ceased to respond to any stimulus. A precisely similar result could be obtained with hydrocyanic acid (prussic acid), but there was this important difference, that with the alcohol the nerve was not dead, but only "dead drunk," and was all right again next morning, responding appreciably to the exhilarating influence of tobacco smoke. With the hydrocyanic acid it was dead, and worked never again. The meetings of the institution for the next week are given elsewhere.

Polarisation of the Electric Ray.—Prof. Jagadis Chunder Bose's "discourse" at the Royal Institution was in the main the exhibition of a series of experiments with the apparatus of his design which was shown at the British Association. A complete description of it, with illustrations, will be found at p. 383 of our last half-yearly volume (the number for October 2, 1896). There are something like half a dozen columns of it in a smaller type than these notes, and therefore it seems waste of space to give a short and probably more or less unintelligible description of the apparatus here. For those who will refer back, it may be added that the promised adaptation for the determination of the wave-length has not yet been carried out, or, at any rate, it was not mentioned on Friday night. Except this, about everything that can be done with Hertzian waves was done. The waves used by Mr. Bose, however, are considerably smaller than those of Hertz, their magnitude being somewhere about a quarter of an inch or so, but, of course, the oscillatory discharge would produce at the same time waves of other lengths, since there would be, not only the harmonics, but various other groups dependent on the resonance period of different parts of the apparatus. That this is not mere inference is shown by the fact that the "spectrum" of the discharge, so far as it has been ascertained, appears to be one of "lines" or "bands," and not a continuous one. The receiver, however, adjusted for any one wave-length pays less attention to waves more than half an octave above or below the point for which it is set. It may give some idea of the actual size of the apparatus to say that the metal polarising gratings are about the size of hair combs, and the receiver is about the magnitude of a rubber hand-stamp, and the contained spirals the diameter of straws. Of course, if a sufficiently sensitive relay working any kind of instrument could be substituted for the galvanometer in the receiver circuit, the apparatus would become one for "wireless telegraphy," but in that case, as Mr. Bose said, it would be desirable to use a much larger receiver and larger waves. These were objectionable for experimental purposes, because of their evil habit of going round corners like a sound-wave, and, moreover, would necessitate the apparatus being of much greater magnitude. Mr. Bose's description of the inductive method by which he was led to devise his form of receiver and the reasons of its superiority to the Lodge receiver were exceedingly interesting. It is also worth remark that no secret was at any time made as to its construction, so that it has been open to all the world to adapt it for practical and possibly money-making purposes. One need not go into elementary matters of polarisation, or explain to the electrician that in a grating or any substance that conducts well in one way and badly in the other, waves in the conducting direction produce currents and dissipate their energy in heat, so that only the waves having one direction—*i.e.*, that at right angles to the bars of the grating—are transmitted. Such radiation is spoken of as being polarised in a plane parallel to the bars of the grating. Almost any grained substance will act in this way, and it has been found that with some polarising crystals the ratio between the conductivity in two directions was as much as 13 to 1. It remains only to add that Mr. Bose showed that, while water was almost opaque to the electric wave, liquid oxygen, in spite of its low temperature, was transparent, while any amount of crystals—including celestine, cryolite, andalusite, apatite, calcite, selenite, beryl, orthoclase, epidote—as well as such substances as slate, jute fibre, human hair (dark acts better than fair), were shown to be polarisers. The action of tourmaline (which is special) on light could be imitated and surpassed for the electric ray by an ordinary book, and that of unannealed glass by unequally chilled paraffin.

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THE MECHANICAL CONSTRUCTION OF ELECTRICAL MACHINERY.

BY F. M. WEYMOUTH.

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THE DYNAMO.

(Continued from page 137.)

In the case of large facings, such as for a magnet shoe or bracket, a clearance of at least $\frac{3}{16}$in. all round should be allowed, as shown at *e* (Fig. 50). Otherwise, if the facing were designed with the same periphery as the part resting on it, the result might become as shown in Fig. 51, which would not look well. It is very important that these large facings should have ample rise, not less, say, $\frac{1}{4}$in.; in large castings $\frac{3}{8}$in. or even $\frac{1}{2}$in. may be necessary. The *raison d'être* of a facing is that the tool, when machining, can pass off freely into space at the ends. It is extremely awkward, if through want of sufficient rise in the facings, in the case

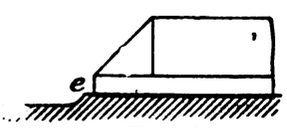

FIG. 50.

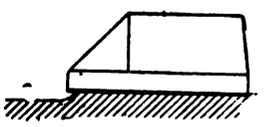

FIG. 51.

of a warped casting, the level of the machined surface required comes below the level of the surface of the casting. The point of the planing cutter requires lowering, of course, to the level of the cut to be made before it can start; and so, if a new casting is not obtained, it is necessary by other means to remove the metal at the beginning and end of the surface, so that the planing tool may get down to its work.

Figs. 52 to 55 show four different methods of arranging the facing for a bearing on a pedestal. In the first two the clearance, *e*, will be noted; but in the last two the outsides are flush. At *c* (Fig. 52) the facing is finished off with an ogee, as in Fig. 30. This is a very common way and looks well, and the round surfaces are conducive to a good casting. The ogee requires more room than the sharp corner at *s* (Fig. 53), and makes the top of the pedestal correspondingly larger. An advantage following this fact, however, and the radius added at *a*, is that it gives room for the head of a bolt inside, only requiring a plain drilled hole for its reception; thus the expense of a tapped hole for a tap-bolt is avoided. By a little alteration a bolt might also be used in Fig. 53, but not with such ease. In the two last, tap-bolts are practically essential. The rule about leaving a clearance on the facing all round is discarded in Figs. 54 and 55, it will be noted, for here it is easy to chip

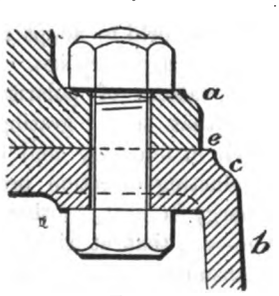

FIG. 52.

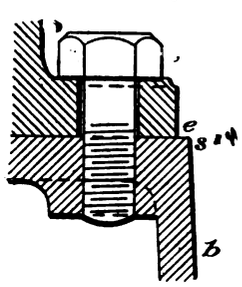

FIG. 53.

away any projection of one part over the other, and in this method neatness is arrived at, which is the main end in view in all cases. In Fig. 55 a deep boss is included in the side of the pedestal, which has to be drilled, thus forming what is called a blind hole, and tapped for the tap-bolt. The inconvenience of this latter hole, as compared with the through holes in the previous illustrations, will be obvious; for the scrapings from the taps, instead of falling through, have to be lifted out. With a number of holes to be tapped, this delay mounts up and forms an item of extra expense. It will be noted that in the cases shown in Figs. 52 and 53 these look well with a slight batter or slope on the side of the pedestal, as shown at *b b*. In Figs. 54 and 55, with the flush surfaces, these look better quite vertical. For the latter, however, there is a further reason. It will be observed that if the sides, *d d*, were sloped as at *b b*, the angle *n* in the bearing flange would become acute. But in cast iron, on account of the brittleness of the material, it is an almost invariable rule to avoid, when sharp, any angles less than right angles. It will be observed that clearance holes are shown in the bearing flange in Figs. 52, 53, and 55. In these cases the bearing will be kept in place by taper pins, but this is a point we shall touch on later. The approximately vertical dotted line in Fig. 55 indicates the outline of the pedestal either side of the boss. Of these four methods, Fig. 52 may be considered as giving the best appearance when finished. The other three are more compact; but in Figs. 54 and 55 the chipping required outside is additional labour.

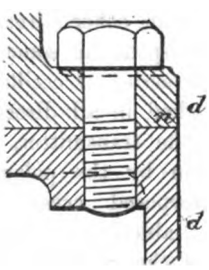

FIG. 54.

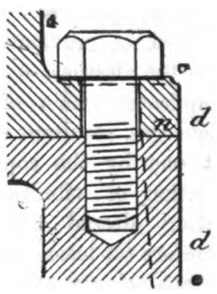

FIG. 55.

On an earlier page we touched on the inadvisability of having curved side members in a pedestal. An example, then alluded to, is reproduced herewith in Fig. 56, and is shown side by side with another two-member pedestal, which, though on different grounds, is also of weak form. It is obvious that a curved member, as at *a* in Fig. 56, under compression between its ends, will tend to become curved still more; or, in tension, will tend to straighten. As regards the immediate effect of compression on such a member, it is much the same as though it were a beam supported at the ends and loaded in the middle, as indicated by the arrow, *c*. The question of deflection has to be considered; for a beam will deflect under a strain very far short of what might be required to break it, or even of what might be regarded as its safe working load. But it is plain that to obtain absolute rigidity all such deflection must be eliminated. Inasmuch, therefore, as of all forms of structure a loaded beam is probably the most liable to this evil, any shape, form, or section given to a member requiring to be rigid that will liken it, when in use, to a loaded beam, should be avoided. The great point here to be borne in mind is that in any respect in which a structure is liable to deflection, in that respect

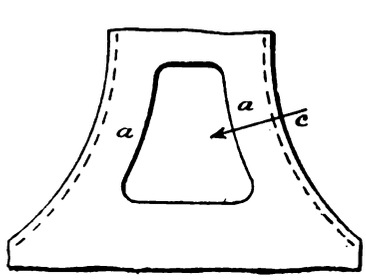

FIG. 56.

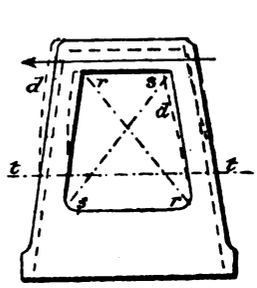

FIG. 57.

also it will be liable to vibration. But stretch, or compression, under any given load between the ends, that would cause a curved member to "give," would be very infinitesimal in a member of the same length and section if straight.

The objection to the design in Fig. 57 is somewhat similar, though not quite the same as the foregoing. It will be observed that with a transverse strain across the top as indicated by the arrow, this form of pedestal will tend to collapse diagonally: the diagonal, *s s*, will tend to shorten, and *r r* to lengthen. The sides being rigidly held at the top and bottom will tend to deflect, as shown by dotted lines, *d d*. We have, in fact, room for deflection here again, and consequently for vibration. To secure rigidity, therefore, diagonal bracing would properly be required on the lines *r r* and *s s*, and this would

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be so the more the form approached that of a mere rectangular frame. The weakness of the design in Fig. 57 will, of course, be aggravated when the section of the side members (on *t t*) is merely as shown in Fig. 58: for the little flanges, *l l*, are but a small safeguard, in point of design, against this tendency to deflection. Consideration will therefore show here that the best method to attain rigidity is to let the pedestal approximate rather to a triangle than a rectangle as illustrated in Fig. 59. It will be seen here that a cross strain above, as at *g*, will merely put one side member into tension, and the

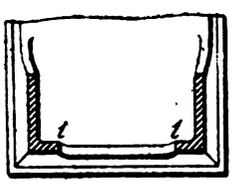

FIG. 58.

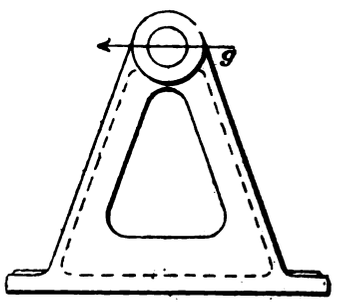

FIG. 59.

other into compression; and there is no application of the argument as to diagonal collapse: and the sides are straight. Thus there is room for no deflection as in either Figs. 56 or 57, and consequently for no vibration. Of course, designs such as in Fig. 56 and 57 are "saved" by casting them very heavy: only this is not good practice, involving, as it does, a more or less considerable waste of metal.

We now come to another type of two-pedestal bed-plate, illustrated in Figs. 60 and 61. This is approximately a

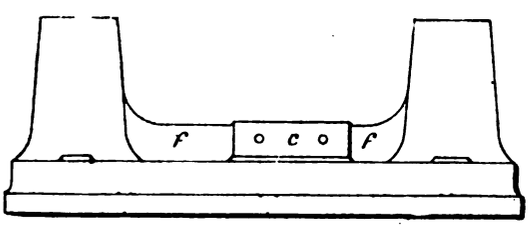

FIG. 60.

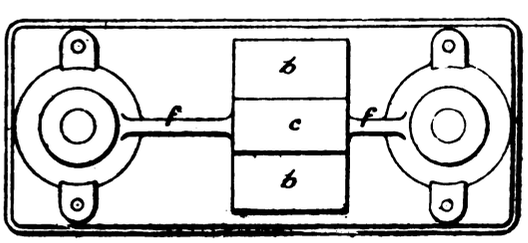

FIG. 61.

form used by Messrs. Crompton and Co. The machine, of which this is a part, cannot be said to be either over or under type, inasmuch as there is a yoke both above and below the armature. But the latter yoke is embodied in the bed-plate, as though for an overtype machine. It projects above the top of the bed-plate, as shown, *c c*, and there are facings, *b b*. Hence the magnets, bolted to the yoke, and made to stand on the facings, are enabled to make magnetic contact with the cast iron on their lower ends, as well as on their side surfaces where they meet the yoke. In this respect they may be compared with Figs. 20 to 23, where there was no such bottom contact, and the weight of the magnet came on only a narrow shoulder. The pedestals are hollow cones, and stiffening ribs, *f f*, between these and the yoke give additional strength lengthways. To the subject of this bed-plate, however, we shall return later.

In Figs. 62 and 63 is represented a type of bed-plate quite distinct from any we have as yet noticed, and is a form used for undertype machines. This consists of a cast-iron rectangular frame, whereof the sides are of channel section, as shown in Fig. 63, which is a section on *t t*. Two opposite facings, *a a*, are for the pedestals or bearings, and the other two, *b b*, are for the brackets of gunmetal, or other non-magnetic metal, carrying the magnets. An advantage of this design peculiar to itself, is that by making it sufficiently wide, and adopting low bearings, the armature and magnets may be so lowered down within it that the horns below will be a very little above the ground level. Thus a very low machine is attainable, such as will be very stable with the combined wide base and low centres of gravity and gyration. A further advantage is that, owing

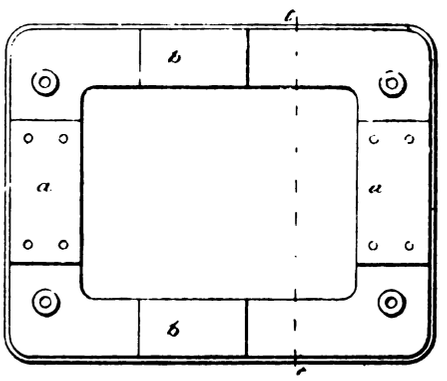

FIG. 62.

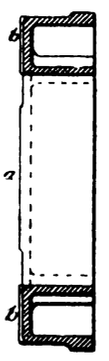

FIG. 63.

to the absence of any central portion to the bed-plate, waste magnetism escaping from the magnets to the bed-plate has to travel around by *a a* from one pole to the other, the length of this path being a source of resistance thereto. The form of this bed-plate is hence conducive to a minimum of magnetic waste. It is to be observed, however, that if such a bed-plate were supported on two diagonally opposite corners, a very slight load on the other corners would cause a measurable deflection downwards. Or if one end, *a*, of such a bed-plate be rigidly held, it will be perceived that the side members, *b b*, owing to the smallness of their section and their comparative length, could easily be sprung up or down by strains at their outer ends, such as would be produced by a transverse strain across the bearing on the other end, *b*, and parallel to that end. This bed-plate hence is of a type peculiarly dependent on the foundations on which it rests for the maintenance of its own level, unless, of course, it were cast very deep and heavy. Examples of this kind of bed-plate are made by Messrs. Ernest Scott and Mountain, Limited, and by Mr. Wilson Hartnell.

A device suggested in a design by the last-named maker is that of fixing the bearings between jaws cast on the bed-plate, as shown at *c c*, Fig. 64 and 65. This method is, of course, not uncommon in the case of plummer blocks in ordinary machinery. It is optional to plane, or otherwise tool, the parts to an exact fit, as indicated in half-end view in Fig. 64; though a more common plan is to insert hard wood or iron wedges, as shown at *d*, Fig. 65. A single wedge may be used, in which case either the jaw, or the edge of the foot of the bearing, must be sloped to

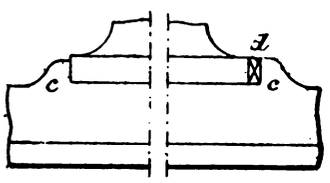

FIG. 64.

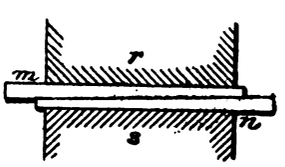

FIG. 65.

FIG. 66.

suit: or else "folding wedges" may be used, as represented in Fig. 66. In this latter method, the wedges being of equal taper, it will be observed that the outer sides, *m n*, become parallel; hence, by their adoption, it is rendered not necessary that the parts they drive asunder, such as *r* and *s*, should have their opposing sides otherwise than parallel with each other. The structural principle involved is the same as with the blocks, *h h*, in Figs. 9 and 10—namely, that the main strains are communicated directly from one part to another, and not through the bolts. This refers to the pull of the belt. But to keep the bearings in place endways, it will be advisable to let the holding-down bolts (as at *a a*, Fig. 62) be turned smooth and fit drilled holes. These will be tap-bolts screwing into tapped holes in the bed-plate, and by

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removing them the bearings can then be drawn away endways with the shaft. The projecting ends of the wedges can be cut off after fixing. We are informed by Mr. Wilson Hartnell that his use of these jaws is not invariable.

(To be continued.)

THE LOCAL DISTRIBUTION OF ELECTRIC POWER IN WORKSHOPS, ETC.

BY ERNEST KILBURN SCOTT.

PART I.

(Continued from page 106.)

Fig. 10 shows a milling machine, designed by the writer, to take the place of planing machines for tooling dynamo magnet bars and such like rectangular pieces of metal. It will be seen that there are two milling cutters, A and B, one vertical and the other horizontal, so that two sides can be machined at the same time. These cutters are driven by a small enclosed motor, D, mounted on the cross saddle, which saddle is otherwise similar to that of an ordinary planing machine. The feather shafts and 10 or more toothed wheels, etc., which are at present employed for transmitting the power to the milling cutter, are thus done away with. Another motor, E, traverses the table forward by means of worm and wheel gear, which may be made so as to give a very rapid return to the table. As the speed of the table per minute whilst cutting is only at the rate of ½in. for steel to a maximum of 2in. for soft brass, the machine attendant is able to get a second piece of work ready whilst the first is being machined, and there is consequently considerable saving in time. The adoption of these machines would give a considerable saving in belting, because, as is well known, the belts of an ordinary planing machine have to work under very severe conditions. The trade in these self-contained tools is only limited at present, but as those firms who have already got electrical power laid down begin to make extensions a steady demand will spring up, the cost of the motors being partially paid for by the saving in shafting and belts.

A consideration in connection with these self-contained tools, is that where overhead travellers are in use it is common practice to have a line of shafting along each wall, so as to keep the belting out of the way; and as often as not, this results in too much space being left unoccupied down the centre of the bay. This space can, of course, be readily occupied by machines if they are driven direct by motors, and the position of such machines may be at any angle with the wall and not as at present—either parallel to or at right angles to the wall. In some workshops it frequently happens that the tools are kept in wasteful positions from fear of the trouble

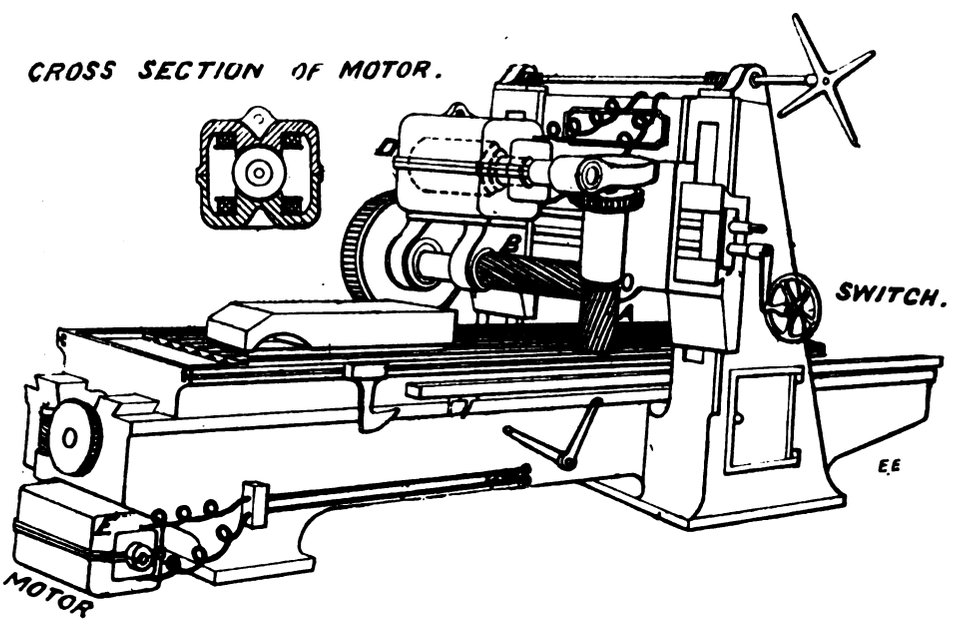

FIG. 10.—Milling machine for magnet slabs, etc.

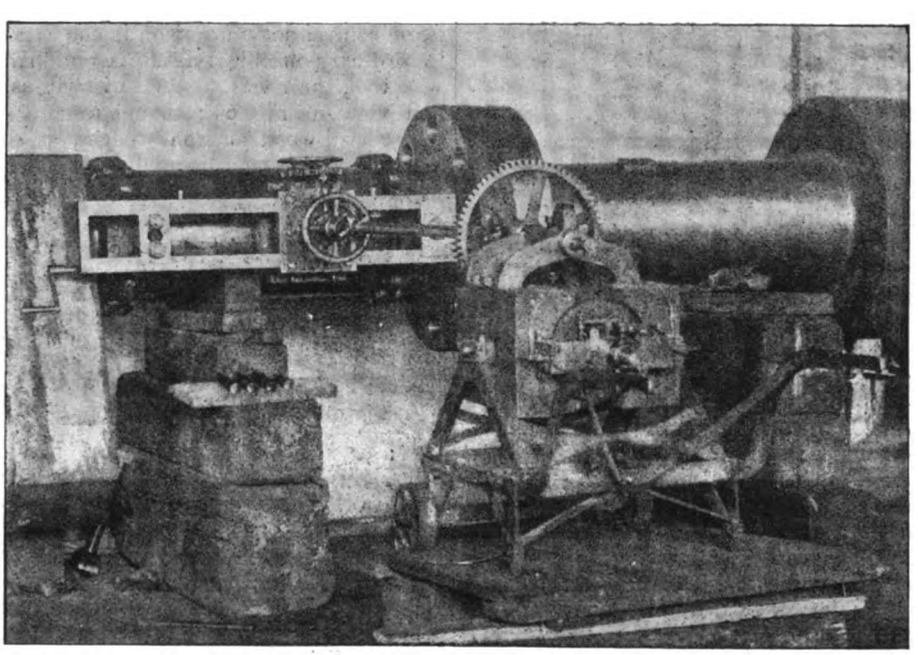

FIG. 10A.—Portable keyway cutting machine driven by electric motor.

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and expense entailed in shaft alterations. With self-contained tools this is entirely overcome, as it is not necessary to line them up to any system of shafting. All that is required is the putting up of a little extra cable, and perhaps the moving of the starting switch. When we consider the amount of time and trouble involved in setting-up and adjusting a line of shafting, hangers, and belts, the unapproachable flexibility of the electrical system is at once evident. This flexibility was well illustrated at the Crocker-Wheeler Works, Orange, New Jersey, after the fire in the summer of 1895. Whilst the new building was being erected, the old machines were operated under temporary cover in the ruins of the old works. The machines were removed to their positions in the new building from time to time, and by this means the company was enabled to turn out 20 per cent. more work in that year than ever before, in spite of the fact that for three months their factory was in ruins.

The employment of electrically-driven semi-portable tools is likely to be a very valuable feature in bridge building and such like constructional work, and it will also result in the placing of more tools in erecting shops than has hitherto been the case, and thus a saving in the transportation of heavy castings and forgings will follow. Figs. 10A, 10B, 10C, and 10D show three portable tools designed by Mr. Kodolitsch, of the Austrian Lloyd Arsenal. The portable keyway cutting machine is especially interesting, and practical men will at once recognise the great saving which results from the adjustment of a light machine to a ponderous shaft instead of *vice versâ*. The

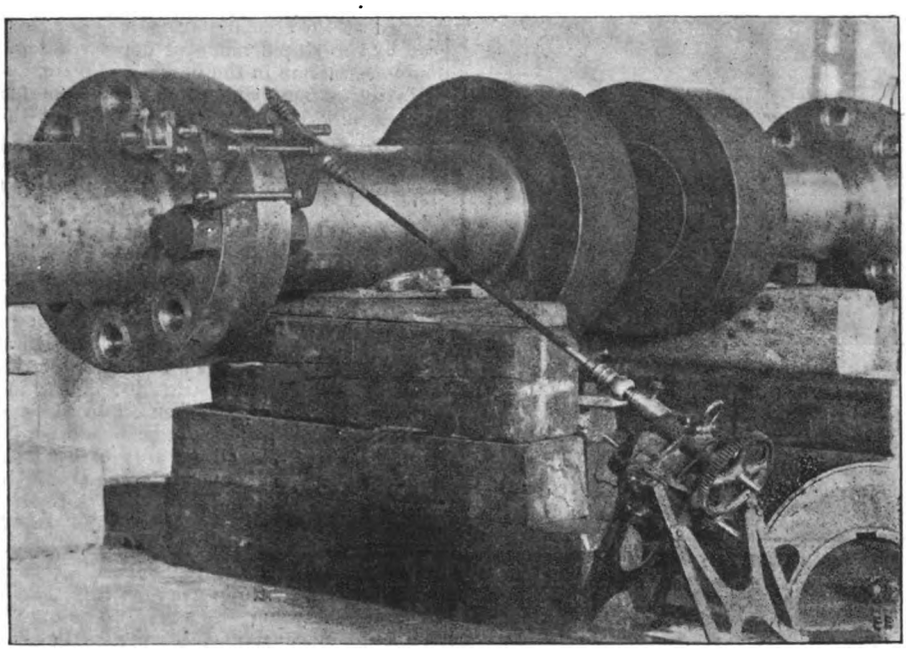

FIG. 10B.—Electric drilling machine operating on a large unwieldy shaft.

tube expander can also be used for tapping holes; a man and a boy can easily expand 200 tubes a day.

In most engineering shops the cost of machining heavy bed-plates, etc., is out of all proportion to the work done, on account of the large amount of time spent in transporting them from place to place and in the fixing to each separate tool which is required to operate upon them. Drilling and tapping is especially troublesome in this way, and it very often pays to do the work by hand with a ratchet brace rather than have the trouble of carrying the bed-plate to the radial drilling machine, which, when driven mechanically, must necessarily be fixed close to the side of the shop. By adopting the electrical system, this is entirely done away with. The small holes can be drilled with a portable motor, running on wheels, and driving the drill by means of a

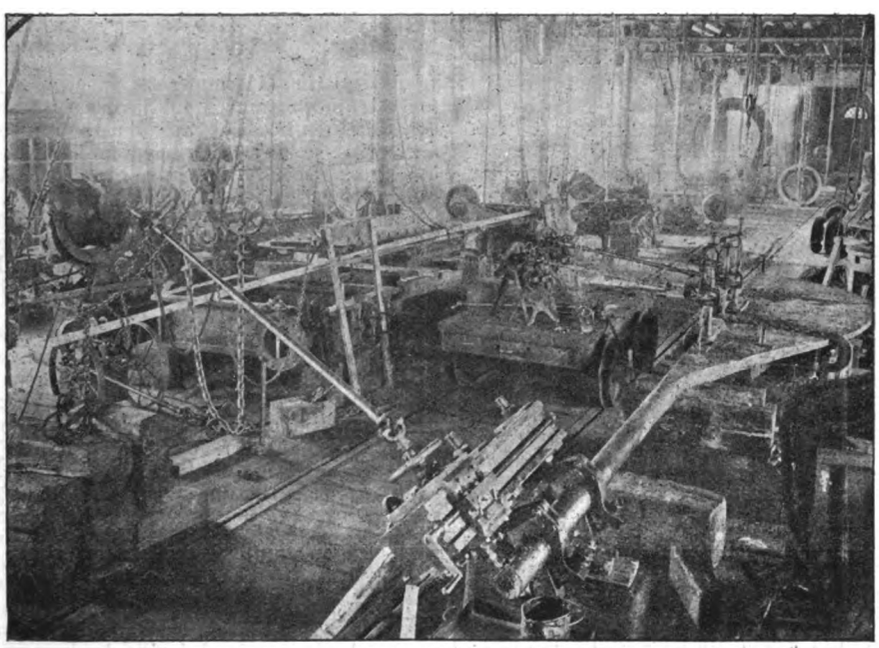

FIG. 10C.—Two electric drills and one key seater at work on a heavy forging.

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flexible shaft (such apparatus is extensively employed in shipbuilding yards), and the larger holes by means of self-contained radial drills, which can be bolted to foundation

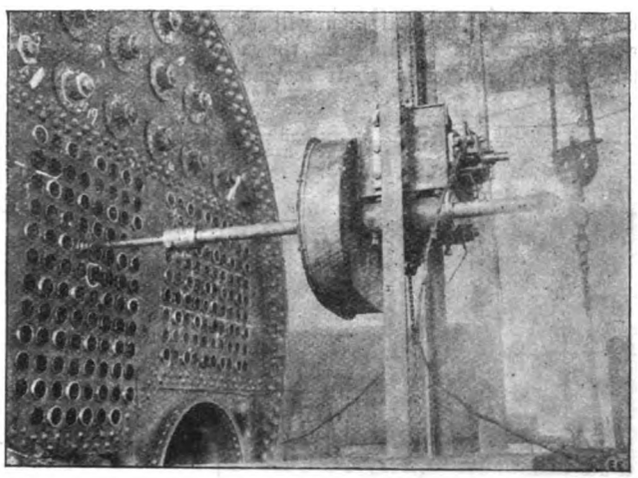

FIG. 1CD.—Tube expanding by electricity. This machine will also tap holes and screw in fire-box stays.

plates already fixed at convenient points on the workshop floor, detachable sockets being provided for the cables.

(To be continued.)

RADIATION.*

BY C. M. DORMAN.

(Concluded from page 150.)

Waves can be transmitted along the rod by transverse flexure of its axis, just as they travelled up our stretched rubber tubes. Suppose the wave to be travelling from the cylindrical to the rectangular section. If the vibrations at the junction happen to be N. and S., they will travel on through the rectangular rod in the same azimuth. If E. and W. in the cylinder they will be E. and W. in the rectangle. Should, however, the azimuth in the cylinder be N.E. and S.W., the vibration in the rectangle will have to be considered as resolved into N. and S. and E. and W., and since the resistance to flexure is different in the two azimuths, the rectangular disturbances will travel along the rod with different velocities. The circular part of the rod can be looked upon as isotropic, since transverse flexures will travel through it at the same velocity whatever may be their azimuth.

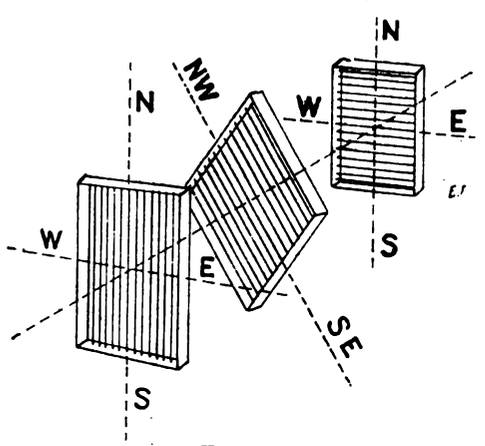

FIG. 9.

In a plate of some crystals, such as tourmaline cut parallel to its axis, it is found that not only are the vibrations sorted out and reduced to two planes, but that those vibrating at right angles to the axis are, even in a comparatively thin plate, completely absorbed, the tourmaline only transmitting vibrations occurring parallel to the axis, a plane polarised ray being the result. If this transmitted plane polarised may be made incident on another tourmaline plate parallel to the first, with its axis turned through 90deg., the incident vibrations will take place across the axis, with the result that the ray will be completely stopped. Let the axes of the two parallel tourmaline plates be N.S. and E.W. respectively (Fig. 9). While in this position introduce between them, and parallel to both, a plate of Iceland spar cut parallel to its axis, and let this axis be equally inclined to those of the two tourmalines, say N.W. and S.E. The ray transmitted by the first tourmaline will be vibrating N. and S. On reaching the spar, its motion will be resolved into two rays—one vibrating N.E. and S.W., and the other at right angles to it, or N.W. and S.E. On arrival at the second tourmaline, these will be resolved into N. and S. and E. and W. The former will be absorbed, and the latter transmitted as a plane polarised ray. The interposition of the crystal plate has thus prolonged the journey of the ray, which would otherwise have stopped at the second tourmaline, and this power, which often goes by the stupid name of depolarisation, is a definite sign of double refraction in the interposed plate.

Having attempted, I feel very imperfectly, to sketch the manner in which ether particles disport themselves when free *in vacuo*, and when constrained by the presence of molecular matter, we ought to be in a better position to grasp the fact that in ether waves are similar in all respects except dimensions, whether their passage is rendered manifest to us as the cause of chemical action, light, heat, or electricity. To the members of this society the last mentioned should possess absorbing interest, and we cannot spend what little time remains to better advantage than in the consideration of electrical waves. This has already been touched upon when examining the oscillatory discharge of a condenser. Stokes tells us that when returning from France, after witnessing Foucault's demonstration that light travelled slower in water than in air, Brewster could not bring himself to believe that the whole of space was filled with some substance in order that "that little twinkling star" should be able to send its light to us. He lived, however, to see that this something had other offices to fulfil. A subsequent generation of thinkers were puzzled at the idea of space filled with different media—one for the transmission of light, another for heat, and so on. Clerk-Maxwell belonged to this school, and pointed out with consummate skill that a ray of light was nothing more or less than an electromagnetic disturbance causing the ether to vibrate in the manner we have been engaged in picturing. He showed that a wave's velocity of propagation, depending as it does on the medium's elasticity-density quotient, would, in the case of light, depend on the refractive index, and in the case of an electric wave on the reciprocal of the square root of the product of the medium's specific inductive capacity and magnetic permeability. Compare now the velocity of a wave in air and in any other transparent medium:

$$\frac{V\ \text{air}}{V\ \text{med.}} = \frac{\frac{1}{\sqrt{K\mu\ \text{air}}}}{\frac{1}{\sqrt{K\mu\ \text{med.}}}} = \sqrt{\frac{K\mu\ \text{med.}}{K\mu\ \text{air.}}} \quad . \quad . \quad (1)$$

$$\frac{V\ \text{air}}{V\ \text{med.}} = \sqrt{\frac{K\ \text{med.}}{K\ \text{air}}} \quad . \quad . \quad . \quad . \quad (2)$$

In the equation (1) the permeability, μ, may be neglected, since for all known transparent bodies it is practically unity. The equation then becomes (2). But the ratio of a ray's velocity in air to that in any other medium is that medium's refractive index, and specific inductive capacity is that of any medium compared with air as a standard. If, then, Maxwell is right in his surmise that a ray of light is an electromagnetic wave, the refractive index ought to be equal to the square root of the specific inductive capacity. And so it is. It is true there are some apparent exceptions, but these can be accounted for by the difficulty of measuring K under the same conditions as when the refractive index is noted, the elasticity of the bound ether being in these instances different for slow reversals to what obtains for periodicities of 500 billions a second. Another great buttress of the electromagnetic theory of light is the fact that the ratio between an electromagnetic and an electrostatic unit of electricity—which, by-the-bye, is in the inverse ratio of their dimensions—is a velocity. In plain language, this means that an electrostatic unit must be set in motion before it becomes physically equal to an electromagnetic one. The velocity, V, of this motion is the velocity of light. To put it a little more clearly, an electromagnetic unit of current flowing round a circle of unit radius produces at the centre of the circle a unit magnetic field in a medium like air whose permeability is practically unity. Now imagine an exactly similar circular wire also immersed in air, every unit of whose length is charged with an electrostatic unit of quantity—that is to say, let there be π units of electricity equally distributed over the wire. If we could, as it were, glue the statical electricity to the wire and cause it to revolve round the centre, what might be looked upon as a convection current would be the result. This is actually a fact, as proved by the experiments of Rowland, and the circumferential speed of the wire to obtain unit field at the centre would have to be the speed of light in air. All this is very strong evidence, showing as it does that since the value of the electrostatic unit depends on the specific inductive capacity, and that of the electro-

* Presidential address, delivered January 11, 1897, before the Northern Society of Electrical Engineers.

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magnetic unit on the permeability of the medium, the velocity, V, is a definite concrete quantity depending on the physical nature of the medium in which the experiments take place, and is independent of the geometrical dimensions of the apparatus used. But something more was wanted, and this was supplied by Hertz. We, who are practical men, while admiring his superb mathematical reasoning—or as much of it as we can understand—find more delight in the beautifully simple manner in which he let loose an electric ray in his laboratory, and made it to do his bidding. Hertz started his waves by means of the oscillations of a vibrator connected with the secondary of a powerful induction coil. This took the form (Fig. 10) of two

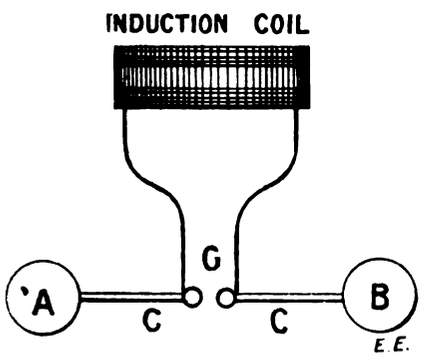


FIG. 10.

spheres or plates, A B, connected by a nearly continuous brass rod, C C, broken, however, by a spark-gap at G. The ether in the gap having been once disturbed a path of comparatively low resistance is offered, through which the vibrator discharges itself by a series of to-and-fro swings, as has already been described, just as if it were entirely insulated from the induction coil. The periodicity or electric note of the vibrator depends on its capacity and inductance, and although Hertz only obtained some 30,000,000 vibrations a second, more recent experimentalists have obtained much quicker swings; Prof. Bose, with smaller apparatus, getting 50,000,000,000 a second, which corresponds to a wave-length of 6mm., a little under ¼in.

TABLE A.

Velocity = wave-length × periodicity.
= 300,000,000,000 mm. per second.
= 180,000 miles per second.

—	Wave-length mm.	Octaves from A.	Periodicity per second.
Hertz	10,000·0	23½ below	30,000,000
,,	300·0	18½ ,,	1,000,000,000
Bose	6 0	13 ,,	50,000,000,000
Heat	0 035	5 ,,	10,000,000,000,000
Red light A	0·00076	0 —	392,000,000,000,000
Yellow ,, D	0·00059	½ above	506,000,000,000,000
Violet ,, H	0·00039	1 ,,	754,000,000,000,000
X-rays	?	?	? < billions >

Even this, as will be seen from an inspection of the Table A, is 13 octaves above the electric note corresponding to red light.

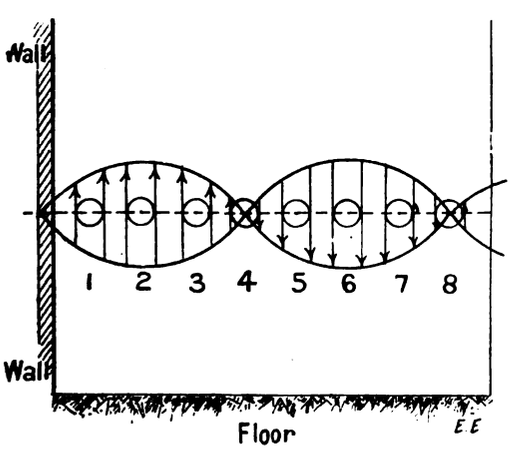
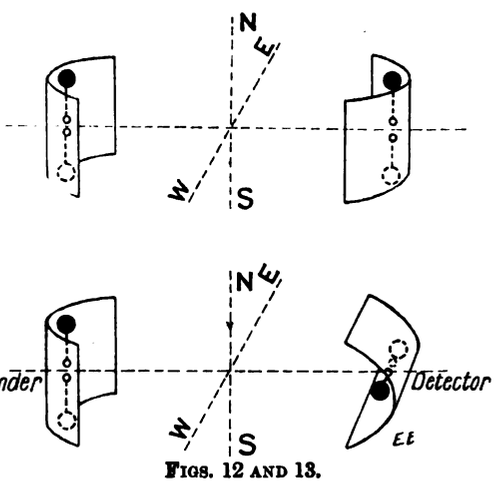


FIG. 11.

It would take rather a large diagram to show these waves drawn to scale. If a red light wave were drawn an inch long the shortest electric wave produced by Bose would be 220 yards long. The motions of the ether particles within the gap are transmitted successively to their neighbours outside, and so ether rays are projected in every radial direction. By causing a wave to impinge on a metallic reflector placed normal to its direction, Hertz turned it back on itself and formed a stationary wave, a moving representation of which is again thrown on the screen. The black wave is represented on its journey from the vibrator, and the skeleton one above is the result of the interference of the reflected one, and, as you see, consists of vibrating segments and fixed nodes. The method adopted by Hertz for locating the positions where the ether is at rest was by inserting in the path of his waves suitable conductors, generally consisting of a circular hoop of wire broken at one point by a spark-gap. The induced electric oscillations produced in this detector were strong enough to produce minute sparks at the gap when it occupied certain definite positions relative to the nodes and segments.

Fig. 11 shows a vertical section of a Hertz reflected wave, the axis of the vibrator being in the plane of the paper, and the ether vibrations being consequently to a great extent polarised and taking place in the same plane. The Hertz detector, which was a wire bent into a circle about 14in. diameter, with a break in the circle forming the spark-gap, is shown standing in the same vertical plane in eight different positions. The amplitude of the ether particles' excursions at different parts of the wave is shown by the length of the vertical arrows. The vibrator being to the right of the figure, the reflecting wall is shown on the left; and it will be observed that the reflecting node is shown some distance behind the metallic reflector fixed on the wall. Theory tells us that the node should be on the wall when the ray is reflected from a perfect conducting surface, its position in the actual experiment indicating imperfect conductivity of the metal used as a reflector. In position 1, with the spark-gap towards the wall, the arrows show that a smaller force acting under unfavourable conditions (across the air-gap) is overbalanced by the larger force acting more favourably (where the metal ring is unbroken). A strong rain of sparks was here observed, that became somewhat weaker when the gap was turned away from the wall, in which position



FIGS. 12 AND 13.

the stronger force was weakened by the air-gap, and at the same time the smaller opposing force was strengthened by the removal of the gap. The same considerations apply to the positions 3, 5, and 7, the sparks being always stronger when the gap was turned to the neighbouring node. At 4, where the centre of the detector is at the node, the length of the arrows is the same but their direction opposite. The sparks will therefore be the same whether the gap is at the left or right of the circle. In this position, however, when the gap is turned to the top or bottom of the circle, its removal allows the two forces to both act at their best, and stronger sparks are the result. At 2 and 6, where the centre of the detector is at the middle of the vibrating segment, the two forces are equal, and, as regards the detector, opposite. Consequently when the gap is at the top or bottom there are no sparks. When turned either to the right or left, however, the opposition of the air-gap upsets the balance and feeble sparks ensue. With this beautifully simple apparatus did Hertz, to use his own words, "exhibit the propagation of induction through air in a visible and almost tangible form." No sooner was he satisfied that he had detected these transverse waves, and definitely shown that finite time was necessary to their propagation, than he tackled this new branch of practical physical optics, and proceeded to show that most of the ordinary optical experiments could be repeated with these long, very ultra-red electric rays. By placing the axis of a small vibrator in the focal line of a parabolic cylinder, he obtained a parallel electric beam identical, except as regards wave-length, with a luminous beam produced by a source of light placed in the same position as the vibrator. By this means he was able to detect the existence of the ray at as great a distance as 20 yards from the source. By interposing an exactly similar metallic mirror (Fig. 12) the rays were brought to a focus and sparks made to appear in a small linear detector

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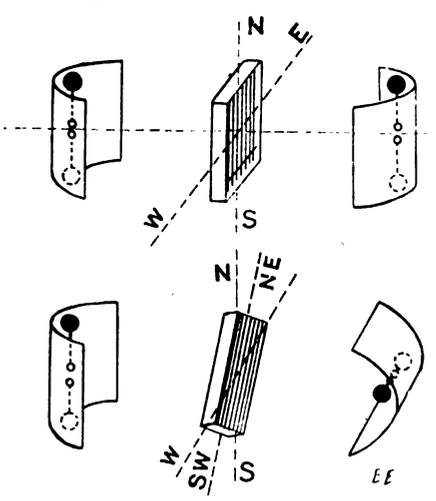
placed in its focal line. Rectilinear propagation was shown by the interposition of metallic screens and noting the comparatively sharp electrical shadows produced. That the ordinary laws of reflection are obeyed follows from the experiment with the two conjugate mirrors, but a separate series of experiments with plane metallic mirrors showed that the angle of incidence was equal to that of reflection. It seems only natural from the method of production that these electric rays are, as has been already mentioned, to a certain extent plane polarised. This is plainly shown to be a fact if in the experiment with the parabolic cylindrical reflectors the receiving one be turned so that its focal line is at right angles to the other, as shown in Fig. 13. The sparking at the detector now ceases entirely, showing that the beam is polarised and that its vibrations are in a N. and S. plane. In this position the action of the mirrors is analogous to the polariser and analyser of a polariscope. He constructed a wooden frame, supporting a number of straight parallel wires like a harp, and showed that when the frame was placed normal to the direction of the beam, with the wires parallel to the vibrator, as shown in Fig. 14, the rays were completed intercepted, but when turned round through a right angle so that their azimuth was E. and W., the rays passed easily through it. When the mirrors were crossed, as in Fig. 15, the presence of the frame had little effect if its wires were N. and S. or E. and W., but when placed at 45deg., or N.E. and S.W., or N.W. and S.E., the field which through the crossing of the polariser and analyser had remained dark was opened, or depolarised, and sparks again appeared at the detector. Its action is consequently exactly like that of a crystalline plate in a polariscope. To demonstrate refraction he constructed a huge prism of pitch, weighing 12cwt., and showed that the wave-front was veered round, and the beam refracted just like a luminous one, and measured the refractive index of pitch for the length of wave he was using and found it 1·69. Unfortunately he was taken from us before he had reached his prime, but not before he had pointed out the way for others to follow.



FIGS. 14 AND 15.

The method adopted by Hertz for locating the positions where the ether was in motion was not perhaps so convenient as that used by Dr. Lodge and subsequent observers. Lodge took advantage of the fact that ether in vibration effected a special form of microphone, for which he coined the terrible word coherer. His favourite form consists of a glass tube full of metallic filings. The electric resistance of this column of loose metallic pieces is diminished when agitated by an ethereal vibration in a very similar manner to a Hughes microphone when agitated by a sound wave. With the aid of this form of detector, which can be made extremely sensitive, the size of the apparatus used can be considerably reduced and the experiments rendered easier and less costly. Perhaps the most interesting experiments with these Hertzian rays since the time of their discovery is the proof that they are doubly refracted when passed through a plank of timber cut parallel with the grain. This acts towards these long waves just as a crystal plate cut parallel to the optic axis effects polarised luminous rays, and opens a darkened field in the same manner as a Hertz wire grating. This exhibits that the electrical elasticity in the direction of the wood's grain is different to what it is across its grain. Wood planks cut across the fibre are only simply refracting, as might be expected. Radiant light from an electrical point of view embraces all transverse ethereal vibrations, those vibrating only 100 times a second causing waves 1,860 miles long thrown off from our alternating generators, and the tiny X-ray vibrating millions of millions a second. Although the luminous rays, which affect the eye as white light, and which only embrace the octave between 400 and 800 billion periods, can by suitable means be rendered monochromatic as far as vision is concerned, it is pretty certain that even when only yellow light is perceived rays of periods altogether outside this octave are also present. A Hertz receiver, a Lodge coherer, the thermopile, the human retina, and the photographic plate will only exhibit the presence of vibrations of certain limited periodicities. That none of these vibrations are useless in the design of nature is certain, and if, as is more than probable, we are in the future permitted to ascertain more and more about the mechanism whereby energy is transmitted through interstellar space, shall we ever be allowed to know whether matter is really only ether in motion, and if so, what is the nature of that gravity which occasions mass?

In conclusion, and perhaps in self-defence, it must be pointed out that the object in view to-night has not been the presentation of any new facts or theories to you, but merely the arrangement of certain almost axiomatic facts, in such logical sequence as to enable the practical man to see that it is not absolutely necessary to use high mathematical analysis in order to obtain a tolerably clear insight into what is generally looked upon as a somewhat abstruse branch of physics.

A FEW PRACTICAL NOTES ON ALTERNATE-CURRENT SWITCH-GEAR.*

BY MR. L. ANDREWS.

(Concluded from page 152.)

In Fig. 2 the two alternators, A, B, are working in parallel, and supplying the lamps, C. At a given moment the direction of the current through the whole system will be represented by the arrow-heads shown full, provided both machines are generating current. It will be noticed that the current through the shunt winding of the magnetic cut-out, D, is opposite in direction to the current through the series winding, consequently the field produced by the one is wiped out by the field of the other.

If one of the machines, say A, is suddenly disabled it becomes a short-circuit on the 'bus bars, and the current from the other machine rushes into it in the direction of the dotted arrow-heads. Of course, the fuse of this machine ought to immediately blow and cut it free; but if, as often happens, only one of the other machines is running at the time, or possibly two machines of a smaller output, then since these have to provide all the current being used by the lamps, in addition to that required to blow the faulty machines' fuse, they will generally succeed in blowing their own fuses first, and so completely interrupting the general supply.

It will be obvious that a motoring current from any one machine will not affect the direction of the current in other portions of the system; consequently, the direction of the current in the series winding of the compound-wound solenoid will now be reversed relatively to the current in the shunt, and the two fields will now help each other to release the catch, thus opening the circuit and disconnecting the faulty machine. It may appear at first sight that the shunt current will not balance the series current for any load—that is to say, if the windings are proportioned so that a series current of 15 amperes just balances the effect of the shunt winding when the machine is generating, and just releases when it is motoring, then a generating current of 45 amperes would appear to so predominate over the shunt as to be of itself sufficient to release the catch. This would be so with a continuous-current arrangement, but with alternating currents the shunt increases almost in direct proportion to the series, because when the shunt coil only is acting on the core its self-induction will be so great as to allow only a small current to pass. But since the current in the series winding is in an opposite direction to the current in the shunt, it decreases the latter's self-induction by mutual induction as it increases, and so allows a proportionately larger current to pass. This increase of the current is so marked, that I have found it possible to use an incandescent lamp in series with the shunt to indicate the current in the series winding.

Last year we had our station at Hastings equipped with cut-outs made upon this principle, and they always worked very well. They were adjusted to cut out with a motoring curent of 15 amperes, but would not release a generating current of not less than 100 amperes. We thought this would be quite sufficient a range to work between. But one day the horrible thought occurred to us that if we got a short-circuit on our mains the balancing theory would not work, because the series circuit would be very large, whereas the shunt current, being short-circuited, would fall to practically nothing. Consequently the series current, having nothing to balance it, would have it all its own way and immediately release the catch. The result would be most disastrous, as all the working machines in the station would promptly be cut out of action. I was bound to

* Paper read before the Northern Society of Electrical Engineers, January 25, 1897.

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admit that my remedy for motoring currents would be likely to cause more breakdowns than it would prevent. For some weeks I almost despaired of getting over this difficulty. Several combinations of springs, relays, etc., were tried, some of which worked and some did not. They were, however, all too complicated to be a permanent success, and I will not detain you with a description of them, but will simply explain to you the final satisfactory result of several months' experimenting with these various devices. This is shown at D1 (Fig. 2). You will see we still use a compound-wound solenoid connected up as before, the only difference being that the shunt winding is wound half in one direction and half in the other, and the normal position of the core is exactly in the centre of the coil. If we again let the full arrow-heads represent the direction of the current through all parts of the system at a particular moment when both machines are generating current, then it will be seen that the direction of the current in the shunt winding of the solenoid, D, is opposite to that in the series winding in the top half of the solenoid, but in the bottom half both of the currents are flowing in the same direc-

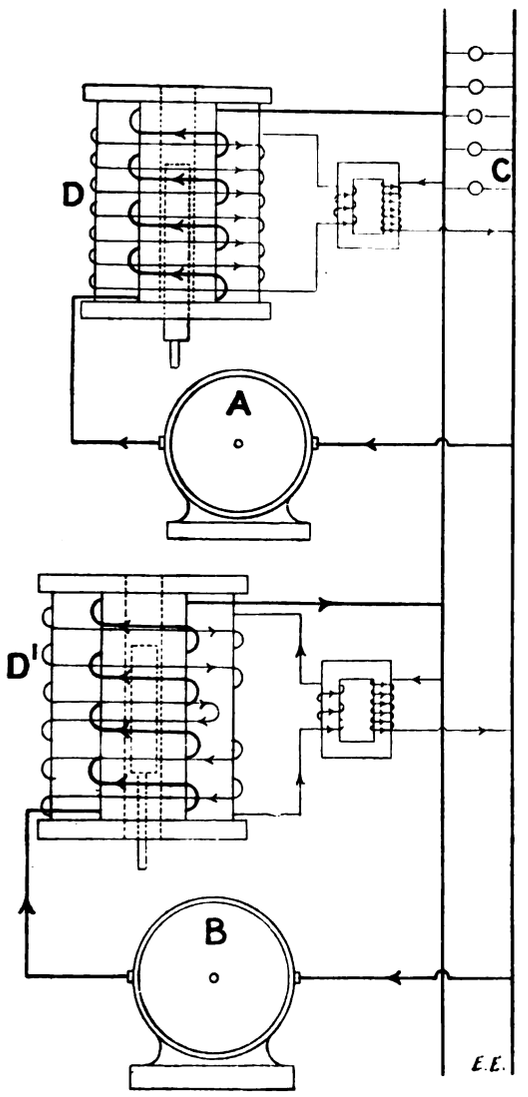

FIG. 2.

tion. The result is that the two windings neutralise each other at the top, but assist each other to produce a magnetic field at the bottom, and the tendency is to hold the core down, thus making it impossible for the cut-out to release. Should the generator become disabled, the direction of the shunt remains the same; but the series is now reversed, as shown by the dotted arrow-heads. The shunt winding now opposes the series in the bottom half of the coil and helps it in the top, thus producing a magnetic field above the centre of the solenoid, causing the core to spring up and release the catch supporting the weight, and so disconnecting the faulty machines from the general supply. It is not necessary to provide a separate transformer for each switch; in fact, at Hastings we excite all the shunts off the station lighting circuit. The shunt current by itself will not have any effect upon the core, because the two windings, being wound in opposite directions, will neutralise each other. Again, the series winding alone will tend to hold the core in the centre of the coil, but as that is its normal position it will not be moved.

I cannot conceive any condition under which this apparatus will cut out except with a return current, and then it never fails to do so. I have had short-circuits on the main since we have used these switches, but they have not shown any tendency to cut out. It is, of course, very necessary that the catch supporting the actuating weight should be so designed that it cannot possibly be released by any amount of mechanical vibration. On the other hand, it should be fairly sensitive, or it will require a very large coil to release it, because the series winding must be large enough to carry the full current of the machine for several hours without undue heating, and at the same time there should be enough turns to release the catch with about 25 per cent. of the full output of the machine. Of course, it is possible to use a relay, but relays generally mean complications, which should, I think, be avoided. I have found the catch shown in Fig. 1 far more satisfactory than any of the many others we have tried. This is not, as may appear at first sight, merely a long lever doubled back upon itself. If it were, a small increase of pressure on the weight would release it. As it is, no amount of pressure on the lever, L1, will set it free, because it is so constructed that the arc described by the end of this lever exactly cuts the fulcrum of the lever, L2. A very slight pull on the end of this second lever will release the weight.

If some magnetic device such as I have just described is used, other fuses are not necessary to protect the machines. If they are used they should be heavily fused, at any rate much more so than any of the circuit fuses.

It appears to me that sufficient attention is not always paid to the prevention of accidents to the attendants in designing high-tension switch-gear. I think it should be impossible for the most careless man to get injured by a shock—that is to say, there should be no high-tension parts exposed anywhere. As far as the machines and connecting wires are concerned, this precaution is usually taken, but on the switch gallery one often sees a large amount of exposed conductors, which it would be

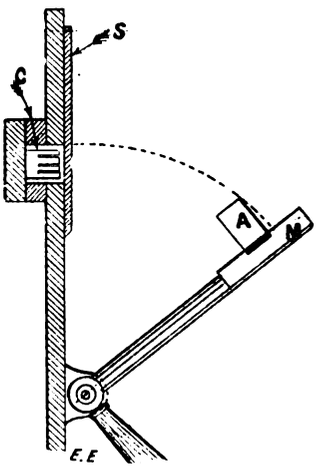

FIG. 3.

extremely uncomfortable to touch. The chief excuse for so much exposed metal is the difficulty experienced in breaking a large high-tension current without the aid of a long break. Some engineers prefer to use water to extinguish the arc, and the switches we are now using at Hastings are constructed upon this principle. Although we have had no trouble with them, I must say that I do not like the idea of having water on a switch gallery.

During the past few weeks I have been experimenting with a switch which, I think, will eventually prove to be in many respects more satisfactory than a water-break switch. The crude idea of this arrangement is shown in Fig. 3. This sketch represents a front and side elevation of the switch closed, and a side elevation of it opened. The only high-tension parts—namely, the contact, C, and the connecting piece, A—are shaded. It will be seen that these are entirely covered up by the marble slab, M, when the switch is closed, and when it is opened the two contacts, C, which are then the only high-tension parts, are covered by the small asbestos shutter, S. This shutter is also used to break the arc, and it does this most effectually.

The general arrangement of the switch-gear connections is almost as important a factor in the problem of obtaining safe and economical working as the construction of the switches themselves. I think arrangements should be made for running any machines or circuits separate from the common 'bus bars if necessary. This arrangement is particularly useful in stations where the steam required to run a spare set of plant at full speed is a large proportion of the total steam consumption. For instance, at Hastings last winter, the total output of our station was between 150 and 200 kilowatts for two or three hours every day, and during the whole of this time we had to keep three 100-unit machines running in parallel to do this work, because if we had depended upon two only, and one of these suddenly broke down, it would have been rather hard on the

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remaining machine to expect it to take all the work whilst the spare machine was being run up and put into parallel.

If two spare 'bus bars are provided, one for the machines and one for the circuits, then some circuits can be connected directly on to the main 'bus bar, and others on to the spare circuit 'bus bar. The latter is coupled to change-over switch, by which it can be connected on to the main 'bus bar or on to the spare machine 'bus bar. As a rule it is connected to the former. If one of the machines supplying these two 'bus bars breaks down, then the spare circuit bar with its load is thrown over to the spare machine 'bus bar, and at the same time this spare machine is run up to take this load.

At Hastings this change-over switch is automatically and simultaneously released by switching out the faulty machine. Fig. 4 is a diagrammatic sketch of our high-tension connections. The course of the current from the alternators, A1, A2, is through the outer conductors of the ammeters, B1, B2, and through the fused plugs, F, to the outer 'bus bar and main ammeter, C. Here it divides itself up, part goes through the circuit fuse plug and ammeter to circuit No. 1, and returns through the inner conductor and the right-hand fuse plug direct to the inner 'bus bar, and the remainder goes through the plug and ammeter to circuit No. 2, and returns through the middle fuse plug to the spare circuit 'bus bar, and from this to the inner 'bus bar *vid* the change-over switch, G. The spare alternator, A 3, is also connected to the outer 'bus bar by its fuse plug and by the middle fuse plug to the spare machine 'bus bar. If the switchboard attendant finds something going wrong, say, with the alternator, A 2, he merely closes the small switch, S, which rings the bell, D, thus signalling the driver to immediately run up the spare plant, and as soon as the volts on this machine have reached their normal pressure (or before, if necessary), he switches out the faulty machine, A 2. As the weight of this cut-out falls, it

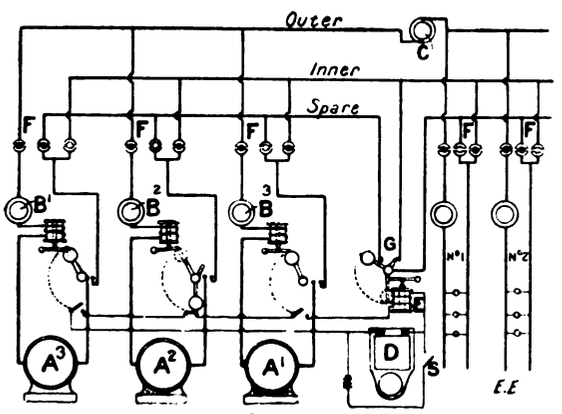

FIG. 4.

completes the battery circuit through the coil, E, thus releasing the change-over switch, and so taking a portion of the load off the main 'bus bar at precisely the same moment as the power to supply that load is cut off. Thus the majority of the lamps are quite unaffected, and those that are thrown over to the spare machine only give a slight jump—often unnoticeable.

I have only shown three machines and two circuits on this diagram, but it will be obvious that the same principle can be applied to any number of either. We always arrange our circuits to have about the load of one machine on the spare circuit 'bus bar. During the few months we have used the arrangement described we have found it even a greater boon to us than we anticipated. In the first place, if things go radically wrong, as alternating currents have a way of doing occasionally, then it is very essential that the switchboard attendant does not lose his head, and so fails to control the switches in their proper rotation. If, as with us, he only has to control one high-tension switch, he cannot go far wrong. Secondly, it enables the station to be worked with a much higher plant load-factor. During the last three months of 1895 we generated 11,000 more units than in the corresponding months of 1895. We have nevertheless been able to reduce our cost of coal, oil, waste, and labour for these months from £1,050 in 1895 to £850 in 1896. I must admit, however, that this saving is partly due to the use of a cheaper coal—namely, Llangennech dust. But it may chiefly be attributed to the fact that for several hours each night we now only run two engines where we used to find it necessary for safe running to use three. Thirdly, in the event of a rapid increase of load such as is caused by a fog, if there is not time to get another machine in parallel, then a portion of the load can be thrown on to the spare machine, and the two 'bus bars paralleled at leisure. Fourthly, circuit switches are not needed in this arrangement; if a circuit is to be switched off, it is only necessary to plug it on to the spare 'bus bar and switch it over on to nothing. Fifthly, if a machine or circuit is known to be faulty and liable to break down at any moment, it can be run separately, so that its failure will not affect other machines or circuits. Sixthly, all the circuits and machines can be run on the spare 'bus bars, and the main 'bus bar left dead for repairs or extensions. It is not necessary to use a separate synchroniser for connecting the main and spare 'bus bars in parallel, as the main ammeter serves perfectly for this purpose, because when they are out of phase the ammeter only registers the difference between the amounts of the two currents; when they are in phase it registers the sum of the two.

I think the fields of the alternators should be excited in parallel off an entirely separate exciter, or even preferably off a storage battery. This arrangement greatly simplifies the regulation of pressure. As a matter of fact, we have often found it possible to run for two or three consecutive hours without touching a single regulating resistance, and to maintain during the time a perfectly straight voltmeter curve with three overloaded Mordey alternators having their fields excited in this way. I should have no hesitation in leaving our switch gallery for an hour without an attendant during the heavy load period, doing all the regulation of pressure by controlling the speed of the engines.

If return current cut-outs are used, there can be no objection to separately fusing the field of each alternator; and I certainly think it is safer to do so, because if the field of one alternator breaks down it will not then affect other alternators working in parallel with it.

We now only use two alternate-current voltmeters in connection with our switch-gear. One of these is connected across the secondary of a small transformer on the main 'bus bars, and the other one is connected to another small transformer, the primary of which can be plugged on to any individual machine or circuit. At one time we used a voltmeter across a single coil of the armature of each machine, but we did not find this arrangement so satisfactory as the present method.

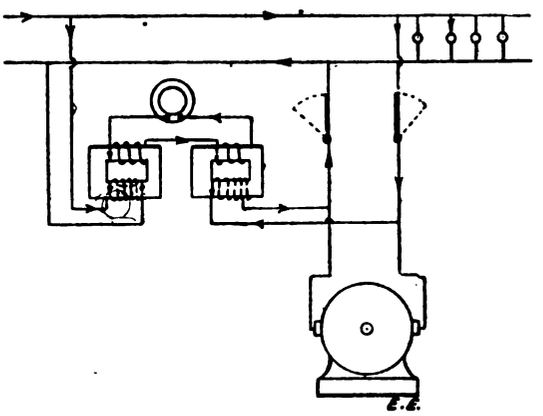

FIG. 5.

Trouble has sometimes been caused by the synchroniser connections being reversed, either by accident or maliciously It is often impossible to know from the appearance of a synchroniser which is the right way to connect it up. Report says that when our alternators were run in parallel for the first time at Hastings Mr. Mordey came down to superintend the operation, and he remarked before switching in that he could not tell whether the machines were in phase or out of phase when the lamps burnt brightly, as it entirely depended upon which way the synchroniser was connected up, consequently he should have to switch in on chance. This he then did, and the noise made by the machine made it pretty evident that they were out of phase. This drastic method of testing one's synchroniser connections rather reminds me of the nurse who objected to using a thermometer for testing the temperature of her child's bath, because she could always tell if the water was too hot, as the child then turned red, whereas, if was too cold, it turned blue. For my own part I always prefer to use the following simple method: Before switching an alternator on to the 'bus bars for the first time, I take out one of the connecting wires from the alternator terminals, thus opening this circuit. I then close the synchroniser switches and the main switches of this machine. This gives the arrangement shown in Fig. 5. Now, if the synchroniser is wrongly connected up, the lamps will be extinguished, but if they burn brightly, then we are sure the connections are right.

I think every switch gallery should have a full-sized diagram of connections painted on the wall above the switch-gear. Although we have the one or two devices I have decribed, which are bound to tend to make our switch-gear connections rather more complicated than usual, yet engineers who have never been in the station before are able to trace out every connection by the help of this diagram in a very short time.

We have noticed in using the switch described in the early part of this paper that it never fails to cut out if a bad synchronise is made, whether the machines are switched in too early or too late, and yet, as I explained just now, the

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cut-out will only release with a motoring current. This led me to think that we never got a big generating current, or it would assuredly cause the machine to roar and not be cut out. It is only during the past week that I have been able to determine what really occurs. What I have needed for this purpose has been a recording ammeter which would be practically dead beat, and which would also indicate the direction of the current relatively to the direction of the current in the other machines. I have been able to get this by attaching the flat tape spring of an Ayrton and Perry ammeter on to the core in the solenoid, D1 (Fig. 2). The pointer was removed from the Ayrton spring and a small mirror put in its place. A spot of light from an arc lamp in an adjoining room was

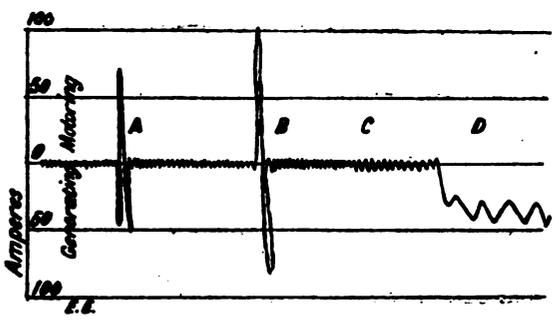

FIG. 6.

thrown on to the mirror, and from this it was reflected on to a sheet of rapid bromide paper. This sheet of paper was moved forward at a uniform speed by clockwork. The records obtained by this arrangement are shown in Fig. 6. A shows the effects of switching in when the machines were coming into phase, and the synchronising voltmeter had only risen to about 90 volts instead of 100. It will be seen that we first get a generating current of about 50 amperes, then it reversed, and we get a motoring current of about 75 amperes. This evidently caused the switch to cut out, but before the circuit was interrupted the direction was again reversed to a motoring current. The dotted character of the curve is due to the momentary extinction of the arc at each alternation of the current. This is both interesting and useful, for it enables us to see what time elapsed between the coil releasing the catch and the circuit being interrupted.

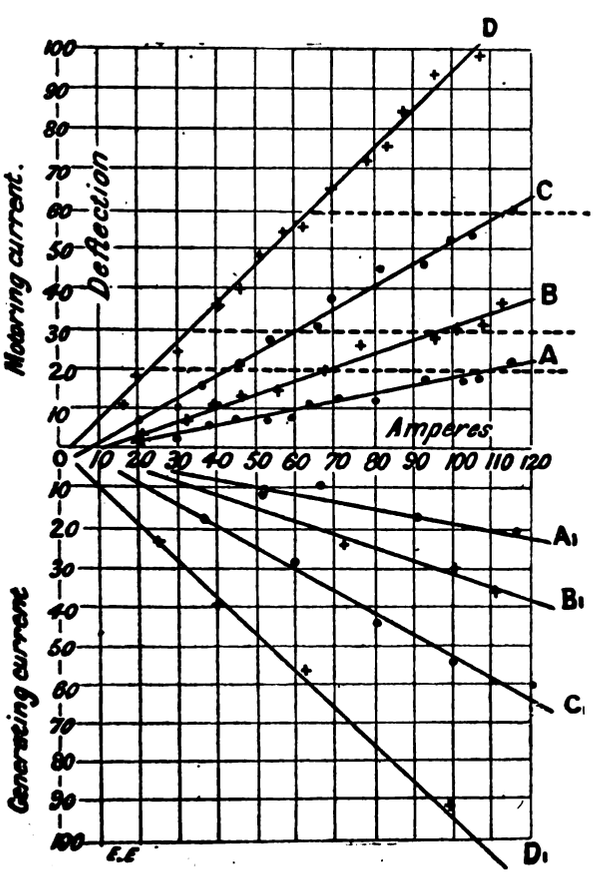

FIG. 7.

Each dot represents one two-hundredth part of a second, and as there are about 20 dots, it shows that it only took one-tenth of a second. B shows the effect of switching in too late—that is, allowing the synchroniser voltmeter to rise to 100 and then letting it drop again to 95 volts. It will be seen that we then started off with a motoring current instead of a generating current. This immediately caused the cut-out to be released, but before the circuit was interrupted the direction of the current was again reversed to a generating current. C shows the effect of switching in properly—that is, letting the machines get over the steady phase and catching a quick phase when the synchronising volts are on the increase. The machines now drop quickly into step without any perceptible rush of current.

I have often been asked if there is any danger of my switch cutting out when there is a lot of synchronising current passing from one machine into another. To ascertain this, I inserted the recording ammeter just described in series with a 50-ampere machine whose ammeter was fluctuating between 70 amperes and zero. The results obtained are shown at D (Fig. 6). I think this curve makes it clear that however much synchronising current we may get you do not get a motoring current, consequently the switch will not cut out.

The compound-wound coil, D_1 (Fig. 2), makes an admirable watt indicator. The diagram (Fig. 7) shows the deflection you get with varying currents in the series winding and varying voltages across the shunt winding. The Curve A represents the deflection obtained with motoring currents in the series winding varying from 1 to 130 amperes, and with a difference of potential across the shunt of 22 volts. A_1 shows the same deflection is obtained with a generating current, but that it is in an opposite direction. The Curves B B_1, C C_1, D D_1 show the deflections obtained with the same currents, but with voltages across the shunt of 36, 55, and 100 respectively. You see we get a deflection of 20 with 24 amperes and 100 volts = 2,400 watts; or 45 amperes and 55 volts = 2,375 watts; or 67 amperes and 36 volts = 2,420 watts; or 110 amperes and 22 volts = 2,420 watts. Again, we get a deflection of 60 with a current of 63 amperes and 100 volts = 6,300 watts, or with a current of 115 amperes at 55 volts = 6,325 watts. You will also notice that the deflection is directly proportional to the watts. This continues to be so until the coil becomes saturated.

FORTHCOMING EVENTS.

The following are some of the announcements for forthcoming week:

TO-DAY (FRIDAY).—Royal Institution (the Bishop of London on "The Picturesque in History"), 9.—Anglo-American Telegraph Company's meeting.—The Prince of Wales distributes the certificates to the scholars and exhibitioners of the Technical Education Board of the London County Council at the Queen's Hall.—Institution of Civil Engineers' students' meeting ("Pelton Water-Wheels"), 8 p.m.—Dinner to Dr. Nansen by the Royal Societies' Club, 7 p.m.—Institution of Mechanical Engineers.—Also at Paris, meeting of the French Society of Civil Engineers.

TO-MORROW (SATURDAY).—Royal Institution (Mr. Armbruster's third lecture).

MONDAY, FEBRUARY 8.—Society of Arts, Cantor lecture (Mr. Burton on "Pottery").—Also at Manchester, before the Northern Society of Electrical Engineers (Mr. Gibbings on "Supply at 230 Volts").—And at Newcastle-on-Tyne, dinner of the North-East Coast Engineers.

TUESDAY, FEBRUARY 9.—Institution of Civil Engineers ("Cold Storage at the London and India Docks," by Mr. H. F. Donaldson), 8 p.m.—Royal Institution (Prof. A. D. Waller, M.D., F.R.S., on "Animal Electricity," fourth lecture), 3 p.m.—Society of Arts (Mr. G. McCullock on "Lithography," Applied Art Section).—Also at Liverpool, the Overhead Railway Company's meeting.

WEDNESDAY, FEBRUARY 10.—Society of Arts, John-street ("Chemistry of Tea," by Mr. David Crole), 8 p.m. Sir Steuart Colvin Bayley, K.C.S.I., C.I.E., will preside.—London Chamber of Commerce, Eastcheap (Railway and Canal Traffic Acts), 3 p.m.—Also at South Shields, meeting of the North-East Coast Engineers, 7 p.m.—And at Lynn, opening of the Trades' Exhibition.

THURSDAY, FEBRUARY 11.—Institution of Electrical Engineers, at the Institution of Civil Engineers, 25, Great George-street, Westminster (discussion on the paper on "Electric Interlocking the Block and Mechanical Signals on Railways"), 8 p.m.—Royal Institution (Mr. J. W. Gregory on "The Problems of Arctic Geology. Lecture I.), 3 p.m.—Society of Arts, Indian Section, at the Imperial Institute ("The Progress of Science Teaching in India," by Prof. Jagadis Chunder Bose), 4.30 p.m.; and at John-street, Adelphi, Howard lecture ("The Mechanical Production of Cold," by Prof. James A. Ewing, M.A., F.R.S., third lecture), 8 p.m.

FRIDAY, FEBRUARY 12.—Institution of Civil Engineers' students' meeting ("Cooling Reservoirs for Condensing Engines," by Mr. Harold W. Barker"). Mr. Henry Davey, M.I.C.E., will take the chair.—Junior Engineers, at Westminster Palace Hotel, at 8 p.m. ("Bridge and Girder Work").—Royal Institution (Prof. John Milne, F.R.S., F.G.S., on "Recent Advances in Seismology"), 9 p.m.

SATURDAY, FEBRUARY 13.—Royal Institution (Mr. Frewen Lord, on "The Growth of the Mediterranean Route to the East," first lecture).

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THE

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TO CORRESPONDENTS.

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All communications intended for the Editor should be addressed C. H. W. Biggs, *139-140, Salisbury Court, Fleet Street, London, E.C Anonymous communications will not be noticed.*

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THE ALL-BRITISH TRANS-PACIFIC CABLE.

This is the title of an article in the current number of *Blackwood's Magazine*. The name of the writer is not given, but whoever he is he knows his subject thoroughly, and has placed it clearly and temperately before his readers. The history of the Trans-Pacific cable is a somewhat painful one. There is no question, and never has been, except from deeply-interested parties, as to its practicability or as to its utility. Had it not been for the unceasing opposition of such interested parties, the cable would have been laid and at work long ere this. We do not blame the opponents, who had great monetary interests at stake, so much as the various authorities who refused to discount the arguments of the opposition and put the true value upon them. We have always supported the scheme, and have done so upon two grounds: (1) its great strategic importance to the Empire; and (2) its commercial value. Its strategic importance ought long since to have brought assistance from the Home Government, and it is the lack of this assistance that delayed the carrying out of the project. The commercial importance was recognised by various colonies, who were prepared to grant subsides. We must refer all readers interested in the subject to *Blackwood's* article for a highly compendious history of the project, for we are unable in the space at our command to do more than give the salient points in the history. The late F. N. Gisborne suggested a cable *viâ* Honolulu to Australia in the early seventies, and the "Tuscarora," one of the United States navy, surveyed the route in 1874. Cyrus Field took the matter up, and came to England in 1879 with a view to its realisation, and about that time Mr. Sandford Fleming, C.M.G., became interested in the matter. In 1884 Canada petitioned the Home Government in the matter, requesting that a survey of the route be made, and even went so far as to offer to pay one-half the expense. The Liberal Government of the day refused to budge a step. At the first Colonial Conference in 1887 the promoters and opponents were brought face to face, and then Mr. Sandford Fleming perfectly annihilated the late Sir (then Mr.) John Pender's arguments in opposition. In our opinion neither the latter gentleman nor any of his colleagues should have been permitted to have a voice in the matter, and they never would have been had they not controlled votes in the House of Commons. The questions for the Home Government were those relating to strategy, to the well-being of the Empire, to the possession of an unbroken line of communication with the principal colonies which touched upon no foreign soil, and could not be tampered with by foreign Governments. As we have several times in the history of this controversy stated, Mr. Pender was possibly justified in taking the course he took—first, in opposing the scheme tooth and nail; second, by reducing his tariffs to scotch or kill the contemplated cable; and, third, if he could stop its progress neither way, to carry out the work himself. Of course by this we mean that the companies he

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controlled would undertake the work. From his point of view the latter was only to be done as a *dernier ressort*, for it would have increased capital account by a million and a half or two million pounds without any commensurate return from revenue. The cable under his control would have been in quite a different position to the cables under other control. Opposition did not stop the scheme, so a decrease in tariff with arrangement as to subsidies was tried, and for the moment successfully so. The cessation of agitation for this cable from English-speaking centres was the opportunity of the French, who lost no time in making a start, and "in the early part of 1893 actually laid the first section of their cable from Queensland to New Caledonia," receiving a subsidy from two Australian colonies of two thousand pounds a year each for thirty years. No doubt the disgust at the action or want of action of the Home Government had much to do with the giving of these subsidies. The author of the paper says the "Home Government as well as the rest of Australia" adversely criticised this action, but we maintain the Home Government was out of court because of its own crass stupidity in not assisting to carry out the wishes of the Colonies. Adverse criticism should be directed against the Home Government, not against the Colonies. Canada, however, was not to be denied; and, under the able and energetic advocacy of Mr. Sandford Fleming, has kept the matter before each successive Home Government. Upon the accession of Mr. Chamberlain to office, more attention was directed to Colonial requirements, and it is hoped that the whole project may this Jubilee year be agreed. We cannot do better than give, in conclusion, one of the paragraphs of the article from *Blackwood's*: "It only remains," says the author, "for the Imperial Parliament to sanction the carrying out of a project which the Colonies have so much at heart. The liability incurred is insignificant. It consists of a third share of a capital of £1,600,000, which Mr. Sandford Fleming calculates to be sufficient for the undertaking. The interest on £1,600,000 at 2½ per cent., together with any unforeseen expenses, would not amount to more than £45,000, which, with £30,000 for working expenses, makes a total of £75,000. The surplus of revenue over expenditure for the first three years is estimated at £154,000. The contractor who lays the cable undertakes to keep it in repair for three years; but after that the cost of repairs will have to come out of revenue, so that in the tenth year the total surplus will be £742,000, and the whole £1,600,000 would be paid off in twenty years without costing the taxpayers a single penny. The reduction of the tariff from 4s. 9d. to 3s. 3d. will effect in the first year a gross saving of £190,000 to Australasia and this country. From a strategical point of view the all-British Pacific cable route is of incalculable importance to the Empire. The present lines to India and Australia are the following: (1) Lisbon, Gibraltar, Malta, Egypt, and Red Sea; (2) France, Italy, Greece, Egypt, and Red Sea; (3) Germany, Austria, Turkey, Russia, and Persia; (4) Germany, Austria, Turkey, Russia, and the Pacific Coast; (5) Lisbon, and the West and East Coast of Africa. All these routes pass through foreign countries, and could at once be interrupted in case of war. The Russian journal, the *Novœ Vremya*, recently said: 'In case of an armed conflict between this country and England, our first task would be to block England's communication with India and Australia.' With good reason has Lord Wolseley condemned the policy of trusting to the present telegraphic routes to East as nothing less than suicidal."

RESEARCH FELLOWSHIPS.

As a contradiction to the recent unfounded charges brought against the Central Institution, nothing could be more appropriate than the recent action of the Leathersellers' Company. The court of this worshipful company, of which Dr. W. H. Perkin, F.R.S., is master for the present year, have voted a grant of £150 a year to the City and Guilds of London Institute, in addition to their ordinary subscription, to be applied in founding one or more fellowships, entitled "Leathersellers' Company's Research Fellowships," for the encouragement of higher research in chemistry in its relation to manufactures at the institute's central technical college. The scheme for the award of the fellowships (given elsewhere in our present issue) provides that the amount attached to each fellowship shall be determined by the Executive Committee of the institute, regard being had as far as practicable to the nature of the research, the time required to complete it, and the merits of the candidate, subject in all things to the approval of the company. And that every fellowship shall be tenable for part of a year or for one year, and may be renewed for a second or third year, but in no case shall be held for a further period. A fellowship of this kind is a most valuable aid to a good student not blessed with unlimited cash, and does infinitely more good than devoting the same sum to giving a large number of inferior students such a smattering of knowledge as acts as an edged tool against them afterwards.

TECHNICAL EDUCATION.

The following are the details of the scheme for the Leathersellers' Company's Research Fellowships in Chemistry, founded December 2, 1896, during the mastership of Dr. W. H. Perkin, F.R.S., under the City and Guilds of London Institute:

I.—NUMBER AND AMOUNT OF FELLOWSHIPS.

1. The grant of £150 a year offered by the Leathersellers' Company shall be applied in founding one or more fellowships, entitled "Leathersellers' Company's Research Fellowships," for the encouragement of higher research in chemistry in its relation to manufactures.

2. The amount of the grant attached to each fellowship shall be determined by the Executive Committee of the institute, regard being had as far as practicable to the nature of the research, the time required to complete it, and the merits of the candidate, subject in all things to the approval of the company.

II.—CONDITIONS OF ELIGIBILITY.

1. Applications for fellowships shall be made in writing, addressed to the honorary secretary of the institute, at the

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head office, Gresham College, E.C., and shall state the name of the proposed research and the qualifications of the candidate.

2. The fellowships shall be open to natural-born British subjects who are (*a*) students of the institute who have completed a full three years' course of instruction in the chemical department of the Central Technical College, or (*b*) candidates duly qualified in the methods of chemical research in its relation to manufactures, without restriction as to age or place of previous study, but preferably to class (*a*).

III.—AWARD.

1. The fellowships shall be awarded by the Executive Committee with the consent of the company in accordance with this scheme, or with such modifications as the company may from time to time approve.

2. The Executive Committee shall appoint a special committee to receive applications and select candidates, and to report thereon, and upon the progress of researches, and such committee shall include the representative or representatives for the time being of the company on the Executive Committee.

3. The Executive Committee shall report to the company the award of each fellowship, and at the close of each session shall report the results or progress of the research or researches undertaken during the session.

IV.—TENURE.

1. Every fellowship shall be tenable for part of a year or for one year, and may be renewed for a second or third year, but in no case shall be held for a further period.

2. Holders of fellowships shall devote their whole time to the prosecution of research, unless otherwise sanctioned by the Executive Committee, and shall report as required on their work.

3. The researches shall be carried out at the Central Technical College, and the holders of fellowships shall be subject to the regulations of the college and the supervision of the Board of Studies.

4. The company reserve to themselves the right at any time to modify this scheme, or to withdraw all or any of the fellowships.

A NATURAL-DRAUGHT HIGH-POTENTIAL TRANSFORMER.*

A new transformer for use with high-voltage currents has been introduced by the General Electric Company of New York. It is of the special "type H" natural-draught type, and is used for long-distance transmission work. In transformers of this type the primary coils, well taped and bound, are insulated from each other by thick layers of felt; as many as four primary coils per limb are sometimes used. Between the coils of the primary and the secondary winding an air-space of ½in. intervenes. The whole is mounted upon a solid iron foundation and securely braced, and is then covered with a corrugated iron cylinder provided with a ventilating roof.

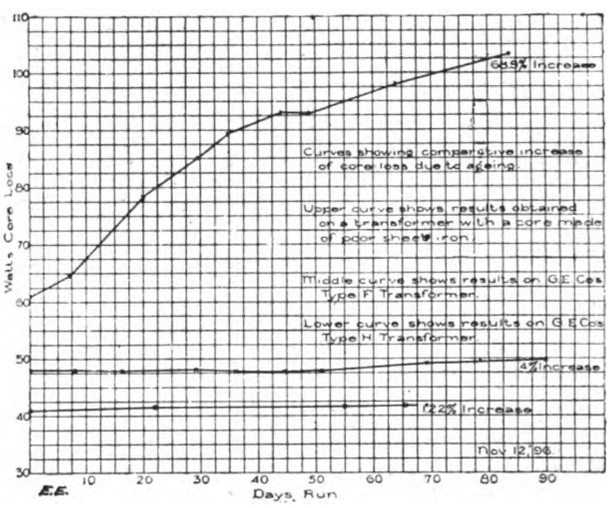
One of the first transformers of this type has been for the past five months in service where it is necessary to reduce directly from 10,000 volts to 125 volts without intermediate transformers.

It is now a well-recognised fact that the loss in a given body of sheet iron subjected to a definite number of magnetic reversals per second, and at a definite density of magnetisation, does not of necessity always remain the same. It is only by the greatest care that iron is brought into the condition in which it gives minimum loss when subjected to alternating magnetisation, and the manner in which this result is obtained and the conditions to which it is subjected in actual use have both to be considered to insure keeping it in this condition.

Failure to properly consider these facts will produce a transformer which may give a fairly low core loss when first produced, but which after being in use for a short time will give a core loss 25, 50, or even 100 per cent. greater than at the start.

* From the *Electrical Engineer* (New York).

This phenomenon is known as "ageing." The accompanying diagram shows a curve of actual results recently obtained on a 2,500-watt transformer of well-known make, tested by the General Electric Company, as a practical illustration of this fact. At the time of the last test the increase in core loss, it will be seen, was 68·9 per cent. after a run of 90 days under normal conditions of commercial operation.



To reduce this loss in its transformers has formed the subject of exhaustive study by the engineers of the General Electric Company at Schenectady. The result of continued experiment allows this company to guarantee its transformers as free from the serious defect of "ageing"; in most cases absolutely negligible, and in extreme cases not more than 4 and 5 per cent. On the same curve are given the actual results obtained on one of the General Electric standard type H 60-cycle transformers, and from this it will be seen that the loss comes within the above limit.

INSTITUTION OF ELECTRICAL ENGINEERS, Jan. 28.

Sir HENRY MANCE (president) in the chair.

We gave last week the ballot-list and the opening portion of Mr. Hollins's address on "Railway Signal Interlocking." The continuation of this is given below: there was only time for one speaker, and the rest of the discussion was adjourned.

The **Chairman**, before the paper was taken, referred briefly to the death of Mr. John Aylmer, the honorary treasurer for Paris, whose resignation on account of ill-health was the occasion of some sympathetic speeches at the annual general meeting. Mr. Aylmer, said the Chairman, had been a most popular man during the many years he had held his post. The secretary had been instructed to forward a letter of condolence and sympathy to Mr. Aylmer's widow.

This having been formally approved,

The **Chairman** again rose to announce that the Willans premium, awardable every three years by the Institution and the Institution of Mechanical Engineers alternately to the best paper presented during that period dealing in a general way with the utilisation, transfer, or economy of energy, would be increased by the Council to 25 guineas. He might also add that the Council had had under consideration and had practically determined on a considerable augmentation of the premiums to be given for the best papers presented. He mentioned that just in case anybody might be hesitating about sending in a paper.

Some conversation followed as to the precise terms of the Willans bequest and the precise kind of paper that was eligible for the premium, **Prof. Perry** expressing an opinion that it was almost impossible to contribute a paper on the subjects germane to the Institution's work without dealing with "energy" and its utilisation or transfer. Ultimately it was decided that the conditions of the Willans trust should be circulated for the information of members.

The paper then followed. The next meeting is on February 11, when the discussion will be continued.

ELECTRIC INTERLOCKING THE BLOCK AND MECHANICAL SIGNALS ON RAILWAYS.

BY F. T. HOLLINS (MEMBER).

(*Continued from page 143.*)

Sykes's Electric Interlocking.—I now come to the description of the system which the directors of the Great Eastern Railway (recognising the rapid growth of their enormous suburban

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traffic, and being determined to afford every protection that the combination of electrical and mechanical apparatus can give, to safely and expeditiously deal with this traffic) have thought fit to adopt, at a cost of little less than £25,000, over practically the whole of their suburban lines. Sykes's complete system of double line lock and block requires three line wires, in addition to the wire for the treadle, or rail contact, circuit. Figs. 8, 10, 11, and 12 show the instrument in the form used upon the Great Eastern Railway for ordinary through working.

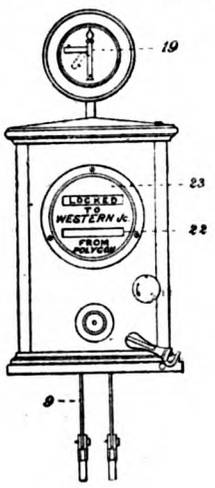

FIG. 8.

There are three strong rods (see Fig. 9) connecting the locking instrument with the signal lever. One is the actual locking rod; the second is the switch rod, which, by the motions of the lever, connects, in one position (signal "on"), the *line wire* to the locking coils; and, in the other (signal "off"), the *rail contact wire* to the locking coils, and puts the line direct to earth; whilst the third is the rod which actuates the "Train accepted" and "Train on" discs, and prevents plunging to accept another train until the signal lever has been taken off and again put to danger. Fig. 9 shows diagrammatically the connections between the instrument and the lever, so that the effect of the different motions may be made clear. The electrical connections (minus the semaphore coils) are also shown, to better illustrate the method of operation. The locking instrument coils, 1, are fixed upon soft iron prolongations of a powerful compound permanent magnet, 2, and the armature, 3, in the "locked" position (as shown) is held up to the cores of the coils by magnetic attraction. The coils are wound, or the circuit joined up, in such a direction that a strong current from the line neutralises the magnetism induced by the permanent magnet, and the armature, 3 (which forms a portion of an angle-piece, 4, with its axis at 5), pressed away from the cores by a strong adjustable "push-off" spring, 6, is discharged, and the small wheel, 7, on the opposite arm of the angle-piece, 4, sliding from underneath the catch-piece, 8 (attached to the

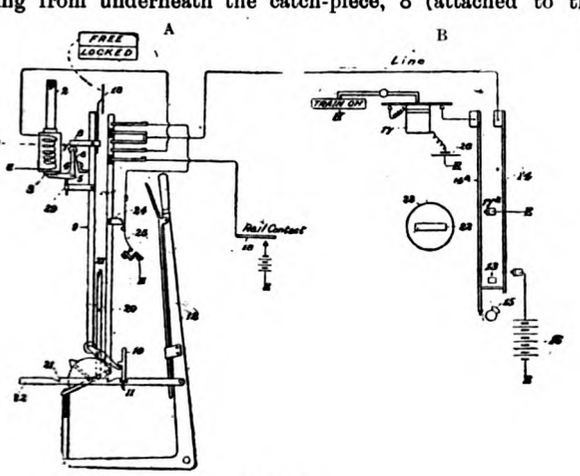

FIG. 9.

locking rod, 9), allows the rod to fall, and in doing so it raises the lock, 10, out of the slot, 11, and thus releases the signal lever, 12. With this diagram (Fig. 9) all the operations may be followed. We will assume that the lever and the locking instrument (which is really the receiving portions of the apparatus) are at station "A"; and the plunger, 13, battery spring, 14, switch hook, 15, battery, 16, and "Train on" apparatus, 17 (in a similar complete instrument), are at station "B," the rail contact, 18, being a train's length ahead of the starting signal at "A." "A" has a train, and gives the "Is line clear" signal to station "B" on the block bell. If the section is clear, and his starting or section signal has been put to danger (he cannot do so without), "B" plunges, indicating to himself "Train accepted" by the disc, 21, at the lower aperture, 22, in the screen, 23, and his plunger, 13, becomes locked. This plunge joins the battery, 16, to the line, but without breaking down the "Train on" circuit, the latter, during the act of plunging, getting earth from the stop, 17A. The current transmitted releases the lock, 10, at "A" as explained, and indicates by a disc, 18, carried on the rod, 9, "Free." The signalman at "A" then pulls over lever, 12, and lowers his starting signal, and this operation has the effect of raising the locking rod, 9, lowering the switch rod, 20 (Figs. 9 and 12), connecting the rail contact circuit to the locking coils, 1, and the line to earth direct. At the same time the lock, 10, has again dropped into another slot, 21, in the tappet, 22, of the lever, back-locking the same in the "off" position, and indicating "Locked" on the instrument. I may here explain that on the Great Eastern Railway we have so arranged this slot in the tappet that, although the lever cannot be put right back, so as to allow of another train being accepted, it can be put sufficiently back to throw the signal to danger in case of emergency. On the train leaving "A," "Train entering section" is given on the bell to "B," and on its passing over the rail contact, 18, the circuit is closed and the back lock is released, the signal put to danger and relocked, and the *line* wire again connected to the locking coils, 1, the rail contact circuit being left disconnected. In response to the "Train entering section" signal, "B" turns the switch hook, 15, which, breaking the line momentarily (by separating the two springs, 14 and 14A, and thus, coil, 17, releasing the armature and allowing disc, H, to fall in front of the "Train accepted" disc, 21), indicates to himself "Train on," and to "A" "Line blocked," by raising the small semaphore arm. Should, however, "A" have omitted to give "Train entering section" to "B," the act of putting his signal to danger behind the train at

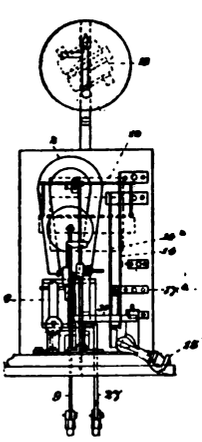

FIG. 10.

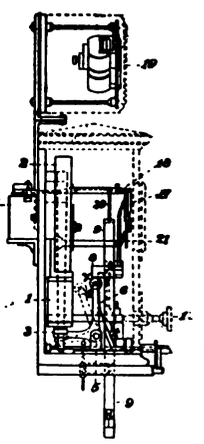

FIG. 11.

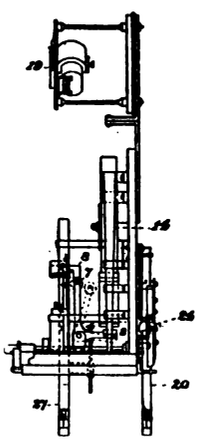

FIG. 12.

"A" gives "Train on" to "B" through the tripping-piece, 24, on the switch rod, 20, pressing against the spring, 25, in passing it, and thus momentarily breaking the line circuit. After the train has passed "B" and the signal has been put to danger, the switch hook, 15, is turned back off the plunger, 13, and the putting back of the signal lever, 12, again raises the rod, 27, carrying the "Train accepted" disc, 21 (Fig. 11), and the "Train on" disc, H, is also raised by the little rod, 28, on the top of rod, 27 (Fig. 9); the "Train on" disc is afterwards held up electromagnetically by the coils, 17, and the small battery, 26. The Sykes apparatus was originally joined up to transmit a positive current to unlock the lever, but in view of *possible* lightning effects I have recently had this reversed, so that a strong negative current unlocks the lever, and a constant positive current is required to indicate "Line clear." A constant negative current, such as might be due to a contact, if strong enough to unlock the instrument, would indicate "Line blocked." Lightning currents are, I think, generally positive currents, and therefore in the wrong direction for unlocking the instrument when thus joined up. If, however, a momentary positive current, such as might be due to contact, or possibly lightning, *should* unlock the instrument, it would only alter the *block* indication momentarily, and this would immediately resume its previous indication. A disconnection of the line or the line to earth would indicate "Line blocked," and of course leave the lock unaltered. If, whilst the line is indicating "Line clear," and after the lock has been released at the box in the rear, and the instrument in advance indicates "Train accepted," the line wire was disconnected or put to earth, it would alter the indications of the instrument to "Line blocked" at the rear box. It will be seen that, although these are merely minor points, they are all in the direction of safety. Now it must be obvious that if in putting the lever back in the frame the armature is not lifted close up to the poles of the magnet, and the small wheel, 7, under the catch-piece, 8, of rod, 9, the rod will fall and the

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lever be unlocked. This is a somewhat rare fault, but in order to prevent it, the rod must be adjusted to give a certain overlift so that the wheel goes completely underneath the catch, 8, and the armature be held tightly up to the magnet by the lifting piece, 29, which is provided with a buffer spring to prevent any violent impact of the armature on the cores of the coils. If this overlift was always given such a fault would never occur. But I was not satisfied with this, and I have had all the instruments fitted with a simple device on the locking rod, 9, *compelling* this overlift, by making it impossible to plunge to

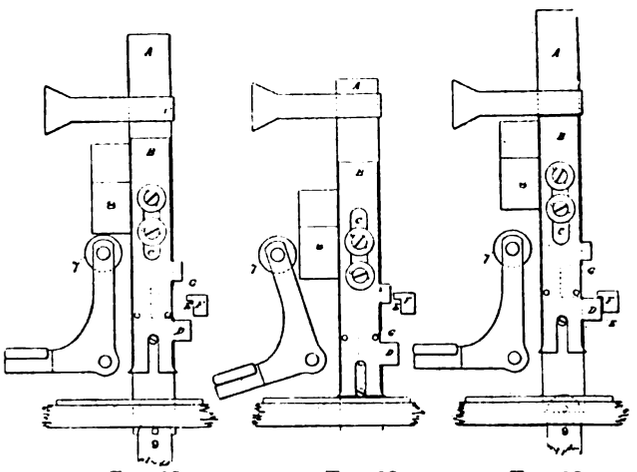


FIG. 12A. FIG. 12B. FIG. 12C.

accept a train unless not only the signal is at danger, but locked in that position. If therefore it falls to "free" when the lever is put back, the signalman is compelled to raise the rod with his hand, and so lock it. It was pointed out that the signalman could then, if he chose, by pressing the plunger whilst in the act of raising the rod, plunge without being locked. I should hardly think he would try to do this; still, a small cavity was then cut in the plunging-piece to so coincide with this safety device that this cannot now be done. Fig. 12A shows diagrammatically how this is effected, and a specimen is on the table. A is the locking blade attached to rod, 9 (Figs. 10 and 11), held up by the small wheel, 7, engaging under the catch-piece, 8, at the same that the armature is held up by the permanent magnet. To the locking blade, A, is attached a metallic friction-piece, B, binding against A, but free to move independently to the extent allowed by slot, C. The friction-piece, B, has a

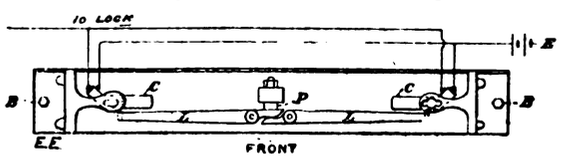
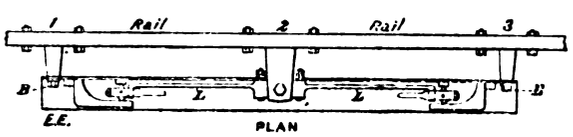
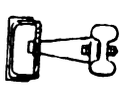


FIG. 13.

projection, D, to engage in the cavity, E, of the angle-piece, F, which is part of the plunger for transmitting the current to unlock the controlling signal at the box in the rear. Now, as shown in Fig. 12A, the instrument is in the locked position, and the angle-piece, F, coinciding with the cavity





FIGS. 14 AND 15.

between, D, and the upper portion of a slot, G, in the locking blade, A, is free to allow the plunger to be operated—that is, so far as the locking blade is concerned. If now the lock is discharged, the blade, A, and the friction-piece, B, fall into the position shown in Fig. 12B; when they are again raised to the locked position, the overlift is given as shown in Fig. 12C, where D is shown engaged in cavity, E, of the angle-piece, F, and the catch-piece, 8, is raised a corresponding distance above the wheel (which is also the measure of the overlift), and is a little beyond the point where the armature "clicks" on the pole-piece of the magnet. Blade, A, is then allowed to fall so that catch-piece, 8, again rests upon the wheel and the projection, D, of the friction-piece, B, is then clear of the plunger angle-piece, F, as shown in Fig. 12A. If the cavity, E, were not cut in angle-piece, F, the upper portion of D would engage with the bottom of the angle-piece when the plunger was pressed in by the hand, and thus, by wriggling the plunger and the rod, plunging would be possible whilst the lever was still unlocked.

The Rail Contact.—In any complete system of electric interlocking there can be no doubt that the rail contact, or treadle, is the most important factor to be considered, because upon its reliability the safety of the system mainly depends. It is the means that shall indicate the presence of the train clear of the section to which it refers, and is really the positive permission to the signalman to admit a following train into the section. It is essential that a rail contact should only be actuated by the weight of an engine or carriage. It will not do to be merely actuated by the flange of a wheel. It must not be capable of being actuated by a trolley, or being walked over, or jumped on, or by a bar or other reasonable weight falling upon it. It must not be capable of being operated by hand, or other means but the deflection of the rail. The battery must be fixed near

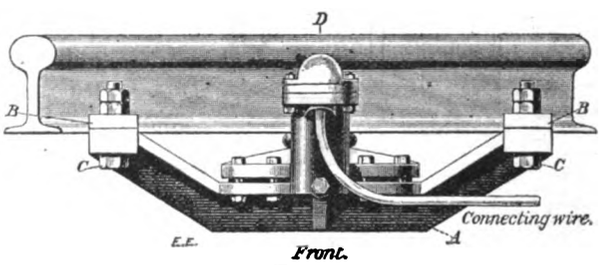


FIG. 16.

the contact *and not at the signal-box*, so that any failure of the circuit must be, as the Government inspector remarked at a certain enquiry, in the direction of safety. Both Sykes's and Siemens's contacts are doubtless excellent examples, and both are carried on the rail itself. Sykes's contact is shown in Figs. 13, 14, and 15, and a model is on the table.

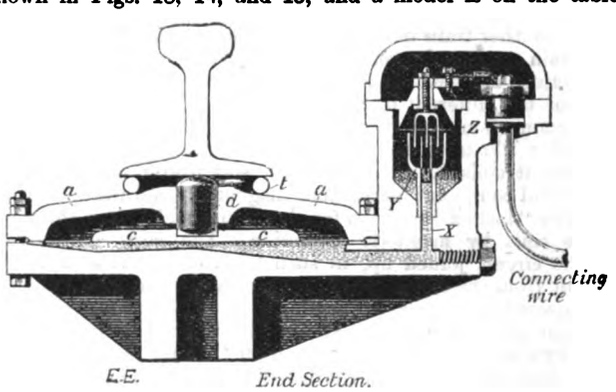


FIG. 17.

Three cast-iron brackets, 1, 2, and 3, are secured to the rail, and the treadle bolted to 1 and 3 by bolts, B, B. The centre brackets has an adjustable pin, P, which passes through a slot and rests on the tails of two levers, L, L, the extreme ends of which are under the mercury-cups, C, C. The weight of an engine or coach over the spot P results in the tilting of the mercury-cups, thus making or breaking contact, as the case may be. Siemens's contact is shown in Figs. 16 and 17. Fig. 16 shows a side view of the complete apparatus attached to a rail, and Fig. 17 is a section showing the working parts of the apparatus. The contact-maker is supported by a strong cast-iron beam or small girder, A, which, by means of claws,

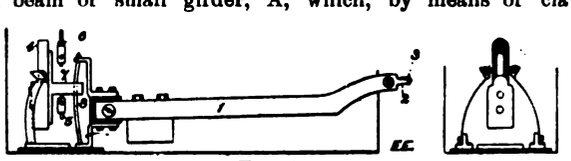


FIG. 18.

B, B1, and screws, C, C1, is firmly screwed to the bottom flange of the rail, D. In the centre of the beam is a broad shallow dish, the rim of which is covered by a thin steel plate similar to the diaphragm or membrane of a telephone. On this iron diaphragm rests an iron disc, *c c* (Fig. 17), which is held at the centre by the plunger, *d*. This plunger is so adjusted that it just touches the under surface of the rail when the apparatus has been firmly screwed to the latter. The dish, steel diaphragm, and the disc are covered by a dome, *a a*, in the centre of which moves the plunger, *d*, and on this cover, and under the foot of the rail, is a ring of solid indiarubber, *t*, laid round the plunger, *d*, to protect it from the penetrating sand, which otherwise might impede its free action. The pressure upon this steel diaphragm

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by the deflection of the rail, due to a passing train, forces some of the mercury in the dish underneath up the tube, x, and the cup, y, into which the contact points, z (to be joined together), are suspended, and thus closing the electrical circuit. Neither of these forms have, however, been made use of on the Great Eastern Railway, but it would be interesting to learn from users of them to what extent they are in operation, and what is the result of their experience. The form used on the Great Eastern Railway (and we have about 400 of them in use) is shown in Fig. 18, and a model is on the table. This was designed by myself, in order to obtain a rubbing solid contact, in preference to mercury, and to be self-adjusting by the passage of each train. It is secured to a strong timber, bolted to and underneath the ends of two adjoining sleepers. As will be seen, it consists of an iron containing box, with a long heavy lever, 1, at one end of which is a tail-piece, 2, to fit into a corresponding hole in the web of the rail. A steel key-piece, 3, which is adjustable, is used to avoid undue looseness in the hole owing to wear and tear. At the other end of the lever, and insulated therefrom, is a self-adjusting friction clutch, 7, and contact-piece, 4, which slides somewhat tightly up and down on the steel bar, 8; and the range of the movement of this is controlled by the steel stop-pins, 5 and 6, without interfering with the free movement of the lever itself. It will be obvious that this arrangement provides that, should there be a tendency to make contact through the road sinking, the next train readjusts it, and, therefore, each train may be said to readjust the contact for the following train. This friction clutch rail contact has given great satisfaction. During the six months ending September 30 last (probably our busiest months in the year), although the 400 rail contacts were operated in the aggregate for 5,856,000 trains, there were only five failures; and this, I think, is a remarkable result. During the months of July and August, however, though actuated in the aggregate for 1,953,000 trains, there was not a single failure.

(To be continued.)

PHYSICAL SOCIETY.—Jan. 22.

Prof. AYRTON (vice-president) in the chair.

After **Mr. Croft** had given an exhibition of some simple apparatus,

Mr. E. C. H. Baly read a paper on "**The Passage of Electricity through Gases,**" in which he brought forward as arguments that electric conduction in gases is not of an electrolytic nature the facts—(1) that the sign of the charge on the supposed gaseous ion is variable; (2) the initial resistance of a gas; (3) the invalidity of Ohm's law; (4) the permanence of the supposed gaseous electrolyte; (5) that every mixture of gases must equally be an electrolyte; and (6) that the potential gradient in a vacuum tube when the current is passing has been shown to be very uneven; it is very steep on the cathode glow, and is by no means a regular decline between the electrodes.

Prof. Armstrong, in the discussion, said the author's arguments seemed vitiated by the fact that he had looked upon the subject from one very narrow standpoint only—viz., the ionic hypothesis—and Lord Kelvin, for instance, did not believe in the truth of the ionic hypothesis even in the case of liquids. Prof. Thomson had shown that the phenomena depended on the dryness of the gas, so that the conduction could not depend on the gaseous molecule alone. The case of conduction induced by a neighbouring discharge might be due to the expulsion of condensed vapour from the walls of the vessel. It would appear that in the dry state gases were not electrolytes.

Mr. Enright said he thought it was not correct to say no work was done in electrolysis.

Prof. Silvanus Thompson said that the pursuit of the analogy between the conductivity in gases and liquids was apt to lead one too far. Thus, in comparing the conduction in a mixture of H and Cl with electrolysis, the analogy would be a false one.

Prof. Armstrong said Prof. Dewar had shown that if you cooled the surface of a Crookes tube the discharge stopped. It was quite inconceivable that at these low pressures the gas became liquefied, so that this experiment seemed to show that conductivity depended on the presence of a vaporous electrolyte.

Mr. Enright asked if Prof. Armstrong knew how the presence of an electrolyte assisted conduction?

In a communication, **Prof. J. J. Thomson** said that in the decomposition of steam by a spark, the fact that in the tube, as a whole, the amount of steam decomposed was greater than the amount of gases liberated in a voltameter in series was no objection to the conductivity being electrolytic. The only condition imposed by the laws of electrolysis was that the excess of H or O at one terminal and of O or H at the other, should correspond to the amount of electricity passing through the tube. As an analogy, suppose a water voltameter with a number of metal partitions, which the current has to pass through. With reference to Mr. Baly's objections to the electrolytic theory, there was no reason to think that under conditions other than in solution the atom of hydrogen might not have a negative charge, and the electrolytic theory led one to expect that it would require a finite E.M.F. to send a discharge through a gas. Before such a discharge could take place, the molecules must be split up, and this requires an electric field of finite strength. Again, in the case of a gas, the electric field has to ionise the molecules, so that an increase in the strength of the field will not only (as in the case of a liquid electrolyte) increase the speed of the ions, but it will also increase their number, and thus the current will increase faster than the E.M.F. Further, the ion, once used, can again combine, and since the ionisation is done by the electric field, it can be again split up and used again. If, however, the ionisation has been done by external sources, as, for example, by Röntgen rays, then it is found that the conductivity decreases as the current passes. A variable potential gradient would be produced if the ions moved with different velocities.

Prof. Schuster, in a communication, said Mr. Baly criticised what he called the electrolytic theory, but directed his arguments against a form of the theory which was advocated by no one. The essential difference between a liquid and a gas is, that in the liquid the number of ions is fixed by the chemical constitution of the liquid, while in a gas dissociation had first of all to be produced by the current itself, and hence the number of ions depended on the current.

The **Author**, in his reply, said that on some points he had been misunderstood. He thought that the increase in conductivity could not be due to vapour driven off from the sides, for ultra-violet light also produced such an increase. If Röntgen rays produce ionisation, then there ought to be a reduction of density of the gas.

STREET-LIGHTING AT LEYTON.

The following are copies of reports of Prof. Henry Robinson to the Highways and Lighting Committee:

The substitution of two 13-c.p. incandescent electric lamps for each public gas lamp not giving the degree of improved public lighting that was expected, I think the following observations may be of service to the Council at this juncture. If it is decided that a further improvement is necessary to meet the requirements of the district, then it must be taken for granted that an increased expenditure on public lighting will not be regarded with disfavour by the ratepayers. At the outset I endeavoured to ascertain to what extent the standard of public lighting was desired to be raised. In the absence of any definitely expressed opinion I introduced a very moderate improvement. If, on the other hand, I had introduced too high a standard, the cost would have caused adverse criticism to arise on the ground of extravagance, and the electric lighting undertaking would have suffered proportionately.

In my report of July 1, 1895, I stated that "a better standard than the present" was needed, but I confined the improvement within the narrow limits of that which could be accomplished without any increase of annual expenditure on public lighting than then existed, and this led to the adoption of what is now being carried out—namely, the substitution of pairs of 13-c.p. incandescent lamps for the existing single gas-burner — by which revenue would be transferred from the gas companies to the Council, thus diminishing the probability of any charge having to be made upon the rates in aid of the undertaking. I would still advise the Council making this limited change in all streets where electric mains are laid, and where but little improvement in the lighting is desired, simply for the sake of enlarging the revenue of the undertaking, and thus improving the prospect of an early profit.

As to the method of dealing with the main roads, where a much higher standard of lighting is now demanded, I recommended two or three methods of lighting being tried on a small scale to give you the opportunity of judging for yourselves what standard of lighting should be adopted.

It will be within your recollection that before ordering the present fittings I brought the question of public lighting before you, and submitted an improved form of lamp for the main roads, but you decided not to depart from the two 13-c.p. lamps at first proposed.

One method of improving the lighting is either to use more than two incandescent lamps on the existing posts, or to use two lamps of a higher candle-power than 13. In either case, the existing service lines, fuses, and switches would be utilised. In the latter case the lampholders and fittings would also be used, thus reducing the extra capital cost to about 2s. per lamp for the higher candle-power lamp and fixing.

If two 32-c.p. lamps were adopted in place of two 13-c.p., the extra cost of current, etc., of the additional 38 c.p. would be about £2. 12s. 6d. per annum.

Another method of improving the lighting by incandescent lamps is to arrange the posts nearer together, involving some extra ones. This would be more effective (in providing a better distribution of the light) than the same extra expenditure laid out in increasing the candle-power of incandescent lights on the existing posts.

If arc lighting were to be adopted there are several kinds of lamps which could be worked off the existing mains, either in strings of three (off 150 volts) or six (off 300 volts), but an extra wire would have to be drawn through the conduit to connect the lamps in series. The wire would be of the same size as the present lamp service lines, and could be supplied under the existing contracts with Messrs. Siemens. I would suggest that a few small arc lamps be tried at important street corners—say, three in a string between the town hall and the railway station, and three more elsewhere,

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Arc lamps can be obtained to take any current down to about three amperes, but the efficiency and steadiness decrease with the current. The annual cost of ordinary 50-volt arc lamps, including current, carbons, and attendance, will be as follows:

Three-ampere lamp,	£11	per annum	250	c.p.
Four ,,	,, £13	,, ...	350	,,
Five ,,	,, £15	,, ...	450	,,

I doubt whether the amount of light would be considered satisfactory if two five-ampere lamps were adopted in place of more than three existing lamps. There would, of course, be a considerable increase in annual expenditure if arc lighting is generally adopted. There is a new arc lamp, recently introduced called the "Jandus lamp." It is supposed to be cheaper, on account of requiring less attendance and carbons, and is said to be workable with 2½ amperes. They require, however, 75 to 100 volts, as compared with 50 for ordinary arc lamps.

I advise your authorising me to have the following works carried out, which will afford data to guide you in this matter: (1) three five-ampere arc lamps between the railway station and the town hall, on temporary wooden posts, 15ft. high; (2) two or three Jandus arc lamps erected in a similar manner elsewhere; (3) a few of the existing fittings to have two 32-c.p. lamps put in instead of the two 13-c.p. lamps; (4) to have suitable reflectors applied to a few of the lamps.—Yours faithfully,

HENRY ROBINSON, M.I.C.E.

Westminster, November 24, 1896.

The following is the more recent report, dated January 1, 1897:

In accordance with the arrangement made on the evening of December 22, when you inspected the six experimental arc lamps in the roads, and the two Jandus lamps at the station, I beg to report on the cost of carrying out the lighting of the Leyton and Leytonstone main roads by arc lamps, instead of by the two 13-c.p. incandescent lamps, which are not considered to afford a sufficient improvement on the existing gas lamps. I have based the estimate upon having the arc lamps placed higher than the experimental ones—namely, 22ft. instead of 16ft.—and upon having new cast-iron columns, the existing gas columns being utilised for by-streets.

I concluded that you considered the distance between the five-ampere arc lamps in the Leyton-road—namely, 90 yards—was about right, and that the distance of 123 yards between the seven-ampere lamps at the corner of Crownfield and Victoria roads was too great. To carry out the arc lighting of these roads, I have spaced the lamps so that at no point are they more than 100 yards apart, or less than 63 yards. Forty-two lamps would be required in Leyton-road and 30 in Leytonstone-road, taking the entire lengths of these roads.

I have obtained tenders from several makers of arc lamps and of arc lamp columns. The number of hours that the lamps work without requiring the renewal of carbons varies considerably. The trial ones only last 10 hours. Some forms of lamp last 16 hours, some 32 and in the case of the Jandus lamp it is claimed that it lasts 180 hours In the case of ordinary arc lamps, I advise 32-hour lamps being adopted, worked at six or seven amperes and 50 volts, or six in series off the 300-volt circuit. As regards the Jandus lamp, it requires about 100 volts to work it, and the makers claim that it is equal in efficiency to the ordinary arc lamp, but as this is not substantiated to my satisfaction, the makers in their tender offer to give guarantees.

The cost of the lamps, with 22ft. posts, switches, resistances, and connections to the mains complete, will be as follows:

Brockie-Pell 32-hour lamp	£41	18	0
Crompton-Pochin 32-hour lamp	40	5	3
Jandus 180-hour lamp	41	0	0

Siemens, figures not to hand.

The £40. 5s. 3d. in the case of the Crompton-Pochin lamp is made up as follows:

32-hour 7-ampere Crompton-Pochin arc lamp, with switch, resistance, cut-out, etc.	13	5	3
Lamp column and bracket 22ft. to centre of lamp	16	0	0
Cable connections to mains	11	0	0
Total	£40	5	3

I have tenders for several designs of lamp-posts, and have allowed £16 in the above figures for the 22ft. posts with overhanging brackets, including erection and painting complete. This figure is liable to slight modification according to the design you select.

The cost of working the Brockie-Pell or the Crompton-Pochin lamps will be as follows:

Annual expenses of a seven-ampere lamp.

Carbons	£2	0	0
Outdoor attendance	3	0	0
Proportion of station expenses	5	10	0
Renewals	1	10	0
Extra shift at central station, £200 per annum, on 72 lamps=say, per lamp	3	0	0
Capital charges in respect of proportion of the central-station works and trunk mains	1	0	0
	16	0	0
Capital charges in respect of arc lamps and connections (see separate details)	4	0	0
	£20	0	0

The annual expenses for a six-ampere lamp will be £18.

Capital charges:

22ft. lamp columns cost £16 each—instalment for repayment in 10 years	£1	12	0
Lamp, switch, resistance, and cable connections cost £24—instalment for repayment in 25 years.....	1	0	0
Interest on £40 loan at 3½ per cent.	1	8	0
Total capital charges per 32-hour 7-ampere lamp....	£4	0	0

Assuming that portions of the two main roads were to be lighted by, say, 30 seven-ampere arc lamps, the capital cost would be £1,200. If the whole of the 72 lamps were put up, the annual cost would be £20 per lamp, as given above. If, however, only 30 lamps were to be put up, the annual cost would be £24 per lamp (owing to a larger proportion of the extra station expenses). The annual cost, therefore, of the 30 lamps would be £720. These arc lamps, placed at the distances apart hereinbefore mentioned, would increase the existing lighting thirtyfold. The present cost of lighting the two main roads by gas is about £400 per annum.—Yours faithfully, HENRY ROBINSON, M.I.C.E.

KINGSTON-UPON-THAMES.

The following is the third annual report of Mr. J. E. Edgcome, A.M.I.M.E., borough electrical engineer, to the Electric Lighting Committee of the Corporation upon the working of the electricity undertaking of the borough:

Machinery.—An extra filter is being fitted to the by-pass of the present Reeves filter to prevent oil from condensed water passing into the boilers when the main filter is being cleaned out.

Public Electric Lighting.—All the cables supplying current to the public arc lamps were replaced by Messrs. Siemens Bros. in the spring, the new cables being of at least 50 per cent. better quality than those originally laid. Since the new cables were put in there has been no fault whatever in the street-lighting, which is now in a most satisfactory condition. Two experimental incandescent electric lamps have been fixed in Wood-street and Vicarage-road respectively, and others will shortly be erected in other parts of the borough.

Launch Charging.—The alterations and additions to the switch-board and exciting dynamos for the purpose of charging launches at the riverside were completed in May, and the first launch was charged in June. This branch has been a success, if we take into consideration the fact that being a new departure many owners of electric launches during last season were not aware that there were facilities at Kingston for recharging their batteries, and there is every probability that considerable business will be done in this work, and that it will prove a lucrative means of running some of the plant during the daytime.

Mains.—A number of cables have been laid for the purpose of connecting consumers to our circuits in Beaufort-road, Lingfield-avenue, Gloucester-road, Queen's-road, and Liverpool-road. In Fife-road a large feeder main has been laid from Richmond-road to Clarence-street. This new main is already supplying current to four new consumers with a lamp total equal to 222 lamps of 8 c.p. Besides putting consumers on these new mains fresh services have been connected to the existing mains in Portsmouth-road (two), Clarence street (four), Thames-street (three), Market-place (two), London-road (four), Surbiton Park-terrace (one), and Palace-road (one). Three five kilowatt and five 10-kilowatt transformers, complete with high and low tension switch and fuse gear, have been installed, supplying current from the high-tension feeders into the low-tension distributors at various points. By arrangement with the Surbiton District Council a main has been laid to the Surbiton assembly rooms, where a 15-kilowatt transformer is installed, and with the exception of the small hall this building is entirely lighted by electricity from the Corporation mains. The number of consumers, which had increased from 77 at the end of 1894 to 99 at the end of 1895, has further increased to 129 at the end of 1896, and the total number of 8-c.p. lamps connected, which had increased from 4,000 at the end of 1894 to 4,800 at the end of 1895, has increased to 6,825 at the end of 1896, showing the very substantial increase of 2,025 lamps during the year.

Future Extensions.—The committee will recollect that the present plant is sufficient to deal with a lamp connection of 7,000 8-c.p. lamps, and, as shown in this report, the number of lamps at present connected is within 75 of that total. It will therefore be apparent that, taking into consideration the fact that applications from fresh consumers are being received, it is necessary that considerable extensions should be made to the buildings, generating plant, and mains; and, as it will take from six to nine months to deliver and fix some of the heavier portions of this new machinery, it is imperative that orders for this plant should be placed at a very early date, to enable the new machinery to be in working order before the heavy load of next winter is upon us. To deal with the probable increased demand for current during the next two to three years, I would ask the committee to consider the necessity of carrying out extensions on the following scale: (1) That the engine house and boiler-house be extended a further 30ft. (2) That two high-pressure steam-boilers, complete with mechanical stokers and superheaters, be installed. (3) That a coal elevator and combined coal and ash conveyor be fitted. (This will be found to effect a considerable saving in labour when there are five double-furnace boilers fixed, as one stoker will be able with this coal-handling plant to work all these boilers alone, during even the time of

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heavy load, thus saving the wages of one extra stoker who would otherwise be needed.) (4) That the small loco. boiler be fixed for use during times of light load, and to enable the larger plant in the boiler-house to be shut down during the daytime. (5) That an extra pump be added for supplying feed-water to the boilers. (6) That the main and branch steam-pipes and main exhaust-pipe be extended and connected to the new boilers and engine, and that the necessary steam traps and separators be fitted. (7) That one 300-b.h.p. high-speed three-crank engine coupled to a 200 kilowatt alternator and capable of supplying current to 6,000 lamps be installed. This will leave space in the extended engine-house for a similar combined engine and alternator. This size will be found a very convenient unit for future extensions for working the plant in the most economical manner. (8) That extra alternator, feeder, and exciter panels be added to the present switchboard, which would be extended to allow of these new panels being inserted, space being left for the addition of further panels in the future. (9) That a further network of low-tension mains, of at least ·2 square inch section, be laid in the centre business part of the town to cope with the constantly increasing demand in that portion of the borough, and that additional transformers be added to the present sub-stations to feed into these distributing mains, and that as far as possible the low-tension mains be extended throughout the other portions of the district and joined through switch-boxes to the low-tension network, so that the circuits may be worked as economically as possible, isolated transformers being to a large extent removed and banked in sub-stations.

The accompanying tables show the increase in the number of lamps connected to the mains and the amount of revenue and cost of running the works during 1896, and also the amount of capital and interest payable during that year. They also show the estimated increase in the lamp connections on the circuit and the probable revenue therefrom during the years 1897 and 1898. In the last two cases the increase in the lamp connections is worked upon the percentage increase of each quarter during 1896, as there is no doubt this is the most reliable basis upon which to estimate an increase of this kind. Every fresh installation on the circuit is essentially an advertisement for the undertaking, and the probability is that fresh connections will be made in a greater rather than in a lesser ratio as compared to the past year. If the proposed extensions are carried out, the total capital expenditure upon the undertaking, including the capital expenditure at the present date, liabilities and proposed expenditure will amount to £43,772. The estimated amounts put down for the payment of interest and repayment of capital for the years 1897 and 1898 are based upon the assumption that the whole of this capital will be expended by the beginning of 1898. Probably, however, a considerable portion of the amounts set down for mains will not be expended for some years, so that the amount set out for payment of interest and repayment of capital is doubtless too large an item.

REVENUE ACCOUNT, 1896.

Pence per unit sold. Dr.		£ s. d.
1·794	Coal and other fuel, including carting	1,164 2 9
0·217	Oil, waste, water, disincrustant, packing, gauge glasses, sweep, and petty stores	141 15 8
0·933	Wages for generation of current	605 7 8
0·191	Maintenance of plant, including wages, small repairs, incandescent lamps, etc.	123 19 0
		£2,035 5 1
0·413	Maintenance of mains, including wages of arc lamp trimmer, carbons, small repairs, etc.	262 8 5
	Works cost per unit sold, 3·55d.	
0·583	Proportion of salary of engineer and assistant, salary of clerk, £237. 2s.; stationery, printing, and advertising, £28. 17s. 4d.; general establishment charges—petty cash, office fuel, stamps, etc., £32. 14s. 3d.	298 13 7
0·122	Rent, rates, taxes, and insurance	79 12 2
2·508	Repayment of principal and interest on loans	1,627 8 8
	Lamps, stores, etc.	30 2 9
		£4,339 4 8

Cr. Receipts.	£ s. d.
Sale of current per meter, including launch charging, less discounts and after providing for bad debts	2,172 7 1
Rental of meters and apparatus	81 1 9
Amount for lighting 36 public arc lamps at £20 per annum from January 1, 1896, to December 31, 1896 (inclusive)	720 0 0
Sundry sales	19 10 3
Sundry stores	20 0 0
	3,012 19 1
Deficit balance	1,326 5 7
	£4,339 4 8

UNITS SUPPLIED, 1896.

To private consumers	88,620
To public arc lamps	67,061
Total units sold	155,681

RECEIPTS, 1896.

From private consumers	£2,253 8 10
From public arc lamps	720 0 0
From stores, etc.	39 10 3
	£3,012 19 1

Revenue per unit = 4·644d.

REVENUE SUMMARY FOR 1896.

	£ s. d.
Total works cost	2 711 16 0
Total revenue	3,012 19 1
Deficit on works	—
Profit on works	301 3 1
Repayment of capital and interest	1,627 8 8
Total deficit on the year	£1,236 5 7

ELECTRICITY SUPPLIED, 1896 (excluding public arc lamps).

Quarter ending.	Units.	Electricity and meter rents. £ s. d.
March	24,465	630 19 10
June	11,350	298 8 1
September	14,670	397 12 1
December	38,135	926 8 10
Total	88,620	£2,253 8 10

COMPANIES' MEETINGS AND REPORTS.

CENTRAL LONDON RAILWAY.

The third half-yearly ordinary general meeting of this Company was held yesterday afternoon at Cannon-street Hotel. Mr. Henry Tennant (chairman) presided, and the other directors present were Lord Colville of Culross, K.T., Sir Francis Knollys, K.C.M.G., C.B., the Hon. Algernon Mills, and Lord Rathmore.

The **Chairman** stated that there were 989 shareholders, which was an increase of 215 since last half-year. In moving the adoption of the report he said that tunnelling operations were in full progress, and the sinking of the shafts was to a large extent accomplished. The works for the two tunnels were being carried on in 10 different places, and 15 shields were at work. He congratulated the chairman of the Electric Traction Company (contractors for the line) on the honour of knighthood which had been conferred upon him. The expenditure during the half-year had amounted to £365,228, which, added to the amount previously expended, made a total outlay of £807,326. In view of the payments which would become due on account of the contract during the next few months, a further call on the shareholders of £2 per share, payable on February 1, had been made. In conclusion, the Chairman alluded in sympathetic terms to the death of Mr. J. H. Greathead, the inventor of the Greathead shield, and who was one of the engineers of the railway.

The report was adopted.

Lord Colville of Culross and Lord Rathmore were re-elected directors, and the auditors were also re-elected.

At a subsequent extraordinary general meeting, approval was given to the proposed Bill in Parliament to be intituled "A Bill for conferring further powers on the Central London Railway Company."

The **Chairman** explained that the main object of the Bill was to acquire property on the north side of Oxford-street, very nearly opposite the Davies-street site, and it would involve simply the moving of the station about 66 yards eastward.

WATERLOO AND CITY RAILWAY COMPANY.

The sixth half-yearly meeting of the Waterloo and City Railway Company was held yesterday (Thursday) at Waterloo Station.

The **Chairman** (Mr. Wyndham S. Portal), in moving the adoption of the report, stated that the account for the past half-year showed an expenditure of £67,337, making a total outlay of £280,526 at December 31, 1896. The contracts for the generating station and electric appliances were under consideration, and the works would be completed as soon as possible. Bills had been deposited in Parliament by independent parties for various works (amongst which were the electric railway extensions to Earl's Court and Hammersmith), some of which might affect the Waterloo and City Railway. The directors had to record with extreme regret the death of their engineer, Mr. Greathead, C.E., in whose place they had secured the services of Dr. Alex. B. W. Kennedy, F.R.S.

Sir C. Scott and Mr. William W. Portal were re elected directors, and Mr. F. Hartnell was re-elected auditor. The meeting was then made special for the approval of the South-Western Company's Bill for the session, which was formally adopted.

WILLANS AND ROBINSON, LIMITED.

An extraordinary general meeting of this Company was held last Tuesday at the Cannon-street Hotel, Mr. Mark Robinson in the chair, to consider a resolution authorising the directors to issue, on such terms and conditions as they might determine, the

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unissued balance of the capital of the Company, amounting to 7,500 preference and 7,500 ordinary shares.

The **Chairman**, in proposing the resolution, stated that they had had a good half-year, and they would be able to pay the usual dividend, to which it was still wise to restrict themselves, and to carry a large amount to reserve. If the shareholders could realise the difficulties under which the Company had lately worked they would see how extremely satisfactory this modest forecast really was, and what far-reaching hopes it justified for the near future, when they would have the full use of the spacious shops and the almost perfect appliances which had been provided at Rugby. He then referred at some length to their progress since 1893, the last and busiest year of the old company, when their orders reached 18 900 i.h.p., and stated that in 1896 their orders reached 43 500 h p. If, however, they had taken all the orders that had been offered to them these figures would have been much larger. It was to meet this rapid extension of their business that additional capital was required. Their desire was to raise the producing capacity to 60,000 h.p. They proposed to add 50 per cent. to the capacity of the machine and erecting shops at Rugby and tools to correspond, and to make certain other additions to the plant. This they believed they could do, as well as make a liberal provision for further increase of working capital, by the issue of 9,000 shares—£45,000 out of the remaining £75,000—though they also asked to be relieved of the necessity of coming before the shareholders a second time if or when the necessity occurred for issuing the balance. It was proposed to offer the shares *pro rata* to existing shareholders, and they thought that the market price of the shares pointed to their issuing the preference shares at 6, or £1 premium, and the ordinary shares at 7 or £2 premium. It was proposed to spread the payment over a long period.

Mr. Anderson seconded the motion, which was supported by **Sir Richard Sankey** and **Mr. Willcock**, and carried unanimously.

YORKSHIRE HOUSE-TO-HOUSE ELECTRICITY COMPANY.

The ordinary general meeting of this Company was held on Tuesday at the Great Northern Hotel, Leeds, Mr. Grosvenor Talbot presiding. The other directors present were Mr. G. H. Crowther, Mr. R. W. Eddison, Mr. Robert Hudson, Mr. Samuel Ingham, Mr. A. G. Lupton, and Mr. J. T. Pearson.

The **Chairman**, in moving the adoption of the report, said that the amount of capital expended during the year was £28,851, the larger portion of which (£22,819) had been expended upon the Britannia Mills, which the directors felt would be of enormous value when they had to make use of that place as a station. As a mill it was paying a fair rate of interest. The capital expenditure now stood at £105,377. After deducting £3 000 for depreciation there was a profit for the 12 months of £6,960, and to that had to be added £517 balance from the previous year, making a total of £7,477. At the end of last June the directors declared an interim dividend at the rate of 5 per cent. This absorbed £1,652, leaving £5,825 for disposal now. Of that amount it was proposed to pay a dividend for the half-year at the rate of 7 per cent., making 6 per cent. for the year. For this £2,932 was required, leaving £2,500 for the reserve fund, and carrying £392 to the next account In taking such a course the directors followed out their policy of building up as quickly as possible a substantial depreciation and reserve fund, feeling that the future of the Company depended largely upon what was now laid aside when the machinery was in its best condition. The policy pursued had resulted in a depreciation fund of £4 300 and a reserve fund of £5,000, and considering the youth of the Company he thought there was reason for congratulation that so handsome an arrangement had been made. The total revenue of the past year was £14,757, after deducting rents received from the mill. The revenue of the previous year amounted to £11,431. There was, therefore, the considerable increase of 29 per cent. The expenses of the year, after deducting depreciation, amounted to £5,075. In the previous year the expenses were £4,651, and the increase was thus only 9 per cent During the year 1896 they had sold 701,409 units, as against 524,629 in 1895, an increase of 176,780 units. The number of lamps installed reached a total of 39,396, as compared with 32 539 in December, 1895, an increase of 6,857. A much larger increase might have been shown but for the unfortunate strike in the building trade, which had interfered with the arrangements made to add 1,000 h.p. to the works by September 1 last, and caused the refusal of customers. He trusted they would not be in such a position again. An offer had been made to the Leeds Corporation to light the streets at a far lower price than any other company which might establish itself with that object could offer. They had offered to supply the current from the central station to the end of Boar-lane, and from Leeds Bridge to the dispensary in Briggate, at less than £500 per annum, giving ample light, as well as every security that the light should be continuous and perfect. The directors believed that sum was less than the present cost of the gas, and in the interests of Leeds citizens they hoped something would be done to show that Leeds was progressing in its street arrangements. Further, considerable expense had been incurred in providing low tension through some of the most crowded thoroughfares in order to avoid as far as possible the necessity for cutting off customers. Coming to the question of raising new capital, the Chairman observed that there was at present a very large expenditure going on at the works. Building operations were in progress in order that they might put down new plant and provide necessary offices, workshops, and storerooms, also a house for the fitter. The work was costly, but the greater part of it would not require renewing. The plant needed to be increased by new engines, boilers, dynamos, and other appliances, and they would have to run their mains in all directions round the town. The proposal was to increase the capital from £100,000 to £200,000. It was intended to issue stock for £94,740, and by doing that they would be exactly offering to shareholders one share for each share held, so that they might thereby double their present holdings. This it was intended to do at par. It was just to the shareholders that they should receive everything the Company could fairly bestow on them. The same policy had been adopted on a previous occasion and met with approval, and shareholders would get a handsome bonus in addition to dividends. Not more than one-half of the amount would be called up this year. The remainder would only be called up as capital was required, and probably the calls would not be very fast. He believed the time had arrived when electric lighting property received the confidence of the public. With a wide field, and with care and caution in the conduct of the Company, capital would rapidly have to increase. There were at the present time 120 electric supply stations in England, and there were invested in those companies nine millions of money. Forty-eight of the concerns were in the hands of local authorities, and they had a total capital of £5,750,000. Then there were 25 new stations, either authorised or in course of construction, as well as large additions going on in other directions, enhancing the capital by another million. He thought, therefore, there was good reason for saying that electric stocks had taken their proper place in the markets of the country. In conclusion, the chairman alluded to the efficiency with which the Company were served by their officials.

Mr. S. Ingham seconded the motion, and it was carried.

The proposition to declare the dividend was also adopted, on the motion of the **Chairman**, seconded by **Mr G. E. Crowther.**

Mr. Ingham and Mr. Crowther were re-elected directors, and Alderman Gordon was again appointed auditor.

On the proposition of the **Chairman**, seconded by **Mr. A. G. Lupton**, it was resolved to increase the capital to £200,000 by the creation of 20,000 new shares of £5 each, to rank *pari passu* in all respects with the existing ordinary shares. Mr. Lupton said the directors intended to take up the portion that fell to them.

Replying to a question about the founders' shares, the **Chairman** thought it would be an advantage to the Company if the shareholders could see their way to get rid of these shares. The directors would feel it their duty to seriously consider this question.

A vote of thanks to the chairman concluded the meeting.

LONDON ELECTRICAL CAB COMPANY, LIMITED.

The statutory meeting of this Company was held on Friday last (29th inst.) at Winchester House, E.C., Mr. H. H. Mulliner presiding.

The **Chairman** stated that there was no real business before the meeting. Some persons had been expressing their wonder that a large number of these cabs were not already on the streets of London. It was perhaps hardly necessary to point out that until the Company was formed and the capital received it was quite impossible to order the cabs, and, of course, when ordered it took some time for them to be built. They might no doubt have had one cab ready by this time for the purpose of running trial trips, but personally he was tired of hearing about trial trips with motor carriages. The object of the Board was to see a number of electrical cabs running at the earliest moment on a commercial basis so as to earn a dividend for the shareholders. As far as actually running an electrical carriage was concerned, there was no difficulty about that. Mr. Bersey, whose services they had, and the whole of whose patents they had acquired the use of, had run electrical carriages several years ago which were quite as good even then as any electrical omnibus or other electrical motor carriages which they had seen or heard recently. Since then, and previous to the formation of this Company, Mr. Bersey had wonderfully improved these carriages, and, as referred to in the prospectus, had already attained a great degree of perfection with them. A great deal of time had been taken up in designing the cab, and he believed they had succeeded in producing a perfect and suitable vehicle. After considerable negotiation they had acquired the sole use for the purposes for which this Company was formed of the invention known as the Johnson-Lundell series-parallel controller, on the payment of a royalty per vehicle. After the payment of this royalty the price of the cab would be below the cost at which it could be constructed with any other efficient controller. Suitable premises had been obtained near Westminster Bridge, and he might add that, basing the total rent on the number of cabs which they would hold, it would be a very little over £2 per vehicle per annum. The average rent per vehicle when the stabling for horses was included was, he believed, about £10. A contract for the supply of the requisite current had been signed with the London Electric Supply Corporation on the best terms that it had been possible to obtain. As to the question of the electrical apparatus for transforming the electricity, and for taking off and removing the accumulators, etc, this had all had to be worked out in the same way and tendered for, and was now all on order. On the matter of the accumulators, Mr. Manville had drawn up a complete statement of the various requirements and invited tenders and samples from every maker of repute. These samples were being tested at Faraday House in a perpetual state of vibration, or as near as possible the same conditions they will be subjected to in actual use. Meantime, for the first vehicles, accumulators had to be ordered, and this contract had been placed with the Electric Power Storage Company. He was glad of this, because this company was the oldest, largest, and

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by far the most responsible makers of accumulators in the world; and, further, because they had after some years' experience perfected the Faure-King cell, and with this cell (said the Chairman) nearly all the former defects of accumulators disappear. The Electric Power Storage Company had agreed to guarantee these accumulators at 10 per cent., as stated on the prospectus. The utmost was being done to hurry the delivery of the vehicles, and he expected that in about three months' time they would place some electrical cabs on the streets. Mr. Manville, who was in America, was doing his best to hasten the delivery of certain parts ordered there. He stated that in his opinion electricity was the future motive power for traffic in London, and he confidently believed that the original shareholders in the London Electrical Cab Company would have much to congratulate themselves upon in the future. Referring to the fact that Mr. Bersey had run various electrical carriages, he said that Mr. Bersey had kindly brought one for their inspection, and would be pleased to take some of them for a ride.

Replying to **Mr. Green** and other shareholders, the **Chairman** said that the total amount subscribed by the public was £63,000 and owing to the reasonable manner in which the vendors had acted, the Company was left with about £42,000 as working capital. When success was obtained they would have no difficulty in placing the unissued capital, and not until then would the vendors receive the balance of the agreed purchase price. The first lot of cabs to be put on the streets would number 24, and the others would follow as fast as they could be finished.

NATIONAL ELECTRIC SUPPLY COMPANY, PRESTON.

Directors: E. H. Booth, Esq. (chairman); W. Brown, Esq.; H. Curwen, Esq.; J. Booth, Esq. Engineer: Mr. J. H. Tonge, M.I.E.E. Secretary: Mr. T. Cross.

Report of directors and statement of accounts for the year ending December 31, 1896, to be submitted to the general meeting of shareholders to be held February 10, 1897, at 3.30 p.m.:

The directors, in submitting their report for the year 1896, with accounts as certified by the Company's auditors, are pleased to state that the business shows a steady increase, and that the position of the Company has been considerably strengthened during the past year. The expenditure on capital account now stands at £70,680, a sum of £3,640 having been added during the year. The mains have been extended in Bow-lane, Ribblesdale-place, Upper Walker-street, Meadow-street, Glover street, and Garstang-road. A new feeder main has also been laid from the works to meet the increasing demand in Winckley-square and the neighbourhood. Thirty new arc lamps for public street-lighting have been erected, and the necessary connections made to the mains. The required capital has been raised by the issue of second debentures at 4½ per cent. per annum. The gross profit for the year is £4,025. 7s. 5d., an increase of £1,623. 14s. 4d. over last year. After paying debenture and bank interest, the directors recommend that the balance should be appropriated as follows: interest on debentures and bank interest, £1,115. 17s.; depreciation on machinery, etc., and to provide for bad and doubtful debts, £409. 13s. 11d.; writing off loss on working during 1892 and 1893, £1,000; reduction of preliminary expenses, £174. 17s. 11d.; payment of a dividend, at the rate of 2½ per cent. per annum on the ordinary shares of the Company for the year ending December 31, 1896, £1,324. 18s. 7d.—total, £4,025. 7s. 5d. The plant and machinery have been maintained in a high state of efficiency out of revenue, and are capable of furnishing a much larger output than has yet been required. Mr. Henry Curwen is the director who, in accordance with the articles of association, retires; being eligible, he offers himself for relection. The auditors, Messrs. Thorp and Ainsworth, also retire; being eligible, they offer themselves for re-election.

Dr. General Balance-Sheet.	£	s.	d.
Capital account—amount received	78,735	0	0
Sundry tradesmen and others due on construction of plant and machinery, fuel, stores, etc., to December 31, 1896	1,386	11	6
Sundry creditors on open account	89	13	8
Amount due to bank	2,336	2	0
Depreciation fund	818	11	8
Interest on debentures	386	2	0
Rents, rates, etc., accrued	8	6	8
Net revenue account	1,324	18	7
	£85,085	6	1
Cr.	£	s.	d.
Capital account—amount expended for works	70,680	13	10½
Stores on hand December 31, 1896—general	2,534	6	4
Sundry debtors for current supplied to December 31, 1896 (less allowance for discounts), £2,765. 14s. 7d.; less reserve for bad and doubtful debts, £20	2,745	14	7
Rents, rates, etc, unexpired	74	13	5
Other debtors	24	12	6
Formation expenses*	1,285	13	6
Preliminary expenses	7,729	11	10½
Cash in hand	10	0	0
	£85,085	6	1

* Amount not to be appropriated to the undertaking, being expenses of and incident to the formation of the Company, and of and incident to attempts to obtain provisional orders for other towns.

Dr. Revenue Account, Year ending Dec. 31, 1896.	£	s.	d.	£	s.	d.
Coal or other fuel, including dues carriage, unloading, storing, and all expenses of placing the same on the works	£508	17	10			
Oil, waste, water, and engine-room stores	133	13	5			
Proportion of salaries of engineers, as certified by the engineer	263	11	7			
Wages at generating station	444	11	1			
Repairs and maintenance, as follows: buildings £13. 2s. 10d.; engines, boilers, £115. 10s. 1d.; dynamos, motors, etc., £4. 9s. 8d.; other machinery, instruments, and tools, £17. 0s. 2d.; accumulators, £7. 8s 1d.	157	10	10			
				1,508	4	9
Distribution—Wages	15	0	10			
R and M. mains	48	7	3			
R. and M meters	50	7	9			
				113	15	10
Attending and carbons and repairs				106	2	3
R. and M private arcs and motors				13	4	11
Rents, rates, and taxes				296	3	0
Salaries of managing engineer, secretary, and clerks	363	14	11			
Salaries or commissions of canvassers	53	6	6			
Stationery and printing	50	3	2			
General establishment charges	68	1	11			
Auditors of Company	25	0	0			
Auditor appointed under the provisions of the order	24	13	0			
				584	19	6
Law expenses and compensation				47	5	2
Insurances, etc.	21	7	9			
Wayleaves	0	10	0			
Expenses in connection with raising of capital	31	11	6			
				53	9	3
Total expenditure				2,723	4	8
Balance carried to net revenue				4,025	7	5
				£6,748	12	1
Cr.				£	s.	d.
Sale of current per meter at 7d. per B.T.U.				6,354	13	10
Sale under contract				443	7	3
Public lighting				375	5	10
Current for motive power				531	4	9
				7,704	11	8
Less discounts				1,190	10	1
				£6,514	1	
Rental of meters and other apparatus on consumers' premises				207	13	1
Transfer fees				3	17	6
Profit on private construction and lamp renewals				22	19	11
				£6,748	12	1

Statement of Electricity Generated, Sold, etc.

Quantity generated in B.T. units		349,920
Quantity sold—		
Public lamps	30,749	320,500
Consumers by meter	289 751	
Quantity used on works		12,500
Quantity lost in feeders		13,619
Total quantity accounted for		346,619
Quantity not accounted for		3,301

Number of public lamps: 42 five-ampere arcs, and 18 32-c.p. incandescents.

ST. JAMES'S AND PALL MALL ELECTRIC LIGHT COMPANY, LIMITED.

The annual general meeting of the St. James's and Pall Mall Electric Light Company, Limited, was held on Tuesday last at the Carnaby-street central station, Golden-square, Mr. Eustace J. A. Balfour presiding.

The **Chairman**, in moving the adoption of the report, stated that the net earnings for the past year amounted to £21,369, and the directors proposed to pay a dividend on the ordinary shares of 10½ per cent., as against 7½ per cent. last year and 6½ per cent. the year before. The preference shares, of course, carried their 7 per cent., and on the founders' they proposed a dividend of £36. 17s. 6d., which was at the rate of about 3,600 per cent. During the past year there had been increase in their lamps of 17,017, as compared with an increase of 16,569 in 1895, bringing up the total number of 8-c.p. lamps to 108,803. The output at the stations had increased by about half a million units, as against a quarter of a million in the preceding year, so that it was not only that they had increased the number of lamps, but the lamps which they had gained were earning a large income on the average than their previous lamps. The total cost of production per unit, apart from special charges under the head of depreciation, had been further reduced by 15 per cent. They had completed their alterations in Mason's-yard, and the new plant there had fully answered the expectations of the directors.

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They now had no further complaints of annoyance, such as the old plant gave rise to. The expenditure on capital account for 1896 amounted to, approximately, £9,000. Part of this sum had been expended on new mains and in strengthening and extending the Company's system, while the remainder had been expended in carrying out the necessary work for lighting by electricity the principal streets of the parish of St. James's. The number of public lamps at present erected was 12, and others would be added from day to day. He thought they might congratulate themselves on the results of the past year's working. In his opinion the Company had before it a fairly smooth career, and the prospect of earning reasonable annual profits. He then moved the adoption of the report.

This was seconded by **Mr. Latimer Clark** (vice-chairman), and after a few remarks from **Mr. Neville, General Francis,** and other shareholders, the motion was unanimously agreed to.

NEWCASTLE-UPON-TYNE ELECTRIC SUPPLY COMPANY, LIMITED.

Directors: Alderman T. G. Gibson, J.P. (chairman); Dr. Robt. Spence Watson; Dr. J. T. Merz; Colonel F. F. Sheppee; J. Tennant, Esq.; J. H. Armstrong, Esq.

Report of the directors to be presented to the shareholders at the ninth general meeting of the Company, to be held at the Central Station Hotel, Newcastle, on Thursday, February 11, at 12 noon:

The directors have pleasure in presenting the balance-sheet and profit and loss account for the year ending December 31, 1896, from which it will be seen that the demand for electricity has again improved, the units sold having been 535,953, against 448,832 last year. The expenditure on capital account has been increased during the year by the addition of another complete set of plant and by the extension of mains, including a new line to Byker and Heaton district. This outlay has been met by calling up the unpaid share capital, amounting to £6,800. The total profit, after adding the balance brought forward from last year, is £3,779. 0s. 8d. Out of this the directors have, as proposed in last year's report, written off £700—the balance of capital expenditure suspense account, and have carried the further sum of £1,000 to reserve account, making the entire amount reserved to date out of profits £4,004. 3s. 7d. An interim dividend at the rate of 5 per cent. per annum was paid for the half-year ending June 30, 1896. The directors now recommend the payment of a dividend at the same rate, less income tax, for the half-year ending December 31, 1896. This will absorb £980. 6s. 9d., and leave a balance of £241. 9s. 8d. to be carried forward to next year's accounts. The articles of association have been altered in accordance with the resolution adopted at the extraordinary meeting of shareholders held after last year's ordinary meeting, and the Company's shares are now duly quoted on the local stock exchange. Nearly the whole of the existing share capital has now been issued, and in order to meet the expenditure necessary to provide for the continually increasing demand for electrical energy the directors propose, with the sanction of the Company, to increase the nominal capital from £50,000 to £100,000. This new capital will be issued from time to time as further outlay becomes necessary. A special resolution to sanction this increase will be submitted to the ordinary general meeting in accordance with the Company's articles. The directors venture to think that the time has now arrived when a suitable increase in the amount set aside for their remuneration should receive consideration, and a resolution to this effect will be laid before the shareholders in general meeting. The retiring directors are Mr. T. G. Gibson and Mr. J. H. Armstrong, who are eligible and offer themselves for re-election. The auditor, Mr. T. Harrison, also retires, and is eligible for re-election.

Balance-Sheet.

Capital and Liabilities.	£ s. d.	£ s. d.
Nominal capital—10,000 shares of £5 each		50,000 0 0
Issued and allotted—8,329 shares, fully paid	£41,645 0 0	
850 shares, with £4 per share called up	3,400 0 0	
	45,045 0 0	
Add calls paid in advance	300 0 0	
		45,345 0 0
Five per cent. mortgage debentures		20,000 0 0
Creditors on sundry accounts		15,794 0 6
Reserve account—As at Dec. 31, 1895	2,304 3 7	
Added from 1896 profits	1,700 0 0	
	4,004 3 7	
Less transfers to capital expenditure suspense account	3,004 3 7	
		1,000 0 0
Profit and loss account—Balance as per directors' report of Jan. 7, 1896	183 18 11	
Profit for year to date	3,595 1 9	
	3,779 0 8	
Less transfer to reserve account, £1,700, and interim dividend at 5 per cent. per annum for half-year to June 30, 1896, £857. 4s. 3d.	2,557 4 3	
		1,221 16 5
		£83,360 16 11

Property and Assets.	£ s. d.	£ s. d.
Buildings and plant—As at Dec. 31, 1895	45,071 16 2	
Additions to date	9,345 12 5	
		54,417 8 7
Meters, transformers, etc.—As at Dec. 31, 1895	9,087 2 3	
Additions to date	966 0 1	
		10,053 2 4
Land purchased—As at Dec. 31, 1893	1,639 10 0	
Additions during year	9,358 11 5	
		10,998 1 5
Cost of provisional order as at Dec. 31, 1895		659 14 11
		76,128 7 3
Preliminary and formation expenses, as at Dec. 31, 1894	1,123 0 0	
Preparatory and experimental work, as at Dec. 31, 1894	1,880 10 9	
	3,004 3 7	
Less transfers from reserve account, *per contra*	3,004 3 7	
		0 0 0
Loose plant and tools		478 9 2
Office furniture		115 3 5
Stocks at valuation		2,169 13 11
Debtors on current supply and for work done, etc.		3,632 12 9
Cash at bank and in hand		836 10 5
		£83,360 16 11

Profit and Loss Account, Year ending December 31, 1896.

Dr.	£ s. d.
Station charges—salaries, wages, coal, water, and maintenance	2,963 9 9
Street charges—salaries and maintenance	707 13 3
Rents, rates, taxes, and insurance	364 7 3
Directors' remuneration, £131. 5s.; and office salaries, legal and accountancy charges, stationery, stamps, telegrams, etc., £810. 11s. 5d.	941 16 5
Balance carried down	5,270 6 7
	£10,247 13 3
Special alterations to retaining wall, water-supply system, and adjustment of stocks	241 8 7
Interest—on debentures, £1,000; on purchase-price of land, £258. 11s. 5d.; on calls paid in advance, £134. 4s. 9d.; on deposits, etc., £41. 0s. 1d.	1,433 16 3
Balance carried down	3,595 1 9
	£5,270 6 7

Cr.	£ s. d.
Current supply—Household	8,752 12 4
Public lamps	588 0 0
	9,340 12 4
Apparatus rent	895 15 4
Profit on sale of lamps	6 0 7
Transfer fees	5 5 0
	£10,247 13 3

Balance brought down, being gross profit for year £5,270 6 7

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Oberwesel (Germany).—It is proposed to erect electricity and water works at Oberwesel (Rhein). Proposals from undertakers should be in the hands of the Burgermeister by February 10.

Brussels.—Tenders will be received on the 18th inst. at the Railway Offices, Rue de la Station 38, Arlon, for the construction of an electric generating station building at the Marbehan Station.

Cannes.—Tenders will be received on February 20, at the Mairie at Cannes (Alpes-Maritimes), for the erection of a postal, telegraph, and telephone building. There are five separate contracts.

Bredow (Germany).—The local authority of the commune (gemeinde) of Bredow-a-M. will receive plans, estimates, and offers, up to February 10, for the establishment of an electrical supply works for the commune.

Paris.—Tenders will be received on February 13, at the Tribunal de Commerce, for the electric lighting work in connection with the rebuilding of the Mairie of the 16th Arrondissement, for the Prefect of the Seine.

Hamburg.—The Free City authorities (Finanz Deputation) will receive tenders on February 9 for installing the electric light in the city bakeries. Particulars for three marks (3s.) at the Rathhaus, Hamburg. Local security will be required.

Altona.—The State Railway Authorities will receive tenders on February 20 for the supply during 1897-98 of 179,000 electric lighting carbons, and 4,000 incandescent lamps for continuous and

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alternating current. Particulars for 50pfg. (6d.) from die Königl. Eisenbahn Direktion (Centralbureau), Altona.

Hanover.—Tenders are wanted by the Prussian State Railways for 32,600 telegraph insulators, with and without screwed attachments; 260 tons of wire (not line wire), 2¼ tons of insulated wire, and 1¼ ton of wire rope. Particulars for one mark from the Railway Authorities (Königliche Eisenbahn Direktion), Hanover, Joachimstrasse 7.

Brussels.—Tenders are wanted for a quantity of telegraphic supplies and fittings for the Belgian Government. There are in all 74 lots, many of which, however, are stationery or office requisites. The others include special clockwork, bells, ironwork, lead, tin, glass vessels, porous pots, insulators (five lots), copper for Daniell cells, zincs, various telephonic and telegraphic instruments, retort carbon, manganese dioxide, rubber shoes, etc. Particulars are obtainable at the Brussels Bourse, and tenders are returnable there by February 10.

Wallasey.—The Urban District Council are prepared to receive tenders for the supply and erection of a 200-kilowatt alternator, with engine combined, and for the requisite switchboard extensions. Copies of the specification may be obtained on application to the engineer, Mr. J. H. Crowther, at his office at the Great Float, near Birkenhead, on payment of the sum of £2. 2s, which be returned on receipt of a bona fide tender. Sealed tenders, on the form provided for the purpose, addressed to the Chairman of the Gas and Water Committee, and endorsed "Tender for Steam Alternator, etc.," to be delivered to Mr. W. Danger, clerk to the Council, Public Offices, Egremont, Cheshire, not later than 4 o'clock in the afternoon of Thursday, February 18, 1897. The contractor will be required to enter into a bond with approved sureties for the due performance of the contract.

Fareham.—The Urban District Council require tenders for the following: insulated high-tension twin twisted cables and low-tension concentric cables, earthenware conduits, and laying, including excavation and making good, and sundry house and public lamp connections. Specification and form of tender can be obtained from the consulting engineers, Messrs. Kincaid, Waller, and Manville, of 29, Great George-street, Westminster, S.W., on payment of a fee of £1. 1s., which sum will be returned on receipt of a bona fide tender. A map of Fareham, showing the several streets in which the mains will be laid, can be seen either at the offices of the Urban District Council, Fareham, or at the offices of the engineers, from whom further information can be obtained. The contractor whose tender is accepted must enter into a formal agreement, under seal, with sufficient sureties, for the fulfilment of contract. Sealed tenders, endorsed "Tender for Conduits and Cables," to be sent at or before 4 p.m. on February 15, to Mr. Leonard Warner, clerk, Fareham.

RESULTS OF TENDERS.

London, E.—The Guardians of Mile End Old Town have received the following tenders for lighting their premises by electricity:

Holmes and Co.	£4,316	0	0
Joel and Co.	4,972	0	0
Thames Ironworks	4,926	0	0
A. L. Fyfe	4,137	10	0
J. Richmond and Co	4,400	0	0
Brush Electric Lighting Company	4 329	16	0
Electrical Engineering Company	5,299	0	0
Laing and Co.	5,374	1	0
Sussex Electrical Company	3 456	0	0

BUSINESS NOTES.

Western and Brazilian Telegraph Company.—For the past week the receipts were £2,553.

Dover.—The Town Council have fixed the sites for the eight electric lamps in Biggin street.

Liverpool.—The annual ball of the officials of the Liverpool Telegraph Department was held last week.

The Bristol Trams.—The new line of electric trams from Old Market street to Eastville has just been opened.

Belfast.—The Electric Committee have had under consideration the proposed extension of the electric lighting system.

Ealing.—It was stated at the Urban District Council meeting that the number of 8-c.p. lamps applied for was now 9,718

East Grinstead.—It is proposed to establish telephonic communication with the trunk lines either by way of Tunbridge Wells, Brighton, or London.

Middlesbrough.—The Streets Committee have declared in favour of the application of the Imperial Tramways Company's provisional order being allowed to proceed.

Frensham.—At two of the principal mansions in this neighbourhood the electric light is being introduced—namely, at Pierrepont and at Frensham Place.

A Corporation Chimney.—The Liverpool Corporation have been fined £5 and costs for allowing an excessive quantity of smoke to escape from the chimney of the electric supply works in Oldham-street.

Windermere.—The electric light works were visited a short time ago by the Electricity Committee of the Radcliffe Urban Council, and were received by Mr. Fowkes, the manager to Messrs. Fell and Son.

West India and Panama Telegraph Company.—For the half-month ended January 31 the receipts were £2,465, as against £2,922 for the corresponding period of 1896.

Telegraph Debentures.—Messrs. C. J. Hambro and Son announce the numbers of 100 Great Northern Telegraph Company debentures of 1883, Series B, drawn for repayment on March 1.

Volk's Electric Railway.—The repairs to the line at Brighton having now been completed, the cars have resumed running every five minutes between the Aquarium and Paston-place.

Fareham.—The Urban District Council have received permission from the Local Government Board to borrow the additional sum required for the extension of the electric lighting works.

Fulham.—The Vestry have decided to further investigate the means of producing electrical energy by destruction of dust. A deputation is to be appointed to visit various destructors.

Liverpool.—The electrical engineer has been authorised to carry out the electric lighting of the city hospital north extension at a cost of £317, and of the port sanitary offices at a cost of £22.

Indian Electric Company, Limited.—A Company has been registered under this title, with a capital of £1,000 in £5 shares, to carry on in India or elsewhere the business of an electric light and power company.

Walthamstow.—The chairman of the Urban District Council (Mr. Challis), in a statement as to the work of the Council for the past year, alluded to the fact that a scheme for electric lighting was under consideration.

Price List.—We have received from Messrs. Davies, Kent, and Stewart, manufacturers of electrical accessories, Haddon-street, W., a copy of their calendar and price list, which, being made pocket size, is very handy.

Bournemouth.—The Council have written to the Bournemouth and District Electric Supply Company that they are not prepared at present to entertain the proposal of the company with reference to the sale of the undertaking.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended January 31 amounted to £1,227, as compared with £1,044 in the corresponding week of the previous year, being an increase of £183.

The Lighting of Aberdeen Quays.—The Town Council have, on the recommendation of the Watching, Lighting, and Fires Committee, agreed to contribute £250 per annum towards the cost of lighting the quays by electricity.

Ilford.—A letter was read at the Urban District Council meeting from the Ratepayers' Association asking the Council to take steps to have the town lighted by electricity. The matter will be considered at the next meeting.

Bristol Tramways and Carriage Company, Limited.—The traffic returns for the week ended January 29 were £1,738. 3s. 6d., compared with £1,741. 13s. 8d. for the corresponding period of last year, being a decrease of £3. 10s. 2d.

Monmouth.—The Council, at their last meeting, accepted the sureties of Messrs. Johnson Bros. Hereford, for £2,500 for carrying out their portion of the drainage and electric lighting scheme, and the seal of the Council was affixed to the contract.

Portsmouth.—The minutes having reference to the constitution of the Tramways Committee have been rescinded, and a full committee elected by the Council in accordance with standing orders—viz., three aldermen and 14 councillors, one from each ward.

Tunbridge Wells.—The Lighting Committee report that the total estimates for the electric light stations, cables, lamps, etc., will be £1,500 for the next 12 months, and power is to be sought from the Local Government Board to borrow another £15,000 for the extension.

Waterloo and City Railway.—The directors of the Waterloo and City Railway Company, in their report for the past half-year, state that the accounts show an expenditure of £67,337, making the total outlay £280,526. The fourth call of £2 per share was payable on February 1.

Cirencester.—A letter was read at the Urban District Council meeting from Messrs. Eastlakes, Limited, electrical engineers, of Westminster, asking for facilities for the establishment of an electric lighting station in Cirencester. The matter was referred to the General Purposes Committee.

City and South London Railway.—The returns for the week ended January 30 were £1,101, compared with £991 for the corresponding period of last year, being an increase of £110. The total receipts for the half-year 1897 were £5,489, compared with £5,026 last year, being an increase of £463.

The Houses of Parliament.—Provision is made in the Estimates for the expenditure of £150 for extending to the dining-room and library the scheme of telegraphic communication which has worked so well in the smoking room, and £1,000 for the further extension of the electric lighting of both Houses.

West Hartlepool.—A committee of the Corporation, headed by the Mayor (Councillor J. F. Wilson), are visiting Leeds, Bradford, Huddersfield, Halifax, and Manchester in order to inspect the electric lighting in operation at those places with the view of adopting it for public lighting at West Hartlepool.

Dudley.—The town clerk, in reference to the application of the Council for powers to supply the borough with electricity for lighting and other purposes, has reported to the Gas Committee that the parliamentary agents have attended the Board of Trade and proved compliance with the Electric Lighting and other Acts.

Acton.—The deputation appointed by the Parish Council to lay before the Weaver Trustees the scheme under which it is proposed

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to utilise the waste power of the Dutton sluices to supply Acton and district with electricity, have waited upon Mr. J. A. Saner (the engineer), who promised to again submit the matter to the trust.

Great Horseless Carriage Company.—*The Road* announces that, owing to the statements concerning the promotion of the Great Horseless Carriage Company, Limited, which have recently appeared in that journal the Earl of Winchilsea and Nottingham has expressed his intention to resign the chairmanship of the company.

London Lighting Extensions.—The London County Council have given sanction to notices of extensions from the Notting Hill Electric Lighting Company, the Vestry of St. Pancras, the St. James's and Pall Mall Electric Light Company, and the County of London and Brush Provincial Electric Lighting Company.

Glasgow.—At a meeting of joint sub-committees (watching and lighting and gas and electric lighting of streets), it was unanimously agreed that all the existing electric lamps in the city should take the form of pendant globes similar to those recently erected at Charing Cross, where the illumination has been greatly improved.

Westminster Electric Supply Corporation, Limited.—The Board of the Westminster Electric Supply Corporation, Limited, give notice that, subject to audit, they will recommend the payment of a dividend for the past half-year at the rate of 12 per cent. per annum, making with the interim dividend already paid 9 per cent. for the year 1896.

Bilston.—The District Council have passed the following resolution: "That the Council oppose in the present session of Parliament the Birmingham, Wolverhampton, and District Tramways Bill, and that the clerk and his parliamentary agents lodge a petition against the Bill, and do such acts in relation thereto as the General Purposes Committee shall authorise."

Catalogue.—Messrs. Cox-Walkers, manufacturers, contractors, and engineers, send us their catalogue of electric apparatus, which includes telephones, transmitters, receivers, bells, fire-alarms, electric motors, motor bells, mining and signalling bells and apparatus, and other things too numerous to mention. The catalogue is profusely illustrated and full of details.

Manchester.—The Corporation have resolved to apply to the Local Government Board for power to borrow £130,000 for the extension of the electric light mains, for engines, dynamos, and boilers, and for some structural alterations at Dickinson-street station. The salary of Mr. Wordingham, the electrical engineer, is to be increased by £100 each year for the next four years.

Durham.—The county surveyor, Mr. W. Crozier, reported at the County Council meeting that the Hartlepool Electric Tramways Company, Limited, were applying to the Light Railways Commissioners for an order authorising them to construct light railways in the borough of West Hartlepool, none of which, however, affected county property. The report was adopted.

Folkestone.—The Corporation have passed the following resolution: "That the draft agreement with Mr. Hopkins as revised be approved, and that the Corporation be recommended to affix the seal of the borough thereto, and to direct that the necessary steps be taken with regard to the publication of the same and the submission to the Board of Trade for approval."

Croydon.—It was reported at the meeting of the County Borough Council that the Local Government Board had sanctioned the borrowing of an additional £9,900 for electric lighting purposes, repayable in 25 years. On Sunday the parish church was lighted for the first time by electricity. The cost of the installation has been defrayed by Sir Frederick Edridge, J.P., the deputy mayor.

Stockton.—The Town Council have approved the proposal of the Imperial Tramways Company to establish a system of electric trams on the overhead trolley system subject to certain amendments which had made in the company's proposals. The proposed new system will extend from Middlesbrough and through Thornaby and Stockton to Norton, over a distance of some seven or eight miles.

Cardiff.—At a meeting of the Electrical and Lighting Committee it was decided that a small sub-committee should be appointed to consider the question of taking into the committee's own hands the collection of the electric lighting rents. Mr. Applebee (electrical engineer) reported that those collections now amounted to £5,700 per annum, and clerical assistance in the office was also needed.

Limavady.—A Local Government Board enquiry has been held into a petition of the Commissioners for extended powers affecting the markets and the cleansing of streets. Mr. J. E. Ritten, J.P., and a guardian of the union, said he would sooner see the roads in the hands of the Town Commissioners, as the urban sanitary authority, as he intended this year to apply for a provisional order to lay down electric light in the town.

Teignmouth.—Mr. Denny moved at the Town Council meeting that the surveyor obtain all available information on the subject of electric lighting of the streets. He said that the £900 which they expended in lighting their district would go to provide interest at 4 per cent. on £22,000, and they would not want a third of that to light the streets by electricity. They would also avoid the necessity of enlarging the gasworks.

Llanelly.—Mr. C. J. Howell is still trying hard to get the town lighted by electricity, and has been showing the members of the Chamber of Commerce what has been done in Dock-road and also in the Bungalow. He impressed on them the fact that to light the whole town would only mean an extra expenditure of £80 per year, and finally promised to read a paper on "Electricity" at the next meeting of the Chamber of Commerce, when the whole question will be discussed.

Carlisle.—At a meeting of the General Purposes Committee a resolution was passed that the installation of electric light under the last order obtained by the Corporation for the purpose be proceeded with with all convenient speed in order that the light may be inaugurated next autumn. The order defines a small compulsory area, but it provides that, should it be found desirable, the whole of the city may be supplied.

Sheffield.—The report of the deputation appointed to enquire into the best method of tramway traction has been published. At a meeting of the Tramways Committee the recommendations of the deputation were approved. The system to be adopted is the overhead electric, and a beginning is to be made on the Attercliffe and Nether Edge routes. Fitzalan square is to be the centre of the system, with tramlines along High-street and Fargate.

London County Council.—The Council at the last meeting agreed to lend the Battersea Vestry £2,940 for lighting the vestry hall and offices by electricity. The Highways Committee recommended that they should be allowed to submit to the Board of Trade a clause for the protection of the Council's tramways in the matter of laying electric lighting mains, and to ask that such clause be inserted in all electric lighting orders which might be granted in this and future years. This was agreed to.

Copper.—Again the copper statistics show a reduction in the visible stocks of the metal. The January deliveries for consumption were 18,307 tons, and the supplies were only 15,687 tons, so that during the month the diminution in the stock has been 2,620 tons. The reduction in the last fortnight was 1,096 tons. Of the total supplies of 15,687 tons, no less than 12,495 tons came from North America, this enormous import from the other side of the Atlantic beating all records. Only 541 tons came from Spain and Portugal.

The Armstrong-Whitworth Amalgamation.—At a meeting of the shareholders of Sir W. G. Armstrong, Mitchell, and Co., Limited, a resolution was passed to increase the capital to £4,210,000, in view of the amalgamation with Sir Joseph Whitworth and Co., Limited, by the creation of 210,000 new ordinary shares of £1 each. Another resolution provided that the name of the new company should be Sir W. G. Armstrong, Whitworth, and Co, Limited, and a third resolution provided for the provisional reconstitution of the directorate.

Lancaster.—The Electricity Committee of the Town Council have received a letter from the Electric Lighting Extension Syndicate Company, Limited, enclosing draft of an agreement they suggest the Corporation should enter into with them, whereby they would inaugurate a system of "penny-in-the slot" electricity meters for the supply of electricity to premises not already supplied by the Corporation. A sub-committee has been appointed to meet a representative of the company, with a view of obtaining further information on the subject.

Coseley.—At a special meeting of the District Council, Mr. J. Smith, clerk, reported the result of a conference between Mr. Sellon and a committee of the Council with reference to the provisions of the Birmingham and Wolverhampton Tramways Bill. Various suggestions were made in the interests of the district, some of which, he believed, would be conceded, but others would be considered by the directors, whose decision would shortly be communicated to the Council. It was resolved to oppose the Bill for the purpose of getting it amended in certain particulars.

Halifax.—A long discussion took place at the Town Council meeting with respect to the decision of the Gas and Electricity Lighting Committee to purchase another engine and dynamo at a cost of £3,610. It was stated that the increase in the number of lights required made the outlay necessary, and in reply to questions it was admitted that the electric lighting system was being carried on at a loss. Alderman Woodhead said that this was their second year, and he believed that by the end of the third year they would have turned the corner. The minute was confirmed.

Portobello.—The Cleaning and Lighting Committee of the Edinburgh Town Council have appointed a sub-committee to meet a sub committee appointed by the Electric Lighting Committee on the subject of supplying electric to Portobello. At a subsequent stage of the meeting, on the motion of the convener, another sub-committee was appointed to consider the subject of the extension of the electric light to other thoroughfares of the city, with the view of resolving on a definite policy to enable the committee to fix the sum required for expenditure for the year from May 15 next.

Bromley.—A letter was read at the Rural District Council meeting from Mr. E. Charrington, on behalf of the Chislehurst Electric Lighting Syndicate, asking for a list of the roads within the ecclesiastical parish of Chislehurst, not repairable by the parish, in order that the list might be included in the order from the Board of Trade. Other information was also asked for. The Clerk asked if the Council were prepared to take the responsibility of preparing a list of public roads of that kind. The Chairman was of opinion that the syndicate should obtain the information themselves.

Birmingham.—At the City Council meeting a resolution was passed authorising the Public Works Committee to take such measures with regard to the City of Birmingham Tramways Bill, 1897, the Birmingham, Wolverhampton, and District Tramways Bill, 1897, and the Great Western Railway Bill, 1897, as they might deem necessary. The Public Works Committee, in reorganising the City Surveyor's Department, have formed a new department, called the mechanical and electrical department,

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which will have charge of works connected with the tramways, electric lighting, etc.

Sunderland.—The committee in charge of the electric lighting system have prepared an estimate of the expenditure for the half-year ending September 30, 1897, as follows: rent of station, £64. 8s. 7d.; rates and taxes, £68. 15s.; salaries—engineer's, £150; assistant engineer's, £60; clerk and collector, £39; firemen and others, £328. 5s.; coal, £129. 3s. 4d.; stores, etc, £51. 13s. 4d.; printing and stationery, £20; establishment charges, £45; repairs to machinery, £25; of the battery, £45; of mains, £40—total, £1,066. 5s. 3d. To meet this the estimated revenue is £1,053. 7s. 4d., leaving an estimated deficit on the half-year's working of £12. 17s. 11d.

Colchester.—The Electric Light Works Committee reported at the Town Council meeting that they had considered letters from the Electric Construction Company. The company offered to work the electric plant for two years, and on receiving the payments for current to pay the Corporation £800 per annum to cover interest on capital and sinking fund. The committee recommended the acceptance of these terms, and as an alternative placed before the Council the tender for £10,940 six months after completion of the works, in lieu of £10,675 by payments of 80 per cent. on completion and 20 per cent. after the expiration of six montht. The report was adopted.

The Overhead Trolley.—With a view to reduce overhead trolley construction to a minimum, a system of single-wire distribution for electric tramcars has been invented by Mr. J. C. Henry, of Colorado. For a double track a single overhead conductor is provided, the wire being supported by span wires carried in a zigzag from pole to pole, the poles being placed alternately on opposite sides of the street. The conductor is vertically over the space between the tracks, and each car carries on its roof a slider-bar, which makes a scraping contact with the side of the conductor. Cars moving in opposite directions make contact with opposite sides of the conductor.

Leicester.—Alderman Lennard stated at the Town Council meeting that for the last half-year the output in the electric light department had been 147,421 units, which was considerably more than double the amount for the same period of 1895. In the second half of 1895 the amount was 66,916 units, and in the first half of 1896 it was 90,786 units, while the number of consumers had increased from 157 to 251. The committee had decided to reduce the price of the light, and from January 1 the price had been 5d. instead of 6d. The balance-sheet had not yet been got out, but he believed it would be found they had made a profit in 1896—at any rate, if there had not been a profit the loss would be infinitesimal.

Electricity in Sawmills.—The first sawmill operated by electric power in the United States, and probably in the world, is said to be that of the American River Land and Lumber Company, which is located close to the power-house at Folsom, Cal., of the Folsom-Sacramento Power Transmission. This was started successfully last December, and is cutting 50,000ft. of lumber per day. The current is three-phase, taken from the power-house at Folsom, and the motors are all of the induction type, the installation having been made by the General Electric Company. The motors employed are one of 75 h.p., one of 50 h.p., both running at 720 volts, three of 30 h.p., and one of 5 h.p., operating at 200 volts.

Lights at Sea.—A commission appointed to study the visibility of lights at sea has concluded, by means of numerous experiments, that a white light of 1 c.p. is visible at a distance of 2,800 yards on a clear night, and at a distance of one mile only on a rainy day. It was further found that when a white light of 1 c.p. was visible at a distance of one mile, one of 3 c.p. was visible at two miles, of 10 c.p. at four miles, and of 19 c.p. at five miles. A green light of 1 c.p. is visible at 0·8 of a mile, and the lighting powers of such lights, to be seen at distances of one, two, three, and four miles, must be 2, 15, 51, and 106 c.p. respectively. The best glass is a clear blue-green, whilst for the red light a copper red is, it is stated, the best colour.

Bolton.—At the meeting of the Gas Committee the proceedings of the Electricity Sub-Committee were approved. The position of the Corporation in respect of their contract for maintenance of the accumulators at the electricity works was reported, together with the recommendation of the town clerk as to further action on the matter. The engineer was directed to adopt means to place the accumulators in the condition they ought to be in pursuance to the contract with the Crompton-Howell Company, and a communication was ordered to be made to the contractors stating that the above course is being pursued, and that proceedings will be instituted for the recovery of damages sustained by the Corporation through breach of contract. It was resolved that an electric cable be laid along Park-road from Chorley New-road to the Chadwick Museum.

National Telephone Company.—The directors have resolved, subject to final audit, to recommend at the forthcoming general meeting of shareholders the following dividends for the half-year ended December 31 last: at the rate of 6 per cent. per annum, less income tax, on the amounts paid up on the first and second preference shares; at the rate of 5 per cent. per annum, less income tax, on the amounts paid up on the third preference shares; and at the rate of 6 per cent. per annum, free of income tax, on the amounts paid up on the ordinary shares; carrying £35,000 to reserve and about £6,000 forward. The transfer books in respect of the preference and ordinary shares will be closed as from 5th to 18th inst., both days inclusive, preparatory to the payment of the dividend for the half-year ended December 31. The dividend warrants will be posted on 18th inst.

Wrexham.—The Lighting Committee reported at the Town Council meeting with regard to the electric lighting order that they had received a letter from the Office of Woods requesting the Corporation to have a specified saving clause inserted in the order, and stating that it was the clause usually adopted in parliamentary Bills and orders in similar cases where Crown property might be affected. Two copies of the order when so amended were to be sent to the Commissioner for his consent (so far as Crown property under his management was concerned), to be endorsed thereon in the usual way. It was decided that, subject to the advice of parliamentary agents, to whom the town clerk had sent a copy of the letter and proposed clause, no objection be raised.

Proposed City and West-end Railway.—The engineers to the scheme for the construction of a new underground railway from Bridge-road, Hammersmith, to Cannon-street have prepared for the information of Parliament a detailed estimate of the cost of constructing this railway as proposed by the City and West-end Railway Bill of the present session. The length of the line will be six miles five furlongs seven chains, and the total cost is estimated at £2,880,214, of which the acquisition of the necessary lands and buildings is estimated to absorb £957,000, and the erection of stations £330,000 The railway is proposed to be constructed in separate tunnels for up and down traffic, at a depth of not less than 20ft from the extreme top of either tunnels. The share capital is £3 150,000, with power to borrow on mortgage for equipment purposes a further sum of £1,050 000.

Holborn.—A petition was read at the meeting of the Board of Works from the India and Joint Docks Committee, and other large ratepayers in the neighbourhood, in opposition to the Bill of the North Metropolitan Tramway Company, asking for powers, amongst others, to lay down tramways in St. John street, running to the dead meat market, and to move the cars by animal, electrical, or steam power. They submitted that there were several reasons for strenuously objecting to the proposal. In the first place, the street was not suitable for tramway lines, and in the next place they were not required in the locality, and would not serve any public good. If tramways were laid down in the street, they would interfere with access to the premises of petitioners. The Works Committee recommended that the clerk be directed to take initial steps to oppose the Bill of the North Metropolitan Tramway Company seeking powers to lay down tramway lines in St. John-street and Rosebery-avenue. The report was adopted.

Chelmsford.—The Lighting Committee reported at the Town Council meeting that Messrs Crompton and Co's account for the public lighting of the town by electricity for the quarter ending December 25 was £252. 2s. 6d. The committee had deducted 10s 10d. for fines for lamps which had not been lighted, and they recommended the payment of the balance. This was agreed to. Councillor Maskell asked the town clerk whether he had considered the point he (Mr. Maskell) previously raised as to whether the Town Council had any control over the Chelmsford Electric Lighting Company as regarded their private lighting? The Clerk replied that if the Council thought fit they could appoint an inspector to ascertain if the proper energy were being applied, etc., or if the Council did not appoint one, any private person could apply to the Board of Trade, and they would appoint an inspector. Councillor Maskell moved that this question should be considered by the Lighting Committee, and this was agreed to.

Hull.—At a meeting of the Corporation Electric Lighting Committee, Mr. Milner, borough treasurer, reported that for the year ending December 31 the gross revenue from the Electric Lighting Committee was £4,821, giving a net profit of £1,970. This compared with a gross revenue in the preceding year of £3,627. 3s., and a net profit of £563. 0s. 4d. The Chairman said this was very satisfactory, considering that in 1895 they had six months at 6d. per unit, and in 1896 they had the whole of the year at 5½d. per unit. Mr. Barnard (electrical engineer) stated that there had been a reduction in the working expenses of one third of a penny per unit. He estimated that next year the total income on 420,000 units at 5½d. would amount to £9,625; meter rents, £342; pupil's premium, £30; making a total of £9,997. On the other side it was estimated that the cost of generation would be £2,725; repairs and maintenance, £1 000; management expenses, £850; rents, rates, and taxes, £150; interest on capital, £1 374; sinking fund payments, £1,467; insurance, £250; balance (being profit), £2,181.

Wallasey.—The supply of electric light for the district was inaugurated last week, when the electrical station in Seaview-road, Liscard, was formally opened in the presence of many members of the Urban District Council and others. The new electric light works adjoin the water pumping station, and the District Council have economised the mechanical power in their possession so that the existing machinery can be utilised for providing the supply of electricity to the district. The scheme was suggested by Mr. J. H. Crowther, the engineer and manager of the Council's gasworks, and it has been carried through at a cost of little over £10,000. Already the applications for electric light are more than can be supplied, and the plant will have to be considerably augmented at no distant date. The ferry stages and public offices had been lighted for several days. The contractors for the work at the new station were: for engines, alternators, and switchboard, Messrs. S. Z. de Ferranti, Limited, Hollinwood and London; for cables, Messrs. the British Insulated Wire Company, Limited, Prescot; and for buildings, Mr. John Gourley, Liscard and Liverpool.

Brighton.—The General Purposes Committee of the Town Council have appointed a sub-committee consisting of the Mayor, the Chairman (Alderman Betting), Aldermen Moon and Reeves,

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and Councillors Tester and Titcomb, to consider and report as to the best and most economical means of insuring the Corporation and other public bodies in the borough against loss from damage by fire in any of the buildings and premises belonging to them. An important report has been prepared by the Corporation electrical engineer (Mr. Arthur Wright). He refers to the great development of electric lighting in Brighton, anticipates further considerable use of the light, and strongly recommends a reduction of the charge per unit after the first hour from 3d. to 1½d. He points out that this alteration will greatly benefit the ratepayers at large by reducing the cost of public street-lighting, and states that a tariff of 1½d. after the first hour will make electricity, if it be used regularly, as economical for power purposes or for cooking as the average gas-engine or stove. His report contained other forcible arguments in favour of the reduced price, and the Lighting Committee have adopted his proposals, and made the necessary recommendation to the Town Council. An electricity main is to be laid in Rugby-road.

Liverpool and the Tramways.—At the meeting of the Health Committee of the City Council the Chairman said his attention had been called to a report of the annual meeting of the Liverpool United Tramways and Omnibus Company, and to certain observations made by the chairman of the company at that meeting relating to the disputes which had been pending for some considerable time past between the company and the Corporation. Inasmuch as these disputes were about to form the subject of an enquiry before an arbitrator to be appointed by the Board of Trade, and might therefore be considered *sub judice*, he did not think it would be at all right and proper for him, any more than it was right and proper for the chairman of the tramways company, to refer to these matters. He might say, however, that the Corporation had joined the company in an application to the Board of Trade to appoint an arbitrator, and had asked that the arbitrator should deal with the claims which the Corporation had against the company for injury to their lines by the negligent and untenantly use thereof and by reason of the non-observance of other obligations imposed upon the company. Beyond saying this, he did not think it would be desirable or proper at present for him, or that committee, to make any further reference to this matter in public.

The Lighting of the City.—At the meeting of the Court of Common Council Mr. Brooke Hitching asked the chairman of the Commission of Sewers: (1) If the contract between the Commission and the City of London Electric Lighting Company for the full lighting of the City was yet completed; if not, when it probably would be completed. (2) Whether the Commission was precluded from purchasing absolutely the company's undertaking only 21 years after the completion of the contract. (3) Whether the Commission would raise any objection to the granting of a provisional order by the Board of Trade to a rival undertaking, the price of the current in the City being the highest charged in the county of London for private lighting, and which might be reduced from 8d. to 5d. per unit, as in the case of St. Pancras, by healthy competition. Mr. Turner said the answer to the second question was "Yes," and the answer to the first was that the contract was complete. As to the question of the 21 years, the contract was not complete, as the lighting of the minor streets had not been decided upon, and the 21 years would not commence to run until it was. With regard to the third question, the Commission, so far as it had the power, had given exclusive right to the company to open the streets of the City.

Bristol.—The Parliamentary Bills Committee have prepared the following report on the Bristol Tramway Bill: "This Bill proposes to authorise the Bristol Tramways and Carriage Company, Limited, to construct tramways outside the city, but in extension of their tramways within the city. The Bill generally provides for carrying out most of the agreement of February 19, 1896, between the Corporation and the stipulations of the company with reference to the proposed extension of the Stapleton-road tramways to Fishponds, but it does not make the construction of this extension as far as Station-road, near Fishponds railway station, obligatory on the company, and it would appear that some of the powers sought for laying down double or interlacing lines might apply to tramways in the city as well as to the proposed extensions. The Bill also proposes to authorise the company to purchase lands for the purpose of their undertaking for the erection of stations, works, etc.; but your committee consider that a provision similar to that contained in previous orders, prohibiting the company from constructing or holding stations for generating electricity within the city, should be inserted in the Bill; and your committee recommend that, unless provisions are agreed to by the company, and introduced into the Bill, which will give full effect to the agreement and protect the interests of the city in the manner indicated, the Bill be opposed by the Corporation; and that the arrangement of such provisions and the conduct of such opposition be entrusted to the Sanitary Committee, who have hitherto conducted all negotiations with the company."

Waterloo.—At a meeting of the Health Committee, Councillor Watts's notice of motion suggesting that the tramway company should be invited to extend their line through Waterloo to Crosby was considered, and it was decided to postpone the matter in view of the possibility of the introduction of mechanical haulage. The minutes were approved at the meeting of the District Council. At a later stage of the meeting a letter was read from Mr. Arthur Hill Holme, writing as chairman of the Liverpool District Lighting Company, to the effect that the company would be willing to undertake the construction and working of an electric railway from Seaforth to Waterloo and Crosby if they could be assured of the support of the local authorities at Waterloo and Crosby. They proposed cars driven on a single line by accumulators in the body of the car with electricity generated in the present station at Waterloo. It was also suggested that arrangements by local authorities for electric lighting might be associated with arrangements for the electric traction. Another letter was read from the Simplex Electric Tramway Conduit Syndicate drawing attention to their method of traction. Councillor Killey moved that the letters be referred to a committee consisting of the chairman of the Council and Councillors Bremner, Bezant, Bingham, Colton, German, and Owen, who would be representative of each ward in the urban district. Councillor Broadbridge seconded, and suggested that a stipulation should be penny stages in the fares. Councillor Watts moved an amendment, which was seconded by Councillor Peters, that the matter be referred to a committee consisting of the whole Council. During an irregular discussion which followed, Council Colton expressed his objection to any tramway passing through the district. On a vote being taken, seven votes were recorded against the amendment, and seven for, the chairman giving a casting vote against the amendment. The same voting was repeated on the original motion. Councillor Colson did not vote.

Clontarf.—Some correspondence was read at the meeting of the Township Commissioners in relation to the proposed electric tram service from the terminus at Dollymount to Annesley Bridge. Mr. William Crawford said the Commissioners should accept £150 per annum for wayleave in addition to the sum at present payable—£100. He proposed: "That, having considered the proposal of the United Tramways Company, the Commissioners would be prepared to enter into agreement with the company upon the following conditions: (1) that the tramway company pay the Commissioners the sum of £1,000 for the purpose of improving the road between Clontarf and Dollymount; (2) that the tramway company pay as wayleave £150 per annum, in addition to the sum of £100 at present payable as a guarantee for the maintenance of the sea-wall; (3) that the preliminary costs, together with the costs of the agreement now about to be entered into, be repaid, credit being given for the sum of £105 already paid by the tramways company on account of such cost; (4) that the usual protective clauses be inserted in the agreement, and on the execution thereof the company be at liberty to proceed with the erection of the usual electrical overhead apparatus." Mr. Whyte seconded the motion. The Chairman considered that £100 a year would be sufficient to charge the tramway company for wayleave. Mr. Bonass proposed as an amendment: "That this Board oppose the tramway company's Bill in Parliament next session in relation to the Howth line, unless they are prepared to pay £180 per annum per mile for wayleave, instead of the £100 per year at present paid by them, and that this Board do not adopt the resolution proposed to-day, as no notice of motion has been given of same." Mr. Healy seconded the amendment. Several Commissioners stated that there was no necessity for a notice of motion in the matter, as it had been before the Board for a long time past. The amendment was then put, but only the proposer and seconder voted for it. The original motion was then adopted by the majority of the Board, a clause being added that the above charges would be subject to revision at the end of 10 years.

Brentford.—At the meeting of the Middlesex County Council the Asylums Committee reported that the lighting of the new annexe for idiots and imbeciles, together with portions of the present asylum, with the electric light had lately engaged the attention of the committee. The question had arisen in part owing to the large annual expenditure for painting and redecorating the wards of the asylum caused by the use of gas as an illuminant, also to the inconvenience occasioned in the everyday working of the asylum while these operations were going on, to say nothing of hygienic considerations. Experts had been consulted, and it was reported to them that the consumption of gas in the asylum during the past year amounted to 7,648,200 cubic feet, which at 2s. 4d. per 1,000 cost £892. 5s. 10d. This amount would be very largely increased should gas be the illuminant in the new annexe. The largest quantity consumed on any one day was 46,300 cubic feet, and the lowest 7,300. Where the conditions were favourable (and here the conditions were most favourable) for producing the electric current, the cost per Board of Trade unit would not exceed 2d. (which amount includes interest and repayment of loan), and is about equal to 1s. 6d. per 1,000 cubic feet of gas. The boiler power already provided by the Council for heating and other purposes would be utilised in generating the electric current for 750 lights, which was all the committee proposed to erect for the present, and no addition whatever need be made to the present engineering staff. No more favourable opportunity was ever likely to occur for carrying out this work, and the committee submitted it to the consideration of the Council for adoption, at a total cost not exceeding £5,000, and, further, that they be authorised to carry out the work. The report was agreed to.

Edinburgh.—At the meeting of the Town Council a letter was submitted from Messrs. Davidson and Syme, W.S., on behalf of the National Telephone Company, calling attention to a letter they had sent to the Town Council some months ago asking authority to lay their wires underground. To that communication they wrote they had not received a reply. In course of a statement as to the disadvantages under which the company were working, it was pointed out that in the early days of telephoning the subscription was £20, but with the withdrawal of the restriction by the Post Office, the cheapening of the service, and the increase of subscribers, they were unable to maintain the service in a satisfactory manner from reasons over which they had no control. At

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present Edinburgh had only the single-wire system, satisfactory enough for a small exchange, but not for a large city, and the inconveniences arising therefrom had been intensified by the electric currents in the Corporation mains. The only way out of the difficulties was to provide a "twin-wire" system (giving every subscriber two wires instead of one), which would obviate all the cross-talk and inductive noises; at the same time more powerful instruments could be used, not only considerably improving the local speaking, but making conversation over long trunk lines perfectly clear and distinct. On the single-wire system such powerful instruments only made matters worse. To double the overhead system would cause great inconvenience, and greatly mar the beauty of the city. As regards placing the wires underground, it was not anticipated that any serious difficulty would be experienced. It was not necessary that they should be laid in main thoroughfares, and the company were anxious that the wishes of the Town Council should be considered and given effect to. The work of opening the streets could be done either by the company, under the supervision of the burgh engineer, or by a contractor engaged by the Council themselves. In either case, of course, it would be at the cost of the company, and they would, in addition, be willing to pay a reasonable annual rent for wayleave. In conclusion, they expressed readiness to wait upon the Council, along with the engineers and officials of the company, to discuss the matter, and afford further explanation. The letter was remitted to the Lord Provost's Committee.

The Post Office and Overhead Wires.—The Brighton Town Council have at last received the award of the borough stipendiary magistrate on the appeal made to him to determine the dispute that had arisen between the Council and the Post Office Department respecting the desire of the Department to erect overhead wires for a trunk telephone system along a route of which the Council disapproved. The award has been given against the Corporation, who have decided to appeal against it; this appeal is to the Railway Commission. As the telephone system is being expanded by the Department in all directions throughout the kingdom, the difference that had occurred at Brighton involves some points of considerable interest elsewhere than in the borough itself, for the main issue amounted really to whether the Postal Department is entitled to overrule the wishes of the community as expressed by their proper representatives. In this particular case the Corporation had endeavoured to arrange a compromise. They first objected to the erection of any overhead wires within the borough boundary, but afterwards offered to permit the Department to do as it wished, subject to the conditions, first, that no poles should be placed on the highway where there are buildings on both sides of the road, and, secondly, that any poles erected on other parts of the highway should be removed at the instance of the Corporation whenever in their opinion the erection of houses by the side of the road rendered their removal necessary—the general contention of the Corporation being such overhead wires were a nuisance, and would be detrimental to the residential property, which there was every reason to believe would sooner or later be erected along the route selected by the Department—namely, the main road from Ditchling into Brighton. Otherwise they held that the wires ought to be put underground. The magistrate has dismissed these contentions, partly, it seems, because the wires would not make the road worse off than other parts of the town; "though," he writes, "the inhabitants of other parts of Brighton are not subjected to the annoyance of telephone or telegraph posts, yet their streets are lined with electric lighting posts, and a network of wires is over their heads, though not suspended from posts standing in the streets." As to the alternative routes suggested by the Corporation, he holds them to be inconvenient to the Department. He gives his consent on condition that all wires shall be of copper, and all posts of iron, that no wire shall be hung at a less height than 30ft. above the road, that the posts shall be placed not less than 60, nor more than 80, yards apart, and that the posts shall be placed after consultation with the borough surveyor, and as far as possible in such places as he may desire.

Aberdeen.—Councillors Wilkie and Gray, who were appointed to visit London in connection with the question of motorcars, have prepared a report, which came before the Links and Parks Committee of the Town Council at the last meeting. The deputation state that they have confined their investigations mainly to the question of the practicability of applying self-propelling power to a heavy vehicle such as would be required by the Links and Parks Committee as a conveyance to and from the beach. An offer was made to them to supply an oil-motor omnibus to hold 20 persons for the sum of £348, but, taking into account the objection of smell and considerable vibration, the deputation are of opinion that the oil motor in its present state of development is practically useless for a heavy omnibus. The deputation next turned their attention to electricity. They were disappointed to find that an omnibus to hold 20 persons would weigh over four tons, the necessary accumulators being of great weight. The expense also would be very great. The battery would cost about £120, and it takes an hour to charge the accumulators for a three hours' run, and the deputation were forced to the conclusion that electricity is also at present impracticable. Steam, they think, is the only power capable of doing the work, and the Serpollet street car, which they saw in operation at Willesden, is, they are of opinion, the only thing in the market, or likely to be in the market for some time, which would suit the requirements of the Links and Parks Committee for the conveyance of passengers to and from the sea beach. The cost of running is computed at about half of that where horses are used. The car can be worked and controlled by an ordinary intelligent person, and there is no smell or vibration, or danger of explosion. Sir David Salomons, one of the highest authorities on the present motor-car movement, and a practical engineer himself, pins his faith to steam and the Serpollet carriage. The deputation believe a Serpollet omnibus, to hold from 20 to 30 persons, would cost from £600 to £700. The French makers, however, are so full of work that they cannot supply England, and the English company have not yet completed their own manufacturing arrangements. The deputation therefore recommended that the Council should defer giving any orders until matters are developed, as they believe better terms will be got in a short time when the Serpollet English factory is in operation. The committee received the report, thanked the deputation for their labours, and decided to defer consideration of the matter pending the further development of motorcars.

Swansea—The report of Mr. George Hopkins, C.E, of London, upon the proposed agreement for tramway purchase has been received. After recapitulating the terms of the Bill introduced into Parliament by the Corporation, and mentioning that the tramways of the company are now laid in about 5½ miles of streets, Mr. Hopkins goes on to say: "The agreement for the purchase of the tramways and for granting a lease for 21 years to the company I consider fair and reasonable. The purchase price is very moderate, and, whilst the purchase will prove to be beneficial to the borough, it will also be beneficial to the company, and it will enable them to do that which otherwise they could not do. The advantages to the borough are, *inter alia*, that the Corporation will be the owners of a new and improved system of tramways at once, instead of putting up with the present incomplete system until 1906, constructed in such a manner as to give a more frequent and better service of cars, cheaper fares, several important and necessary extensions, a return of all moneys paid by them in the shape of interest on capital borrowed for tramway purposes, with an additional ½ per cent. for management and, by the operation of sinking funds, they will get all moneys advanced for reconstructing the tramways, for converting single lines into double, for constructing the extensions, and for adapting the tramways for the use of electrical power repaid at the end of 21 years, and all moneys that they provide for the purpose of purchasing the tramways and any property required for widening streets and roads, repaid at the end of 30 years, at which date they will be owners of all the tramways without costing the ratepayers one farthing. The advantages to the company are that they will be able to pay off the debenture debt, get the whole of the existing lines reconstructed with additional passing-places, the extensions constructed, new rolling-stock and additional equipment provided, all the lines adapted for the use of electrical power, and put in a position to enable them to give the public a good and efficient service, and thereby materially increase the receipts. A most important feature of the Bill is that which authorises the working of the tramways by electrical or other mechanical power approved by the Board of Trade, and, by the lease, the Corporation agree to supply the electrical energy required for working the tramways, receiving from the tramway company for this a minimum sum of £3,333. 6s. 8d. per annum. This will be of great benefit to the Corporation, and aid them materially in supplying electric lighting to the borough, as the greater part of the energy required would, of course, be taken in the daytime, and thereby lessen the expenses of electric lighting. From the published reports of the company, it appears that their working expenses are about 8d. per mile run, and their receipts about 9½d. On electrically-equipped tramways the working expenses would probably be not more than 4d. per mile run, and the receipts would be considerably more than 9½d., and with good management, cheaper fares, better service, and increased receipts the company should be able, not only to meet their engagements to the Corporation, but pay moderate dividends to their shareholders. In conclusion, as requested, I beg to state that, in my opinion, the agreement and proposed lease are sufficiently favourable to the Corporation to justify them in entering into the proposed arrangement, and that they are well advised in electrically equipping the lines, and, further, that the Corporation will be well able to supply electrical energy to the company on the terms agreed."

PROVISIONAL PATENTS, 1897.

JANUARY 25.

1936. Improvements in electricity distributing boxes. William Henry Willatt, 15, St. James's-row, Sheffield. (Complete specification.)

1941. Improvements in electric coils. Charles Castel, 9, St. George's-terrace, Regent's Park, London.

1964. Improvements in electric arc lamps. François Fesquet and John Williams Keys, 53, Chancery-lane, London.

1977. Improvements in underground conduits for electric railways. Zalmon Goodsell, 40, Chancery-lane, London.

JANUARY 26.

2082. Improvements in and relating to electric furnaces. John Joyce and James Albert Deuther, 77, Chancery-lane, London. (Complete specification.)

2105. Improvements in electric meters. The British Thomson-Houston Company, Limited, 70, Chancery-lane, London. Walter C. Fish, United States.) (Complete specification.)

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2039. Improvements in electrically-operated gas-burners. Carl Pettersson, 62, St. Vincent-street, Glasgow.

2106. Improvements in closed-conduit electric railways. The British Thomson-Houston Company, Limited, 70, Chancery-lane, London. (Edwin W. Rice, jun., United States.) (Complete specification.)

2107. Improvements in and connected with brake shoes for electric braking apparatus. The British Thomson-Houston Company, Limited, 70, Chancery-lane, London. (Frank E. Case, United States.) (Complete specification.)

2125. New or improved means for economising electric energy in the heating of electrically-heated apparatus and facilitating the use of such apparatus. Henry Edmunds, 47, Lincoln's-inn-fields, London.

JANUARY 27.

2140. The electric self-winding clock. Walter Keene, 47, Ford-street, Shelton, Stoke-on-Trent.

2152. Improved method of generating electricity. Richard Douglas Bailey, 56, Cathcart-road, South Kensington, London.

2155. Improvements in the method and means for simultaneous telegraphy and telephony over the same circuit. Charles Adams-Randall, 63, Chancery-lane, London.

2171. Improvements in electrical perpetual self-propelling driving systems. William Clark and Cecil Clark, Ashton House, The Green, Ealing, London.

2207. Improvements in and relating to the decomposition of alkaline salts by electrolysis and in apparatus therefor. James Greenwood, 4, South-street, Finsbury, London.

2226. Improvements in electrical heating apparatus. John Benjamin Verity and Hubert Russell, 47, Lincoln's-inn-fields, London.

JANUARY 28.

2253. Improvements in electrical accumulators. Arthur Edward Porte and James Robert Sykes, 61, Dawson-street, Dublin.

2272. Improvements in or connected with electric batteries. John Laskey Dobell, 57, Chancery-lane, London.

2275. Improvements in electric meters. Samuel Leith Tomkins, 6, Old-park-avenue, Balham, London.

2291. Improvements in insulating frames for electrodes. Moriez Engl, 18, Fulham-place, Paddington, London.

2301. Improvements relating to time meters for telephonic conversations. Hermann Keim, 18, Buckingham-street, Strand, London.

JANUARY 29.

2378. Improvements in and relating to primary batteries. Walter Rowbotham, 27, Vittoria-street, Birmingham.

2412. An improved method of depositing aluminium by electricity. Henry Joseph Sheldon, "Haddon," College-road, Harrow-on-the-Hill.

2413. An improved form of electrode for galvanic or secondary batteries. Edward William Bonson, 54, Bellefields-road, Brixton, London.

2429. Improvements in and relating to phonographs. Theodore van Heemstede Obelt, 1, Broad-street-buildings, Liverpool-street, London.

2430. Improvements in and relating to the reproducing diaphragms of phonographs and similar sound-recording and reproducing instruments. Theodore van Heemstede Obelt, 1, Broad-street-buildings, Liverpool-street, London.

2441. Improvements in phonographs. William Ford Stanley, 10, Great Turnstile, Holborn, London.

2445. An improved thermometric electrical circuit closer. Giles Henry Zeal, 53, Chancery-lane, London.

2447. Improvements in and relating to accumulators or storage batteries. Percy Wilbraham Northey and the Epstein Electric Accumulator Company, Limited, 323, High Holborn, London.

2462. Improvements in apparatus for soldering or sealing by electricity in a vacuum or attenuated atmosphere. Francis William Ball, 73, St. Stephen's-road, Upton Park, London.

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2478. Improvements in electric battery cases to render the contents of the cells unspillable; to facilitate the introduction of the electrolyte into the cells; to enable the level of the liquid to be easily ascertained; and to facilitate inspection of the interior. Guiseppe Fabbro, Morton House, Trott-street, Battersea, London.

2500. Improved means for supplying current to electrically-propelled railway or tramway vehicles. James Enright, 202, Holland-road, London.

2534. Improvements in or relating to systems of electrical traction. Reginald Belfield, 322, High Holborn, London. (George Westinghouse, United States.)

2558. Measuring apparatus for rotary-phase currents. Siemens Bros. and Co., Limited, 28, Southampton-buildings, Chancery-lane, London. (Siemens and Halske Germany.)

2559. Method and apparatus for dividing an alternating current into two currents whose phases are shifted relatively to each other, more particularly applicable for working or starting single-phase alternate-current motors. Siemens Bros. and Co. Limited, 28, Southampton-buildings, Chancery-lane, London. (Siemens and Halske, Germany.)

2570. Improvements in or connected with electric cables or conductors. Henry Edmunds, 47, Lincoln's-inn-fields, London.

SPECIFICATIONS PUBLISHED.

1888.

16245*. Electric lamps. Coerper.

1896.

778. Secondary batteries. Headland.

1310. Electrical igniting apparatus. Hirst and Angold.

1487. Microphonic transmitter. Charollois.

1518. Means for the distribution of electricity simultaneously to circuits requiring current of uniform pressure and to circuits having variable load. Edmunds. (Mengarini.)

1669. Electric batteries. Turner.

2337. Means for use in working apparatus by electricity. Sautter and Harle.

2683. Electricity meters. Hookham.

2745. Apparatus for blowing organs by electric motors Drake and Gorham.

2875. Electric incandescent lamps. Hall and Cheyne.

2923. Alternate-current dynamos. Johnson, Steele, and Ewart.

4207. Instruments for measuring electric currents. Baron Kelvin.

16268. Electric batteries. Rowbotham.

19818. Electric heaters. Meek and H. W. Johns Manufacturing Company.

22226. Automatic electrical cut-out. Wagg.

23071. Switches or electric currents. Rawlings and Rawlings.

25001. Electric lighting apparatus for cabs and other carriages. Headland's Patent Electric Storage Battery Company, Limited, and Headland.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	9-9½
Brush Company, Ordinary	3	¾-1¼
—— Non. Cum., 6 per cent. Pref.	2	1½-1¾
—— 4½ per cent. Debenture Stock	100	109-112
—— 4½ per cent. 2nd Debenture Stock	100	94-98
Callender's Cable Company, Debentures	100	104-109
Central London Railway, Ordinary	10	9¾-10¼
——	6	5¾-6¼
Charing Cross and Strand	5	9¾-10¼
Chelsea Electricity Company	5	8¾-9
—— 4½ per cent. Debentures	100	112-115
City of London, Ordinary	10	15¾-16¼
—— 6 per cent. Cumulative Pref.	10	16¾-17¼
—— 5 per cent. Debenture Stock	100	123-132
City and South London Railway, Consolidated Ordinary	100	58-60 xd
—— 4 per cent. Debenture Stock	100	139-141
—— 5 per cent. Pref. Shares	10	15¾-16 xd
County of London and Brush Provincial Co., Ordinary	10	9¾-9¾
—— 6 per cent. Cum. Pref.	10	13¾-14¼
—— 4½ per cent. 2nd Debenture Stock	5	9¾-10¼
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	13-2¼
—— 5 per cent. Debentures	—	93-98
Edison and Swan United Ordinary	3	1¾-2¼
—— 5 per cent. Debentures	5	3-4
—— 4½ per cent. Debentures	100	105-110
Electric Construction, Limited	2	1¾-1¾
—— 7 per cent. Cumulative Pref.	2	2¾-3
Elmore's Copper Depositing	1	1-1¼
Elmore's Wire Company	2	⅞-1
W. T. Henley's Telegraph Works, Ordinary	10	18¾-19¼
—— 7 per cent. Preference	10	18¾-19¼
—— 4½ per cent. Debentures	100	109-114
House-to-House Company, Ordinary	5	4¾-5¼
—— 7 per cent. Preference	5	8¾-9¼
India Rubber and Gutta Percha Works	10	20¾-21¼
—— 4½ per cent. Debentures	100	106-109
Kensington and Knightsbridge Ordinary	5	10-10¼
—— 6 per cent. Pref.	5	8-8¼
London Electric Supply	5	1¼-1¾
Metropolitan Electric Supply	10	13¾-14¼
—— 4½ per cent. First Mortgage Debenture Stock	100	119-122
National Telephone, Ordinary	5	7¾-8
—— 6 per cent. Cum. First Pref.	10	17-19
—— 6 per cent. Cum. Second Pref.	10	17-19
—— 5 per cent. Non. Cum. Third Pref.	5	6¾-7
—— 3½ per cent. Deb. Stock	100	106-108
Notting Hill Company	10	11-12
Oriental, Limited, £1 shares	1	1¼-2
—— £5 Shares	5	8¾-9
—— £4½ shares	4½	7¾-8
Oriental Telephone and Electric Company	1	11/16-13/16
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	103-105
St. James's and Pall Mall, Ordinary	5	13-14
—— 7 per cent. Pref.	5	9¾-10¼
Telegraph Construction and Maintenance	12	40-43
—— 5 per cent. Bonds	100	102-105
Waterloo and City Railway, Ordinary	8	9¾-10¼
Westminster Electric Supply, Ordinary	5	11¾-12¼
Yorkshire House-to-House	5	8¾-9

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NOTES.

Institution of Electrical Engineers.—The next students' meeting will be held on Wednesday, February 17, when a paper will be read by Mr. G. J. Lemmens on "The Evolution of the Incandescent Lamp."

Royal Society.—The papers down for reading yesterday (Thursday) belonged to the biology side of natural science, and interesting and important as are Mr. A. Willey's discoveries in reference to the pearly nautilus, they require no reference here.

Obituary.—The death of Prof. Galileo Ferraris, of Turin, has been announced. He was a prominent representative of Italian electrical science, and his somewhat sudden death will be a notable loss to the University of Turin, and to scientific circles generally in Northern Italy.

The Watt Lecture.—Mr. W. H. Preece, C.B., delivered the Watt anniversary lecture at Greenock on Friday last. It dealt with the subject of "horse-power" and its connection with electromagnetic units. We hope to publish the lecture in full immediately, but there is really no room for it this week.

The Telephone System.—For the first time the National Telephone Company shows a reduction in its net income. Of course, the transference of the trunk lines to the Post Office involved a diminution in the gross receipts; but the natural growth of the ordinary business has been sufficient to recompense the company, and the profits have not been diminished.

The Metric System.—Mr. Mundella has been asking the President of the Board of Trade in the House of Commons as to when he proposed to introduce the Bill of last session for the legalisation of the metric system of weights and measures. Mr. Ritchie replied that he was unable at present to fix a date, but he hoped the introduction of the Bill would not be long delayed.

Helium.—From a communication to the Paris Académie des Sciences, it appears that Mr. Berthelot believes that he has obtained evidence that under the prolonged action (200 hours) of the electric discharge helium can be made to combine with benzine. It will be remembered that a similar assertion was made with regard to argon, but the accuracy of the result is decidedly doubtful.

Physical Society.—The annual meeting of the Physical Society of London takes place this (Friday) afternoon at the rooms of the Chemical Society, Burlington House. After which, at an ordinary meeting, papers will be read on "The Use of Very Small Mirrors with Paraffin Lamp and Scale," by Dr. H. H. Hoffert; and "On the Thermo-electric Properties of Liquid Metals," by W. Beckett Binnie.

Technical Education.—The sub-committee on the teaching of chemistry under the Technical Education Board of the London County Council has presented a valuable report, but we have had so much about technical education lately that their conclusions may stand over for the present. Last Friday the certificates awarded by the Board were distributed at Queen's Hall by the Prince of Wales. The aggregate represented scholarships and exhibitions to the value of £40,000.

Some Societies.—We have to acknowledge the receipt of the *Proceedings* of the Royal Society of Edinburgh. Prof. Tait, when he becomes mathematical, is not to be tackled with a light heart, and if further notice is necessary it must be deferred. There has been nothing of interest to electrical engineers at the Civil Engineers or the Society of Arts during the week. A new set of afternoon lectures ("Arctic Geology") has started at the Royal Institution. The announcements for next week of these and such other societies as have reached us will be found elsewhere.

Argon.—From an account in the *American Journal of Science* of experiments on argon by Trowbridge and Richards, it would appear that argon (at low pressures) fluoresces (blue) under the action of the Hertzian waves. The spectrum given by the gas depends upon the voltage of the discharge through it. (This implies a variation of other conditions also.) An oscillatory discharge will give the blue or high-voltage spectrum; but if there is self-induction in the circuit, this is converted into the lower or red spectrum. It is suggested by the investigators that it might be possible to use an argon discharge tube as an inductometer.

The Central-Station Interest.—We have received the first number of the *Bulletin des Usines Electriques*, which is to be the organ of the recently formed body which is to represent and look after the interests of central stations in France. The statutes of this, the Syndicat Professionel des Usines d'Electricité, are given in full. It may be added that the address of both the *Bulletin* and the Syndicat is Paris, rue Tronchet 27. There are lists of members and of central stations. The latter covers at present about 34 places. For the rest, there is a description of the Rouen central station, an article by Mr. Desiré Korda on electric traction, and some notes on legal and other matters. The *Bulletin* is to appear every two months.

A Telephone-Box Explosion.—Last week in Newcastle, at the junction of Dean-street and Mosley-street, just beside the National Provincial Bank, a telephone box blew up. Not there, but about 70 yards further down Dean-street, a workman of the National Telephone Company was at work looking for a fault in one of the wires, and must do it with a candle. An explosion of coal-gas occurred. The man was not much hurt nor any great damage done there, but the explosion appears to have travelled along the conduit to the top of Dean-street. There the cover of the manhole was blown 20ft. into the air, straight up by the Dean-street wall of the bank. It fell with a crash, and broke in pieces. There were a number of people about at the time, but no one was injured.

South Kensington Museum.—Lord Playfair has written to the *Times* to suggest that in honour of the Queen's Jubilee the South Kensington Museum and its annexes should be completed, and the name changed to the Victorian Museum. "For the purposes of technical instruction in art these collections are superior to any in Europe. Berlin and Vienna have avowedly founded new museums on the English type, while Paris has rearranged her museums to some extent in a like way." But while the collections are splendid, "the museum itself has no fitting setting. In front of it there are bare brick walls, 'the Brompton boilers,' shabby railway vans and sheds, and altogether a general squalor which humiliates the nation in the eyes of foreigners who come in large numbers to visit the museum." This, Lord Playfair thinks, should be put right.

The Junior Engineers.—Next week's announcements in connection with the Institution of Junior Engineers are for Tuesday, February 16, at 8 p.m. at the Westminster Palace Hotel, Lecture II. of the special course, on "Dynamo Design, Construction, and Working," by Mr. F. A. Nixon; and on Saturday, February 20, at 3 p.m, a visit to the Metropolitan Fire Brigade Headquarters, Southwark Bridge-road, S.E., by the invitation of Commander Wells. At the last meeting of the institution a lecture on "Comparisons of Similar Structures, Large and Small," was given

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by Prof. Archibald Barr, D.Sc., of Glasgow, Hon.M.I.J.E., in which the lecturer, after enunciating the general principles regarding the loads which similar structures can bear, showed their applications to pistons, cylinders, boilers, beams, etc. Mr. Barr further dealt with rigidity, floating power, and other structural properties, and finally touched on the subject of flying machines.

German Technical Training.—For those who are interested in the matter—we confess to being about tired of it here—it may be mentioned that the *Elektrotechnischer Anzeiger* (January 31) contains an illustrated description of the Hamburg Elektra, which is a new technical training establishment designed to receive students after the completion of their school course. The first illustration shows a quantity of German lads mostly engaged on filing at somewhat ricketty-looking and superfluously clean benches. It is not that there is no mess, but there are absolutely no filings or lathe turnings on the floor. There are two other illustrations, mainly of desks in photographic perspective. Neither the architectural features, so far as they can be seen, nor the fittings, appear to be of a character which would in this country be considered unnecessarily sumptuous. The contributor of the article is Mr. Georg Heber, who, it is understood, is connected with the establishment.

The Central Technical Institute.—The article in the *Engineer*, which was the subject of a note a fortnight ago, has naturally produced a good deal of correspondence. Put shortly, it comes to this, that the institute turns out young men who know instead of older men who do not know, but are supposed to have practical experience, and be what the *Engineer* calls "level-headed fellows." That amounts to people who work more or less by rule of thumb, and who are very careful to avoid as far as possible anything new, which, as they have no theory to fall back upon, would take them at once out of their depth. If employers prefer this class of men, it is not the fault of those who taught the other class. But if it really is so, what becomes of all the outcry for more technical and scientific education in order to get in front of Germany? It is evident that the first thing is to convert the man of business to better ways, and then the rest will follow of itself.

West India Cables.—In reply to a long question from Mr. Tomlinson as to the construction of a cable giving telegraphic communication with the West Indies which should be under British control, Mr. Chamberlain has stated in the House of Commons that he could not state the date at which an agreement for the construction of the cable would be completed. Negotiations on the subject were in progress. A cablegram of three words to Antigua at present cost 22s. 3d. A French cable had recently been laid by a French company, in conjunction, as he understood, with an American company, which would compete for the West Indian traffic with the proposed British cable. He imagined that this French cable would have been constructed in any case, and its construction had not been promoted by the delay with the British cable. General Laurie, the member for Pembroke, said both the Canadian Government and one or more of the West India minor Governments were so anxious that this cable should be constructed that they had already voted or arranged for subsidies to be granted for the purpose.

Ministers and Directorships.—In reference to Mr. St. John Brodrick's resumption of his directorship of the Brazilian Telegraph Company, the *Daily Chronicle* says that it has been informed that he relinquished his post as a protest against the late Sir John Pender's proceedings with regard to the island of Trinidade, and that he only resumed it after that gentleman's death, and after receiving assurances in a high quarter that his directorship would not in any way interfere with his public duties. Our contemporary, however, adheres to the general point that Ministers are better off than on the boards of private companies. There can be no manner of doubt that this is the case. Trinidade is no good to Brazil whatever, and little good to us, though it would be better if it had some inhabitants and a lighthouse. But questions of the ownership of unattached islands, and of a telegraphic communication with half South America which shall not be at the mercy of the revolutionary factions of Brazil, ought not to be prejudiced one way or the other by the fact that a Minister of the Crown is also the director of a telegraph company.

The District Lower Level.—It is to be regretted, so far as can be judged from the proceedings at the meeting of the Metropolitan District Railway Company last week, the prospects of the electric express line are not so favourable as they might be. In the first place, Mr. James Staats Forbes evidently does not care for it, apparently because he does not think highly of the gentleman who is bringing the scheme forward. Mr. Forbes said he knew quite enough about electricity to be on his guard as to the difficulties attending the scheme; but it is probable, all the same, that the objection was quite as much to the promoters of the scheme as to electricity. Subsequently, the meeting got very lively, and displayed an inclination to discuss such matters as whether a certain gentleman's name was Charles Pond or Zachariah Pattle, and so forth. Ultimately, of course, Mr. Forbes triumphed, as usual. But really, apart from the financial history of Mr. Pond, it does not seem much use adding branches when the main line is already choked with traffic; and something of the nature of the electric railway scheme seems the only way out of the difficulty if there are to be further extensions.

A Scotch Motorcart.—They have a motorcart at Dundee, and until they saw it seemed to be rather proud of it. Judging from a picture, it does not seem to be a very pretty affair, and why it should be labelled "Dei donum" is beyond the conception of the writer. It is a petroleum car, and, according to the *Dundee Advertiser*, this is what happened on the trial trip: "The first movement it made after turning the corner at Albert-square was to run into the gutter, where it came to a halt. . . . To start the car the driver had to work a winding-up arrangement at the side, and then connect the gearing with the wheels, when the car was supposed to go. The motor power is ostensibly petroleum, but in reality it yesterday consisted of a 'physical force' party of boys, who, in response to the driver's invitation, cheerfully put their shoulders to the back of the car and made it move. No sooner, however, was the lorry under way than the boys, thinking they deserved some recompense for their trouble, began to hang on the back to get a free ride, when the affair came to a halt." Ultimately a pair of horses had to be sent for to take it home. This seems rather worse than the usual oil motorcart, which does go, but may not be stopped under penalty of shaking one to death.

When Fortune Frowns.—The writer of these notes was last week unwise enough to depart from his usual practice and notice that various people through carelessness occasionally made slips. Nemesis was immediately upon him, and he promptly made a couple or more himself in places where they ought not to be. That, though effective enough, is hardly a desirable way of enforcing one's case or amusing one's readers. Blunder number one was a misquotation, and though that there was something wrong was obvious (what was printed was simply nonsense), and the

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necessary correction would occur immediately to most readers, it nevertheless ought to be formally made at the earliest opportunity. Attention is therefore called to the fact that the phrase between inverted commas at the top of the second column, page 162, should be "whether 'interlocking' be a noun or a participle." As to the second, lest it should also befall another to accept an inaccurate calculation instead of counting noughts for himself, it may be said that the length of an electric wave of about the same frequency as an alternating-current supply would not be greater than the diameter of the earth, but about a quarter of it, or thereabouts. It is a matter of no importance except as an illustration. But in dealing with millions one must keep straight, and with tens that are raised to the higher powers, though the Printer presses and may not wait, and time is short in this world of ours.

Mechanical Engineers.—At the annual general meeting of the members of the Institution of Mechanical Engineers last week, Mr. E. Windsor Richards, the president, occupied the chair, and, in moving the adoption of the report, said the erection of the institution house on the site acquired at Storey's-gate, Westminster, was now being proceeded with, and the council had engaged to have it completed in 18 months. This was the jubilee year of the institution, which was formed 50 years ago in Birmingham, and it was proposed to hold the summer meeting in the city of its birth. The institution was financially in a prosperous condition. Alluding to the work of the Alloys Research Committee, he said it was admitted that everything must be done to bring scientific research into line with the practical application of knowledge to industry and commerce. The munificent gift to the nation of Mr. Ludwig Mond and the bequest of the late Mr. Nobel were only indications of the widespread demand for scientific observation. The example of Germany, where research had so long been encouraged, should be followed. The institution had never lost sight of the importance of scientific researches, and the council, while fully alive to the necessity of economy at the present time, had voted a further sum of £250 to the Alloys Research Committee for extended investigations. The report was adopted. The officers for the present year were then elected, Mr. Richards being reappointed the president. Prof. W. C. Roberts-Austen, F.R.S., afterwards submitted the fourth report of the Alloys Research Committee, and opened a discussion on it.

Two Spanish Telegraphic Journals.—Our contemporary *Electron* has signalised the entry upon its second year by changing the design of its cover. The new design is decidedly preferable in its technical details to the old one, but in England we should not assume that every telegraph clerk read Greek as a matter of course. Possibly it is different in Spain; some things certainly are. For instance, to our insular prejudice it would seem that if the title must be printed in Greek, *'ήλεκτρον*, or something like it, would look better than the present way of doing it. But perhaps they are otherwise minded in Madrid. Our contemporary is, on the whole, very well satisfied with itself, and, judging by its usual contents, not without some reason. And, after all, it is the contents of a paper that are the main thing. A misprint on the cover may be irritating, but is not vital. As has been before observed, the Spanish telegraphic service appears particularly well looked after from a journalistic point of view. The campaign against the inter-urban telephones—which it appears have been competing only too successfully with the Government telegraphs—is continued in *El Telegrafista Español* with, if possible, increased vigour. The competition used to be merely a "peril for the State." Now our contemporary alludes to "criminal responsibility," and talks about a "great fraud." It really does appear that the telephone people have been stretching their concession somewhat; but it is quite possible to protest too much, and one would like to know what the Spanish public think of the matter. After all, it was for the public benefit—not to create a new branch of the Civil service and a new source of revenue to the Government—that telegraphs were invented.

In Case of Accident.—It is some time since the circular of Mr. Dupuy-Dutemps, the French Minister of Public Works, on the subject of what is to be done if anyone gets tangled up with (uninsulated) electric supply wires was drawn up, but as *L'Etincelle Electrique* of January 25 says he "has just addressed" it to all the French prefects, it is to be presumed that it goes into force without modification. After reference to the Académie de Medecine and the Departmental Committee on Electrical Distribution, which, it appears, are responsible for the technical part of it, the circular goes on to say that victims are to be treated as for lightning stroke. When anyone is found in actual contact with the wire, circumspection is recommended before interfering. If it is a continuous-current wire, "it is absolutely forbidden" to cut it "on account of the danger to the victim of the extra current at breaking." With rectified alternating currents it is different. "The cutting can then be done with impunity." As everyone does not know by looking at the outside of it what sort of current a wire is carrying, it is ordered that on overhead lines the posts shall have attached to them "instructions corresponding to the nature of the current used." Where both currents are carried on one series of posts the directions are a little vague, but it would appear that what is intended is that they should be those for whichever of the currents is the more dangerous; but in case of doubt the Minister should be referred to. Circulars are promised for distribution among all sorts of people, from mayors to medical men. France knows that every true Frenchman will do his duty (England only expects it), but if it is part of his duty before helping anyone to run to the nearest post and read a quantity of official instructions to ascertain if he may cut him free, it is rather hard on the "victim." Fortunately, accidents of the kind provided against are very rare, and so it does not really very much matter what kind of instructions are issued "by authority." The really possible danger, where, in the case of fire or hurricane, all sorts of wires come down and get crossed, does not appear to have been contemplated.

Gas Accidents.—Our contemporaries that look after the interests of the gasworks generally take care to keep the world well informed of every occasion when an armature goes, a wire heats, or some of their own gas explodes in an electric main conduit or a transformer-box. These and other accidents do not occur so frequently as to make any very serious demands upon their space. If, however, we were to pursue a similar plan and cut out every gas or petroleum accident that appears in the provincial papers we should have to enlarge our columns. The *Cambridge Express* (February 6), which may be taken as the representative paper for that district, would yield the following: "The overheating by a gas-jet of the ceiling of Mr. Bacon's shop on Market-hill about nine o'clock on Saturday night caused the ceiling and the floor above to take fire. The fire brigade were summoned, and they soon extinguished the flames. Only slight damage was done." And also: "On Wednesday morning, at Norwich, an aged woman, named Butwell, was found lying in an insensible condition at the foot of the stairs in her house. As there was reason

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to believe she had been overcome by the fumes of escaping gas, men were set to work to repair the gas-main in the street. While they were at work on the defective main a tremendous report was heard, and Mrs. Butwell's house was completely wrecked, the floors being forced up and the doors and windows blown out. A married woman and a child, relatives of Butwell, sustained shocking injuries, and were rescued from the *débris* with great difficulty. Mrs. Butwell lies at the hospital in a serious condition." These are fair specimens of the "slight" or "serious" gas accident, and at the same time examples of the sort of thing that could not be done by electricity. As, however, paragraphs of this character in quantity would be decidedly monotonous reading, it will be probably better to make only a very occasional departure from our ordinary rule of noting the electrical accidents when they occur, so that their cause may be ascertained and their recurrence prevented, and leaving gas and petroleum to blow up and burn when and where they choose without special remark. Everybody, except those people who "don't intend to know," is now quite well aware that, so far as safety is concerned, there can be no question as to the superiority of electric over all other means of lighting except natural daylight.

Animal Electricity.—Dr. Waller's fourth lecture on "Animal Electricity" at the Royal Institution dealt with the effect of carbon dioxide on the electrical response of the nerve. Much of the early part of the lecture was an exposition in outline of the physiology of respiration, and the latter part only related to electricity in so far that electrical methods were used to indicate the effects of carbon dioxide or other anæsthetics on the isolated nerve. The nerve (of a frog) is dissected out and enclosed in a box made of sheets of glass, where it can be kept moist, and the vapour of the various substances worked with is sent through the box by an aspirating apparatus or its equivalent. For the electrical contacts the "unpolarisable" electrodes designed by the late Prof. Du Bois Reymond should be used, though if mere stimulation is required, platinum electrodes are sufficient. Some of Dr. Waller's experiments are new. The first effect of carbonic acid, for instance, was to act as a nerve stimulant, but ultimately as a depressant. Its action was precisely comparable to that of such anæsthetics as chloroform or ether, but much weaker. In quantity, carbonic acid produced an abolition of the sensibility of the nerve, but after its action had been removed this was followed by a greatly augmented sensibility. On the other hand, such an anæsthetic as nitrous oxide, or a substance like nicotine, appeared to have no action whatever on the nerve itself, and the explanation of their toxic properties must be sought elsewhere. In the case of carbon monoxide, which also was without action on the nerve, its poisonous effect was easily explicable, as it acted upon the hæmoglobin of the blood in such a manner as to deprive the nerve of its supply of oxygen. When isolated and no longer deriving its oxygen from a circulating medium, the nerve appeared comparatively unaffected in this way. A further reference to the action of carbon dioxide on the nerve, and also the Du Bois Reymond and Hering effects, may be left over until the subject is continued in the next lecture. The question—and it is fundamental with the method of investigation adopted—immediately arises of how far it is safe to conclude from results obtained on the isolated nerve of a cold-blooded animal to the nerve of a warm-blooded animal when *in situ*. The latter will not remain alive when isolated for a length of time in the convenient way that a frog's nerve will; which at once shows that the chemical action (for that is what the whole thing comes to) is not absolutely the same, and at the same time makes experiments exceedingly difficult. So far, however, as they have been carried out, the results appear to be identical with those obtained from the frog's nerves shown at the Royal Institution.

British Association.—The local arrangements for the meeting of the British Association, which will take place on August 18 of this year at Toronto, are already in a very advanced state. The Finance Committee has secured promises of financial aid amounting to about £5,700 from the Governments of the Dominion of Canada and the Province of Ontario, and from the Toronto City Council. The whole of the meetings can be held within the buildings of the University of Toronto, and these having been placed at the disposal of the committees, it has not been necessary to engage rooms outside other than for the presidential address and the popular lectures and discourses, which will be delivered in the Massey Hall, a new building having a seating capacity of 4,000. Canadian hospitality is well known, and it will not be the fault of the committee if the most generous treatment is not given by Toronto to all strangers who come to that city. There will be garden parties and conversaziones and entertainments to suit all tastes, for "the invitation to the British Association has been most cordially endorsed by the Dominion, Provincial, and Civic authorities, and these, as well as the authorities of the provincial and other universities, are prepared to do everything in their power to render its visit profitable and agreeable." A committee has been formed having specially in view the invitation and reception of distinguished foreigners, and it is confidently expected that the leading scientific men of France, Germany, Holland, the United States, and other countries will meet their English and Canadian fellow-workers at Toronto. The American Association holds its meetings at Detroit on August 9, and a proportion of the members will doubtless cross the Canada line to take part in the British Association meeting which follows. Numerous excursions are being arranged. Niagara is close by, and merely as a spectacle would attract probably every stranger who reaches Toronto, but the works for generating electrical power will, of course, be carefully studied. Excursions also are provided to Sudbury, the nickel mining district, and to the gold mines of Western Ontario and British Columbia. The Provincial Government of British Columbia has made an appropriation for entertaining the members of the British Association who will go to the Pacific Coast, and it is understood that the Provincial Government of Manitoba will undertake to entertain the members who do not get further than Winnipeg. Excursions of from 2,000 or 1,000 miles or so would be looked at somewhat with astonishment on this side of the water; 20 or 10 miles is more our notion of a British Association excursion, but doubtless crossing the Atlantic is a thing which does not change the stars, but does change the spirit in which such matters are regarded. From the Canadian point of view the meeting is thought as a rare opportunity to show what Canada is in extent and resources, and the date permits the visitors to see that country under the most favourable conditions. Details as to special steamer and railway rates are promised on application in a circular from the office of the association.

The Pacific Cable.—Though neither in Downing-street nor in the House of Commons can any information be obtained as to the result of the Pacific Cable Conference, two of the Canadian representatives at the conference—the Hon. A. G. Jones and Mr. Sandford Fleming—have, on their return to Canada, been less reticent, and have made statements which fully confirm

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the favourable nature of the report. Mr. Jones, who with Sir Donald Smith, represented the Canadian Government at the enquiry, said, when questioned on the subject at his home in Halifax, Nova Scotia: "The report was a unanimous one, and based on the professional opinions of the highest authorities in the world. It will go to show that the laying of the cable is quite practicable—a question that had not up to that time been fully established. The question as to the division of responsibility between Australia, Canada, and Great Britain was not discussed by the committee. There were certain references to the committee by Mr. Chamberlain. All these points were considered, but the question of financial responsibility is left to be dealt with at a later date by representatives of the various colonies interested with the Chancellor of the Exchequer and the Colonial Secretary. In the meantime the reports will be before the various Governments, and they will then be able to form some opinion as to the probability of financial success." Mr. Sandford Fleming, who was the Canadian expert adviser at the conference, merely says "the report is ample and full, and will be satisfactory to the Canadian people. The report and accompanying papers will establish beyond question all the essential points contended for by those who have advocated for years the laying of the cable." Courtesy to Colonial Governments is a matter that should not be neglected, though Downing-street has not always had too good a reputation in all parts of Greater Britain on that score. But it seems futile to be more reticent than the colonials themselves. The *Daily News* has some remarks on the subject, but it is, of course, the business of that paper "to go for" the Government whenever it has a fair chance. More important are the financial considerations: "That it [the cable] will get nearly half the Australasian business as well as a certain amount of new business of its own creation we may fairly take for granted. That this business is stable and buoyant the statistics of all the Colonial telegraph offices, taken for any number of years, amply prove. Will the Imperial Government therefore see its way to guarantee a loan of about one million and two-thirds? The interest on a million and a quarter of this will be guaranteed by the Colonies. The responsibility of the remainder the Imperial taxpayer would have to face. Against this would be set one-third of the revenue to be derived from the line." What, however, is still more important is, who is to lay and work the line? It should either be a Government affair or else some company that will "run the cable for all it is worth," and not in such a way as not to harm other existing companies, whose cables, good enough in time of peace, are liable to be interrupted in time of war. That is a consideration which should be insisted on if the guaranteeing Governments are to get value for their financial assistance.

Search-Lights in War.—Captain M. A. Boyd, R.E., of the Submarine Mining Establishment, Plymouth, has been lecturing there on "The Application of the Electric Light to Coast Defence." Captain Boyd (he is excellently reported in the *Western Morning News*) said that modern weapons and explosives had greatly added to the destructive work which might be done in a short time by small vessels or landing parties. That pointed to the importance of preventing access to coast defences by vessels under cover of darkness; and it should be remembered that there was on an average 35½ hours of complete darkness every week throughout the year, apart from the effects of cloud, mist, and fog. After dealing with elementary matters, and describing the mechanism of a search-light, Captain Boyd said small vessels could be distinguished in a concentrated beam of light at distances from the projector at from 3,000 to 4,000 yards, and in a 16deg. dispersed beam at from 1,500 to 2,000 yards. The great power of a concentrated beam, and the intense brilliancy with which it lighted objects at a long distance, were of great value, but its area of illumination being small, it required to be kept very carefully on the target. This was difficult, and by multiplying the search-lights the result would be confusion. It was, therefore, generally considered desirable to restrict the employment of search-lights, and use dispersed beams, although their range was short. The typical defence of a large military port would be a scheme of concentrated search-lights in an advanced position, 16deg. dispersed beams behind, in connection with the mine fields, with possibly 30deg. beams commanding any narrow passages or boom obstructions. The principal ports had been provided with apparatus for the last 16 years, and periodical practice was carried out. As to what dependence can be placed on search-lights, when all has been done, Captain Boyd said, in 1892 some instructive trials took place at the Needles, six lights being used—three fixed and three search. Included in the six were four 30deg. dispersed beams. The trials exploded some too sanguine estimates which had been formed of the power of the lights, but it was made clear that the Needles passage could be so illuminated as to make it practically impossible for vessels to pass without being seen. Trials were carried out in Plymouth Sound in August, 1895, and December, 1896, with a view to providing the best disposition of the lights to meet local conditions. In the 1895 experiments two lights were placed in Cawsand Bay, two at Picklecombe, and one on a lighter near the Breakwater Fort. The Cawsand Bay outer light was used as a search-light. It was found that 30deg. beams were very inadequate to illuminate vessels on the most probable line of attack. The lights were at first placed on the top of Picklecombe, but subsequently were moved to a much lower position. The trials carried out in December last were much more complete. Nine beams were employed, and lenses of 16deg. dispersion were substituted for those of 30deg. in all the wider channels, and in addition the lights were more powerful. The attacking vessels were represented by six torpedo-boat destroyers, which entered the harbour at 18 or 20 knots. Observers were posted at all the important points round the Sound, and time records were taken both of the moments the destroyers passed fixed points and also of the periods the vessels could be seen by the observers on shore. The results showed clearly that under the conditions of the trials, the weather being rough and sometimes misty, the vessels could not enter without being seen, but, on the other hand, it appeared that the average time a vessel remained under fire from one point was only from a minute to a minute and a half, and that the average time between the first alarm and the arrival of the vessel at the inner defences might be from 12 to 15 minutes. If the trials had not solved all the difficulties and problems connected with the electric light in coast defence, they were at least much further advanced than a short time ago, and it was to be hoped they would be able to give a good account of themselves should occasion arise. There was some discussion. It is pretty evident that if search-lights are to be depended on, it will be advisable to have plenty of them. They are pretty certain to be aimed at, and some of them may get hit. In connection with the futility of a weak light, which shows where you are, and not where your enemy is, Captain Mills said that an opinion was expressed in connection with one of the engagements of the China-Japanese war that but for the lights of the defence the attack would have utterly failed—at which there were some who laughed.

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THE PRINCIPLES OF ALTERNATE-CURRENT WORKING.*

BY ALFRED HAY, B.Sc.(EDIN.), A.I.E.E.

(Continued from page 135.)

142. We have now to consider the methods of producing a rotating magnetic field by means of alternating currents which differ in phase. We shall assume that we have the means at our disposal of producing two or three alternating currents of the same periodicity and having any given phase difference (Art. 18). Such combinations of alternating currents are termed *polyphase* or *multiphase* currents; the methods of producing such currents we shall refer to later.

143. Any vector may, as we have seen, be replaced by two component vectors (Art. 11) lying along any two given straight lines. Thus we found that the single vector O C in Fig. 8 was equivalent to the two vectors O A and O B. Now a rotating magnetic field is conveniently represented by a rotating vector. Hence, if we take the rotating vector O R (Fig. 96) to represent a rotating magnetic field, we may at any given instant replace it by two component vectors O P and O Q, lying along two fixed straight lines. Let the angle between the positive directions of the two lines be α; let the initial position of the rotating vector be along one of the fixed straight lines, O A, and let its angular velocity be p. After t seconds, the rotating vector will occupy the position O R, where $A O R = p t$. Since R Q is always parallel to A O, it follows that R Q produced will be perpendicular to O R', a line drawn through O at

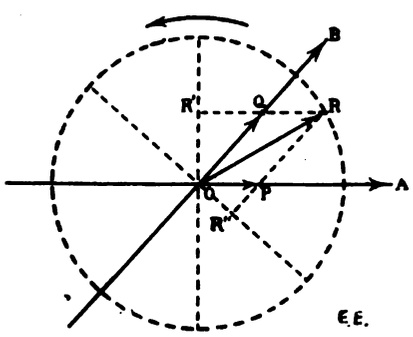

FIG. 96.

right angles to O A. Hence O R' will be the projection of both O R and O Q, and we shall have (Art. 12)

$$O R' = O R \cos R' O R = O Q \cos R' O Q,$$

i.e., since $\cos R' O R = \sin p t$, and $\cos R' O Q = \sin \alpha$,

$$O R \sin p t = O Q \sin \alpha,$$

whence

$$O Q = \frac{O R}{\sin \alpha} \sin p t.$$

Now, since α is constant, it follows that O Q is an alternating vector of the same periodicity as the rotating vector, O R, and of amplitude $= \frac{O R}{\sin \alpha}$.

Similarly, by considering the projection O R'' of O R or O P on a line through O drawn at right angles to O B, we find that

$$O P \sin \alpha = O R \sin (\alpha - p t),$$

or,

$$O P = -\frac{O R}{\sin \alpha} \sin (p t - \alpha), \text{ by Art. 3, equation (4),}$$

$$= \frac{O R}{\sin \alpha} \sin (p t + \pi - \alpha),$$

since $\sin \theta = -\sin (\theta + \pi)$.

We have thus shown that a *rotating* magnetic field will be obtained if two *alternating* magnetic fields of equal amplitude and the same periodicity be superposed on each other, provided there is a phase difference between the alternating fields equal to the supplement of the angle which their positive directions make with each other. The intensity of the resultant rotating field is equal to the amplitude of either of its components, multiplied by the sine of the angle between them; and the period of the resultant field is the same as that of its components.

144. The above results at once suggest a method of producing a rotating magnetic field by means of two alternating currents differing in phase. For if we take a coil of wire and send an alternating current through it, we obtain an alternating magnetic field. If we use two coils set at a certain angle to each other, as shown in plan and elevation in Fig. 97, and send two alternating currents

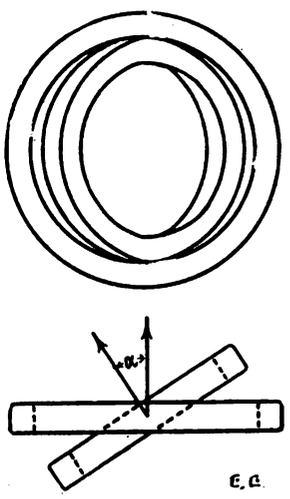

FIG. 97.

having the proper phase difference through the coils, the magnetic field at the common centre of the two coils will be a rotating one, the speed of rotation being equal to the periodicity of the alternating currents. Supposing α to denote the angle between the positive directions of the magnetic fields due to the coils when continuous currents which are reckoned positive are sent through them, it follows by Art. 143 that the alternating currents used for producing a rotating field inside the coils must differ in phase by $\pi - \alpha$.

In most cases the phase difference between the alternating currents is already determined, and cannot be varied; we may then adjust the angular position of the two coils so as to produce a rotating field.

145. In practice, when two alternating currents differing in phase (or *two-phase* currents) are used, the phase difference between them is generally made equal to $\frac{\pi}{2}$. Hence the angle which the two coils producing the rotating field must make with each other is also equal to $\frac{\pi}{2}$—*i.e.*, the coils must be at right angles to each other. In producing a rotating field for an induction motor (Art. 141), it is an

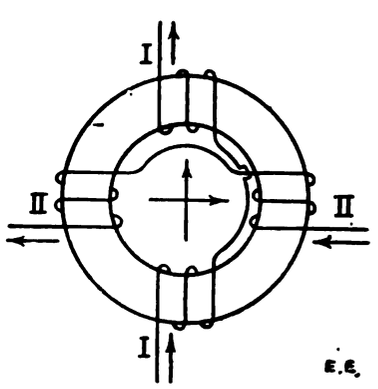

FIG. 98.

obvious advantage to provide the exciting coils with laminated iron cores, for the magnetic reluctance of the circuit is thereby very materially reduced, and the magnetising current required is diminished. The field magnet of such a motor frequently takes the shape of a hollow laminated iron cylinder surrounding the armature, the two sets of coils being arranged at the extremities of two diameters at right angles to each other, as shown diagrammatically in Fig. 98. If a continuous current

* Based on a series of evening lectures delivered at the University College, Liverpool.

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having the direction indicated in the figure be sent through the pair of coils marked I., a horizontal magnetic field is produced inside the cylinder; a continuous current through the pair of coils II. gives rise to a vertical field. Two currents in quadrature with each other sent through the two sets of coils will give rise to a rotating magnetic field, as explained above.

146. A rotating magnetic field, as we have just shown, may be produced by superposing two alternating fields of equal amplitude. Conversely, an alternating field may be produced by the superposition of two rotating fields of equal intensity if they are made to rotate with equal speeds in opposite directions. Let the two rotating fields

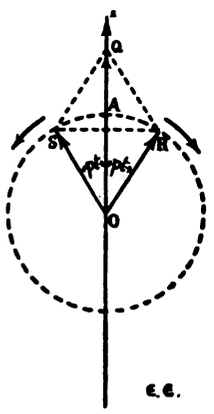

Fig. 99.

be represented by two rotating vectors. There will obviously be instants at which the vectors become coincident. Let the line O A (Fig. 99) denote the position of the rotating vectors when these are coincident. The resultant vector for the position of coincidence is obviously the sum of the two vectors—*i.e.*, it is a vector along O A of double the length. After a time t, each rotating vector will have traced out an angle $p\,t$ (where p is the angular velocity) so that the two vectors are equally inclined to the line O A. Resolving each vector into a horizontal and a vertical component, we have, if R denote the length of each rotating vector,

sum of horizontal components $= R \sin p\,t - R \sin p\,t = 0$;

sum of vertical components $= R \cos p\,t + R \cos p\,t = 2\,R \cos p\,t$.

Hence the resultant vector is always vertical, and we see that it is an alternating vector of amplitude 2 R, and of period equal to that of the rotating vector.

If we have an alternating vector of amplitude O P (Fig. 99), and if at a given instant its value is O Q, then in order to find the corresponding positions O R and O S of

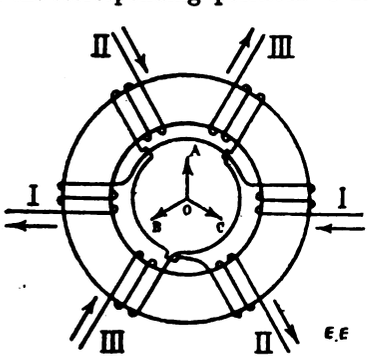

Fig. 100.

the two rotating vectors into which it may be resolved, it is obviously only necessary to bisect O Q, through the point of bi-section to draw a perpendicular to O P, and with O as centre and radius equal to $\frac{1}{2}$ O P to describe arcs cutting the perpendicular in R and S. Then O R and O S give the instantaneous positions of the two rotating vectors.

147. Instead of the arrangement shown in Fig. 98, in which there are two sets of coils supplied with two currents in quadrature with each other, let us next consider an arrangement of three pairs of coils and three currents, as shown in Fig. 100. If the positive directions of the currents be those indicated by the arrows, then the corresponding magnetic fields will have the directions O A, O B, and O C as indicated in the figure. Let the currents flowing through the three pairs of coils be denoted by I., II., and III., and let us suppose that they are alternating currents of equal amplitude, but differing in phase by $\frac{2\pi}{3}$ (or 120deg.). Then the instantaneous values of the three magnetic fields due to the three currents may be approximately represented by the projections on the vertical axis of three equal rotating vectors, 1, 2, and 3, as shown in Fig. 101, *a*.* Now, each of the three alternating magnetic fields may be replaced in accordance with the results deduced in Art. 146 by two equivalent rotating fields. In order to find the relative positions of the six rotating vectors which are equivalent to the three alternating vectors O A, O B, and O C (of Fig. 100), we may choose the instant corresponding to Fig. 101, *a*, at which the vector O A has reached its maximum positive value, while O B and O C are both negative, the former increasing numerically and the latter diminishing. Applying the result deduced in the latter part of Art. 146, we find that at the instant considered the positions of the rotating vectors which are equivalent to the alternating

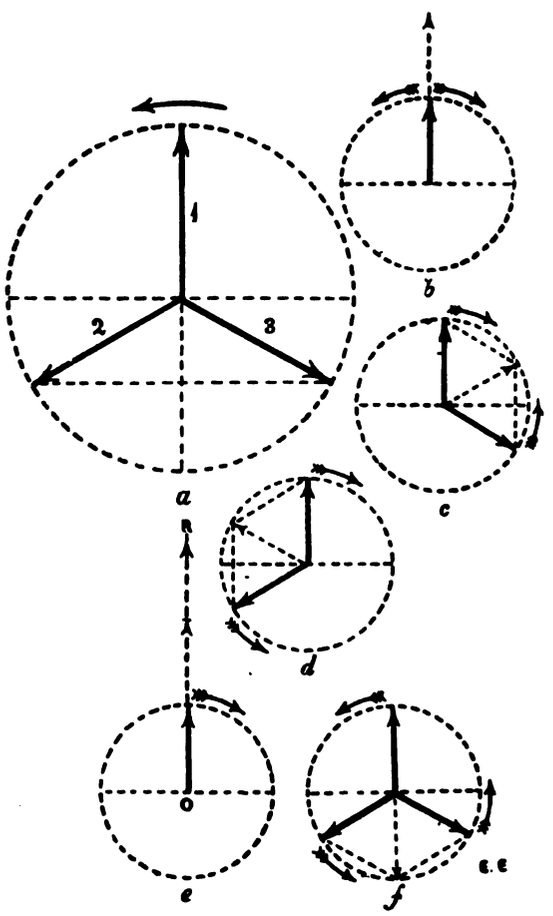

Fig. 101.

vectors O A, O B, and O C, are as shown in Fig. 101, *b*, *c*, and *d* respectively. Taking the three vectors which rotate right-handedly and compounding them, we obtain a single rotating vector O R (Fig. 101, *e*). Again, taking the left-handedly rotating vectors, we find that they balance each other at every instant, as is evident from Fig. 101, *f*. We thus see that the resultant of the six rotating vectors is a single rotating vector. In other words, the three alternating magnetic fields O A, O B, and O C, which differ $\frac{2\pi}{3}$ in phase, yield when compounded a simple rotating field. An inspection of the diagrams will easily enable the student to see that the intensity of the resultant revolving field is equal to 1·5 times the amplitude of one of the component alternating fields.

148. We have thus shown that a rotating magnetic field may be produced by using three alternating currents which

* The permeability being supposed constant.

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differ $\frac{2\pi}{3}$ in phase. Such a system of currents is known as a *three-phase* or *Drehstrom* system. It may be shown that a rotating field may be produced by the use of four, five, or a larger number of alternating currents with suitable phase differences between them; but since the polyphase systems used in practice are all either two-phase or three-phase systems, we shall restrict our attention to these last two.

(To be continued.)

THE LOCAL DISTRIBUTION OF ELECTRIC POWER IN WORKSHOPS, ETC.

BY ERNEST KILBURN SCOTT.

PART I.

(Continued from page 170.)

The radial drill is a tool which is peculiarly well adapted to receive and benefit largely by the application of an electric motor, especially if the motor is carried on the same saddle as the drill-stock, as in Fig. 11. A tool like this can be made cheaper than when the power has to be transmitted from pulleys and cones at the base of the pillar through vertical and horizontal (in the radial arm) feather shafts, with the necessary sets of mitre wheels, etc. In the event of the machine being required to drill holes at an angle, it will be evident that

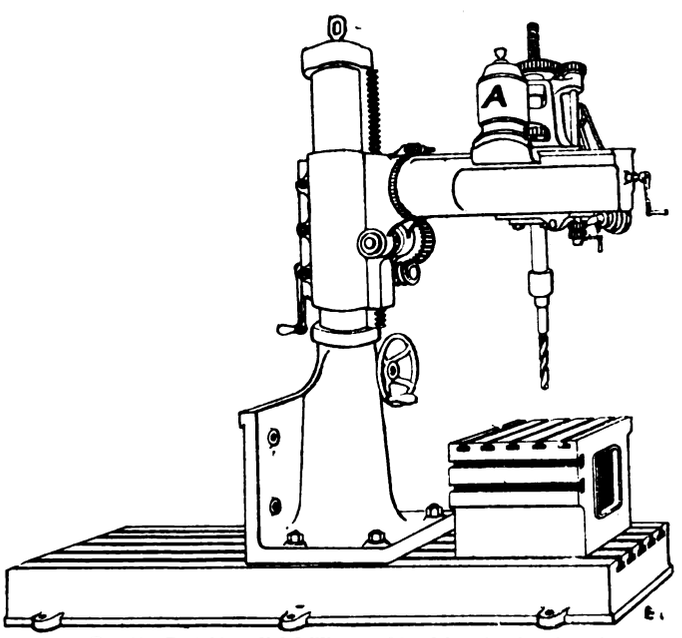

FIG. 11.—Portable radial drilling machine driven by electric motor.

the construction can be very simply arranged for this. The motor, A, being directly attached to the drill-stock, the whole may be tilted within the limits required in practical work, and still work just as efficiently.

The motor is most conveniently arranged with a vertical spindle, and Fig. 12 shows such a motor designed by the writer for machine-tool work. The armature spindle is supported on a roller bearing, A, which, when the motor is running, has only a small pressure upon it on account of the armature core being placed a little lower than the magnets. When the poles are excited they tend to float the armature core upwards, and this takes pressure from off the bearing rollers. The lubricant enters at the top or steadying journal, B, and then passes down the centre of the spindle to the bottom journal, after lubricating which, it flows into the gear box, H, and from thence into an oil strainer ready for use again. The commutator and brushes are so arranged that they may be readily examined by turning the circular door, C, through an angle of 45deg. The commutator shown can be made very cheaply, is easily repaired, and gives a very ample brush surface. The segments are kept in place circumferentially by a broad endless band, D, which is shrunk on to a layer of mica. The brush arrangement is arranged very simply, E and F being the respective terminals for the cable shoes to be attached to; there are no glands and no rocker. The brushes may be made from short ends of soft-cored arc lamp carbons; the soft cores are drilled out and replaced by a bundle of fine copper wires, and these are connected by short flexibles, G, to the body of the brush-holder. A direct copper connection is thus secured, and at the same time there are the advantages of carbon to prevent sparking and the formation of copper globules. The armature conductors are positively driven by thin German-silver discs driven tightly into the core and insulated therefrom by mica. It will be seen that the whole machine is enclosed by the steel magnet casting, and the cast-iron ends carrying the journals, etc., so that there is no stray magnetic field, and, therefore, nothing to fear from iron filings. Where minimum weight is desired, as in portable tools, etc., the end castings are made of an aluminium alloy. Messrs. New and Mayne,

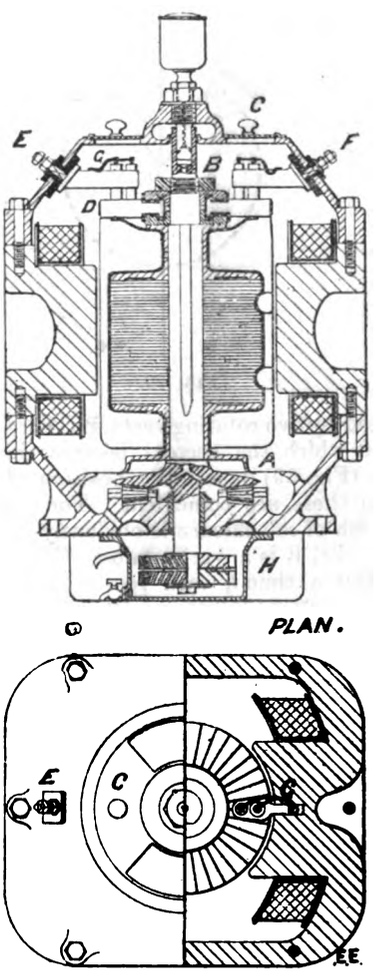

FIG. 12.—Electric motor arranged to work vertically.

Limited, of Palace-chambers, Westminster, are placing these motors on the market.

In the present position of the business it often happens that electrical engineers are asked to apply motors to machines or tools, the exact horse-power of which is not known. This information can be obtained by means of a transmission dynamometer, or in a more accurate way still, by putting down a small dynamo and motor, and taking readings with an ammeter, remembering that in cases where it is necessary to employ a rheostat in series with the motor armature in order to reduce the speed, corrections should be made for the efficiency of the motor, which would of course be variable under these circumstances.

The following information, compiled from various sources, will, however, enable very near approximations to be made for a number of machines in use both in engineering shops and textile factories.

Plate-bending Rolls.—The power required to drive large rolls empty is about ·6 h.p., and when doing work may be formed by the following formula:

$$\text{Total horse-power} = \frac{85{,}000 \times \text{breadth} \times (\text{thickness})^2 \times \text{length of plate}}{\text{radius of curvature in inches}} + \cdot 6$$

This is for cold wrought-iron plates. Red-hot wrought-iron

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or steel plates would only require about 15 per cent. of the power.

Shearing and Punching Machines.—A shearing machine cutting 4,700 square inches of surface per hour in plates ·4in. thick will absorb ·68 h.p. running empty, and about 4½ h.p. when doing effective work. This formula expresses the work absorbed at full load for either shearing or punching machine:

$$\text{Total horse-power} = \frac{\text{Area of surface cut or punched per hour in square inches} \times (1{,}160 + 1{,}690 \text{ thickness of plate})}{1{,}980{,}000}.$$

Metal-cutting Circular Saws.—The horse-power required to drive circular saws running empty is:

$$\text{Horse-power} = \frac{\text{number of revs. per minute} \times \text{dia. of saw in inches}}{32{,}000}.$$

When cutting red-hot iron, the saw moving at a circumferential speed of 7,900ft. per minute and making a cut ·14in. wide, the power is expressed by the formula:

$$\text{Total horse-power} = \cdot 7 \text{ sectional area of surface cut through in square feet.}$$

Red-hot steel would require about 40 per cent. more power.

(To be continued.)

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LECTURE LIV.

(Specially Contributed.)

[We had not intended to give any more of this series of lectures in our columns, as they will, with additions, appear immediately in book form; but just now considerable interest is being shown in alternators having both armature and field stationary, that we give the few paragraphs of the book relating to the subject. Of course, they are purely elementary, and intended only to show the principle of the inductor alternator. A number of machines of this type have been described in our columns during the past three or four years, and we think English makers are far behind their colleagues on the Continent and America in this matter. They probably have very good reasons to advance for this almost utter neglect of the simplest mechanically constructed machine used in electric lighting. So far as we know, there is not a single English-made machine at work anywhere, though Continental-made machines are used over here to a small extent, and on the Continent are gaining ground rapidly.—Ed. *E. E.*]

Inductor Alternators.—This is the name given to the second class of alternators—namely, those in which neither armature nor field magnets revolve. So far, only Mr. Mordey and Mr. Kingdon have attempted to make large machines of this type in this country, and then only as yet experimentally. It is a little difficult to understand such a backward state of things, especially as mechanical considerations point to these machines being better in many respects than any other. Whenever we have a combination of things to build up into a piece of apparatus revolving with considerable velocity, difficulties always arise in preventing slip of one part over or away from the other. Only those in charge of central stations and the various builders know the numerous difficulties that have arisen and the failures that have occurred with dynamos and ordinary alternators. There is no need to cry failures from the housetops, but they are there all the same. The inductor alternator solves these difficulties by having simply a revolving mass of iron. Not only mechanical, but electrical troubles are minimised or avoided. At present, the only point against the general adoption of this type of machine may proceed from a doubt as to its efficiency, and upon this evidence is somewhat conflicting. Many able electrical engineers are of opinion—and I am inclined to agree with them—that a lesser efficiency with greater mechanical and electrical advantages will not long bar the rapid introduction of the inductor alternator. Let us see how it acts. Suppose we have (Fig. 1) a field magnet, F M, energised by its coil, X, and upon the poles the armature coils, A C_1 A C, and a soft-iron piece, A, which can be moved between or away from the poles. When A is in the position shown, the lines of force linking A C_1 A C will be a maximum, and we get a current equal to the sum of the currents in each coil if they are in series. Take A away and the resistance of the magnetic circuit is increased and the linkages diminished, and a reverse current obtained.

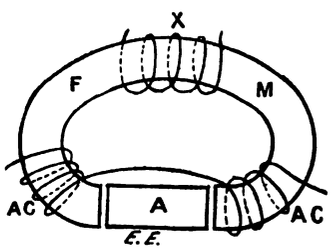

Fig. 1.

The current obtained in each case can be computed in the usual way: linkages per minute × by number of coils in series linked. This apparatus is an alternator, but a very bad one. We might modify it, as in Fig. 2, and arrange a number of soft-iron pieces, A A, around an axle, but this form has few or no advantages over that of Fig. 1. One of

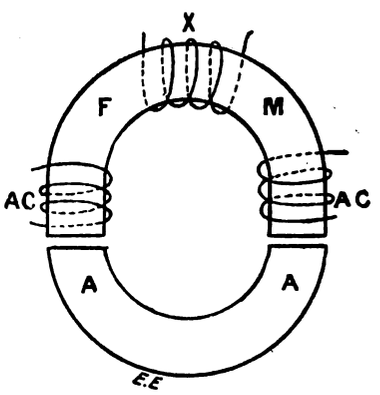

Fig. 2.

the aims of the inductor-alternator designer is to keep the flux constant. Fig. 3 is a great step in advance. Here we have, so to say, four hubs upon the field magnet, F M, and a rotating soft-iron piece, A A. Upon two opposing hubs are wound armature coils. It will be seen that the resistance of the magnetic field is the same whether A A is

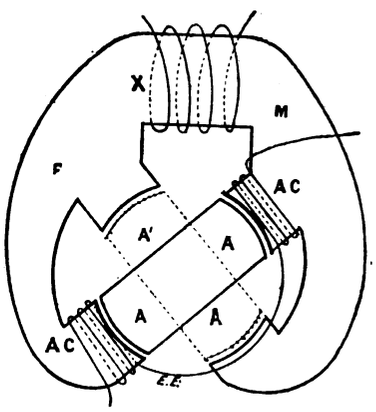

Fig. 3.

in the position shown by the strong lines, or in position A^1 A^1, shown by the dotted lines. The main part of the lines of force will pass through A A in whichever position it is, and when it is in the first position will also pass or link the armature coils, A C A C. If the armature coils are wound in series, the current is the sum of the currents in each coil. When the iron is in the position shown by the dotted lines, there is no linkage through A C A C, and so we get the reverse current by

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the unlinking. Of course, in the form shown (Fig. 3), the resistance of the magnetic circuit will vary as A A passes from one position to the other, and so there will be variations in the number of lines generated in the field. It would, however, be easy to minimise the variation in resistance, and hence in number of lines, by having the hubs practically continuous, except where a space was sunk into the face of the pole-piece to insert the armature coil. Fig. 4 is a section of a machine as designed by Von Dolivo Dobrowolsky, and manufactured by the Allgemeine

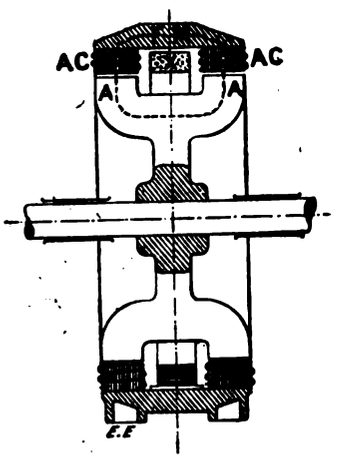

FIG. 4.

Elektricitäts-Gesellschaft of Berlin. The magnetic circuit is completed by an outer case, F M, and its path is shown by the dotted line. A C, A C show the armature coils, which for clearness the illustration shows fully instead of merely in section; X shows a section of the field-magnet

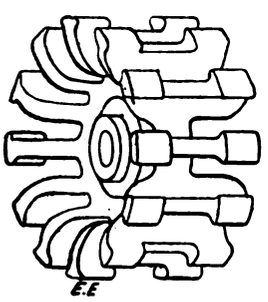

FIG. 5.

coils; A A is the soft-iron rotating piece. Fig. 5 shows the whole rotary part of the machine. The pole-pieces of the inductor wheel give rise on the inner face of the armature rings to points of very uneven distribution of field, so that by rotating the inductor the armature coils

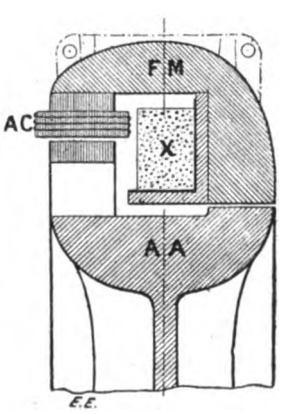

FIG. 6

have constantly varying linkages, and, as we have seen, the rate of linkage or unlinkage determines the pressure and current obtained. Of course, the iron is laminated where necessary. Fig. 6 shows one of the methods—the single form—adopted by Mr. Mordey. It is said, but we have no authorised figures, that his most recent machine gives an efficiency equal to that of any other alternator. The stationary ring is made in halves and carried from the base-plate. On one side is a ring of laminated iron with grooves on its inner face, and upon this ring the armature coils, A C, are placed. Fig. 7 perhaps shows the construction more clearly.

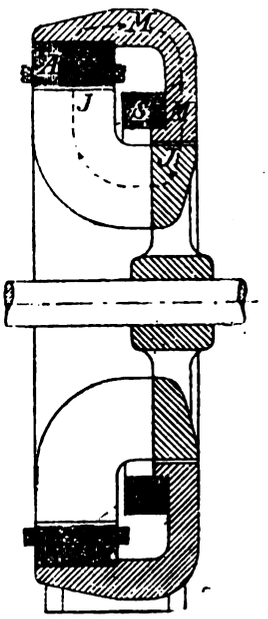

FIG. 7.

This is a section of a machine described by Dolivo Dobrowolsky, in which bar winding is used, and where each of the coils consists of only one copper bar. Machines of this type have been installed for some years at Strassburg. There the 400-h.p. machine has an output of 280 kilowatts at 2,750 volts. It has 40 poles and revolves 150 times per minute. The excitation requires 4,000 watts, or about 1·4 per cent. The hysteresis loss is about 1·3 per cent. Thus we obtain economic excitation, a very small drop in potential, small hysteresis loss, and mechanical simplicity.

A SYSTEM OF HIGH-VOLTAGE FITTINGS.

The introduction by central stations of higher voltages in houses has been somewhat sudden, but there is evidence of a tendency of this system becoming general. One of the main difficulties that the central station had to contend with was the lack of proper fittings, but on this point, as well as on the question of supplying good lamps, the central-station managers are relying on the manufacturers to supply them as the demand increases. In this we have no doubt they will not be disappointed, and soon there will be no more danger or difficulty in installing houses for the higher voltages than for the ordinary 100-volt circuits.

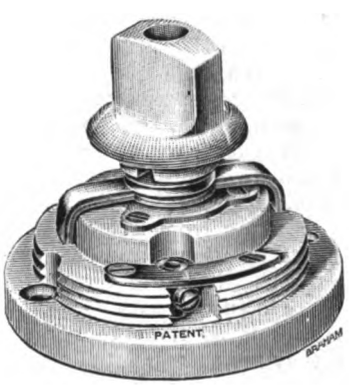

FIG. 1.

The General Electric Company, of London and Manchester, have constructed and patented a system of switches, fuses, wall plugs, ceiling roses, etc., adapted for use on circuits of high voltage—*i.e.*, from 150 to 250 volts. These fittings, shown below, are mainly made of china, and a leading feature is the introduction of china walls or partitions between the conducting parts of opposite polarity and

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between points upon which the circuit is broken. This novel construction of such fittings does not materially increase their size, simplicity, or effective working, but it prevents the forming of destructive arcs. They are thoroughly fireproof, and are especially designed to prevent short-circuits or accidental shocks.

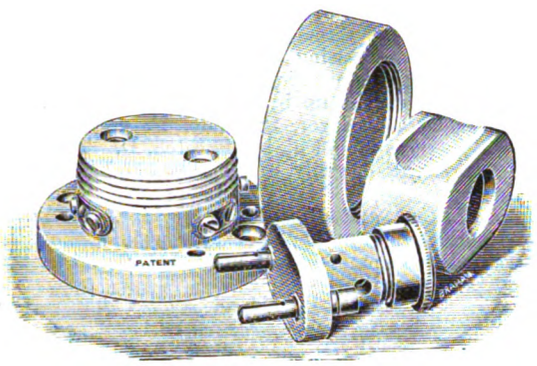

FIG. 2.

H. V. High-Voltage Switch.—This switch (Fig. 1) is made with bridge contacts, and has double-break action. The central brass plates, screw, and spring action are placed inside the china protected recess. Their construction ensures a quick and long break. It will be seen that the

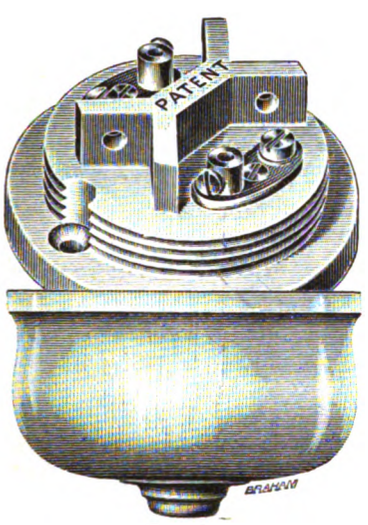

FIG. 3.

design of this switch renders it impossible for the arc to jump over or follow the contact when broken, this being one of the principal precautions required with such switches.

Wall Plug.—One of the weakest parts of a house installation is often at the wall plugs. These fittings contain both

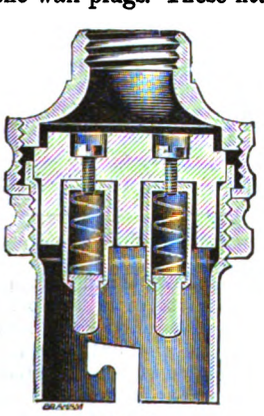

FIG. 4.

poles, and are frequently handled carelessly by the users, thus being often the cause of short-circuits, shocks, and breaking of fuses, and we consider those in use at present entirely unsuited for high voltages. The wall plug we illustrate (Fig. 2) is no doubt safe in these respects. The connecting tubes are embedded inside a circular piece of solid china. Their breaking points are about 1in. apart. The terminals are connected on the outer circumference of the china block, and can be wired direct, with or without fuses. The removable plug is so constructed that it divides the two flexible cords carrying the opposite poles, and at the same time forms a safe and effective cord grip.

Ceiling Rose.—The ceiling rose, illustrated by Fig. 3, is divided by a china wall so as to separate the terminals. The flexible cord carrying the current is wired through two holes on the opposite side wings of the china wall, which thus act as cord grips.

Lampholders.—In the lampholders (of the bayonet

FIG. 5.

pattern), Figs. 4 and 5, the spring terminals are fitted on china with walls in the form of the letter "S," protecting the conducting parts from possible short-circuits, as shown in the illustration. If desired, a porcelain liner is supplied in place of the brass liner, thus forming a perfectly insulated holder for high-voltage lamps.

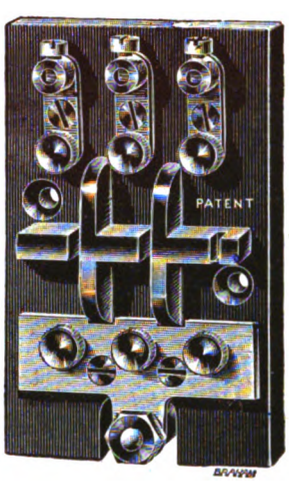

FIG. 6.

Cut-Out Board.—We give also an illustration of a cut-out board (Fig. 6), which is called the patent R.T. cut-out. It will be noticed that a china piece divides the terminals, and that this piece again is provided with slots, in which the fuses are placed. Its effect is to prevent destructive arcing, mostly set up under the sudden break of the fuses. These R.T. cut-outs form part of a system of fuses which is now being worked out by the General Electric Company in connection with the question of high-voltage fuses.

INSTITUTION OF ELECTRICAL ENGINEERS, Jan. 28.

Sir HENRY MANCE (president) in the chair.

ELECTRIC INTERLOCKING THE BLOCK AND MECHANICAL SIGNALS ON RAILWAYS.

BY F. T. HOLLINS (MEMBER).

(Concluded from page 181.)

Although it is exceedingly rare for a failure to take place on the wrong side (that is, the lock to be taken out before the train arrives), there is always the element of possibility that in any form of rail contact it may do so. In order to avoid this I have devised a simple means for ordinary through rail contacts which should practically extinguish this form of failure. At the spot where the rail contact is fixed one of the rails is insulated at each end from the adjoining rail (see Fig. 21), the usual metal fishplates being insulated from the rails (or they may be replaced by oak blocks), and the positive pole of the rail contact battery, which is in a box on the spot, instead of going direct to earth,

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is attached thereto. The battery is then only joined up to earth by the axle and wheels connecting the insulated rail to the opposite rail (which is making good earth), at the exact moment when it is wanted—that is, just as the wheels are passing over the rail, the deflection of which manipulates the rail contact. It should be remembered that with Sykes's locking the rail contact is not connected to the instrument at all until the signal is taken off for the train.

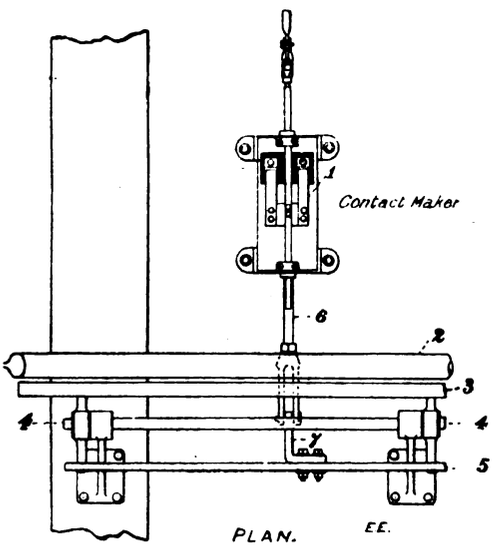

FIG. 19.

The Electric Fouling Bar.—At certain points after passing through a section a train may not require to go into the section in advance, or it may be required to shunt into a siding to let a following train pass, and in this case it would not pass over the sectional rail contact. To provide for this, at the entrance of, but inside, the sidings a Sykes's electric fouling bar (Figs. 19 and 20) is fixed, of sufficient length to ensure that any vehicles entering shall always have at least one wheel on the bar to depress it. A few yards further in the sidings a rail contact is fixed. The depression of the bar by actuating the switch, 1, breaks down the rail contact circuit, so that although the latter is operated as the engine passes over it, it does not release the back lock until the last vehicle has passed over the bar. This ensures the tail of the train being clear of the main line before a following train can be accepted. In Fig. 20 the rail is shown at 2, and the flange of each wheel depresses the bar, 3 (the axis of which is at 4), raising the heavy balanced end, 5, and pulling the rod, 6, connected thereto by the angle-piece, 7, and actuating the switch, 1. At very busy points it is sometimes desirable (in order to get the traffic through quickly) to allow more than one train in a block section, and this can be done with safety with Sykes's system. An advance starting signal is placed well ahead in the section, between two cabins, and is electrically controlled by the signalman ahead. A train being accepted from the rear may be passed out of that section over a rail contact to release the starting signal back lock, up to the advance signal, and the starting signal put to danger behind it. Another train can then be

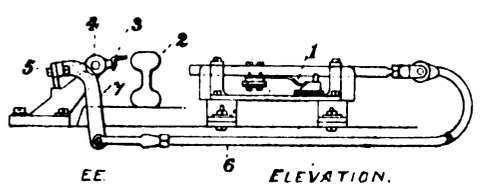

FIG. 20.

accepted from the rear. The starting signal (apart from the mechanical locking) cannot again be pulled off for the second train until the advance signal has been lowered and the first train passed over a rail contact, ahead of that signal, and the signal put to danger and relocked. Then the starting signal is free for the second train, and so on. We may, therefore, have a train between "A" and "B," another between "B" and his advance signal, and a third between that signal and cabin "C," all fully protected.

Sykes's Signal Reverser.—In some cases it is desirable for the train *itself* to automatically place the advance signal to danger, independently of the signalman. A Sykes's signal reverser is fixed between the balance-weight lever and the signal arm, and moves with the upright rod when the arm is lowered. On the train passing over the rail contact, part of the current transmitted therefrom is used to discharge this signal reverser (and the arm goes to danger) at the same time as the back lock of the lever is released in the signal-box. On putting back this lever (which is then locked) it re-engages with the reverser, ready for lowering for the next train. Figs. 22, 23, and 24 show this reverser in its three positions. In Figs. 22 and 23 the signal arm is lowered, and on the train passing over the rail contact ahead, a current is transmitted through the electro-magnet coils, M, which attracts armature, A, and releases the hammer, B, and this, falling on rod, C (see Fig. 23), disengages the catch, D, from roller arm, E; and slide, F, being bevelled, the top weight of the signal arm, the rod and the apparatus falling by gravity and raising the signal arm, forces the roller arm, E, to assume the position shown in Fig. 24, where the hammer is again caught up by the armature, A. When the signalman replaces his lever, the slide, F, moves downward, and the roller arm is caught up by the catch, D. The apparatus is simple, works satisfactorily, and deserves to be more largely used.

Siding, Junction, and Cross-Over Working.—No system of electric interlocking can hope for very wide application that does not specially commend itself, not only for ordinary through

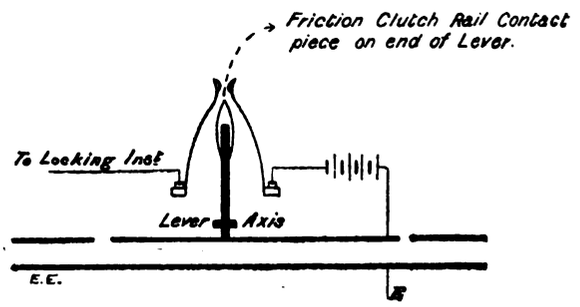

FIG. 21.

working (which is comparatively easy), but as equally safe and applicable for siding, junction, and cross-over working. On the Great Eastern Railway we have found Sykes's system specially suitable, and we have largely taken advantage of its

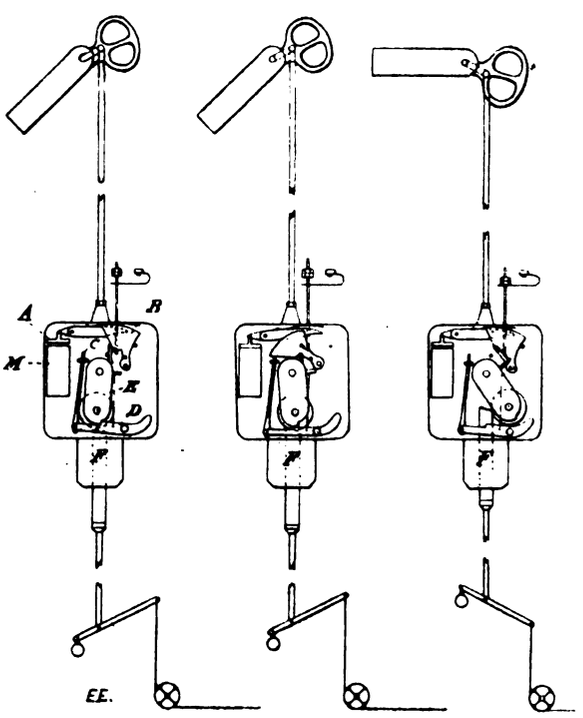

FIG. 22. FIG. 23. FIG. 24.

facilities by providing, I believe, the most complete arrangements yet devised for avoiding mistakes at such points.

Junction Interlocking.—At junctions of converging lines, with very short sections, whilst the ordinary electric interlocking prevents trains being simultaneously accepted from both lines, the locking instruments are so interlocked with the points that the points for a down road must be set so that an up train accepted could not possibly cross the path of a down train, and *vice versâ*. Diagram Fig. 25 will best illustrate what is meant. All the through lines, sidings, carriage roads, etc., are left out, only the lines concerned being shown, and the one signal referred to. Now (with reference to Fig. 25), before Central Junction can plunge to accept, and unlock the section signal for, an up train, from Polygon, he must set his down local points for down local to main, so that a down train could not possibly pass across the path of the up train accepted from Polygon. When this point lever, 1 (Fig. 26), down local to main, is back in the frame, the small lever, 2, on the instrument shelf is

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unlocked. Pulling over this small lever unlocks the plunger, 3, by raising rod, 4, enabling the up train to be accepted, but the same motion of the small lever, raising the locking-piece, 5, on the rod, 4, into the slot, 6, in the tappet, 7, mechanically locks the down points as set, and at the same time the armature, 8, is raised up to the coils, 9, and the small wheel, 10, passing under the angle-piece, 11, on the rod, 4, this small lever is itself, as well as the points, electrically locked. He may now plunge to accept the up train, and he can neither alter the points, the small lever, or the plunger, until the train has passed a rail contact at point, A (see Fig. 25), on the platform line, and is either standing at the starting signal, B, at *danger*, or if the latter is "off" (which would then mechanically lock the same points, and be itself back-locked electrically), until the tail of the train has arrived well over the down road, and the signal again put to danger behind it. The small lever, being unlocked by the current from the rail contact at A, and the starting signal at B being to danger, the points may be altered to down local; but this, by preventing the rod, 4, from being raised (it cannot be unless the locking-piece, 5, coincides with the slot in the tappet, 7), again locks the small lever, and prevents another up train being accepted from Polygon. This arrangement is essential, because, being at a platform, we may require the train to stand there, with the signal at danger, so that a train *may* be allowed to cross its path on the down local. At other nearly similar converging lines, but not at a platform, the signalman is compelled to lower his home signal for one line (which, of course, mechanically locks the lever of the home signal for the other converging line, and the signal for the opposite road, that would cross its path) before he can plunge to accept a train in either direction. And such home signal being lowered enables the signalman to plunge and unlock the starting signal for the same line at the rear box, but the plunger and the signal alike remain locked in that position until the train so accepted has arrived and passed over the rail contact at the clearing point.

Sidings and Cross-Over Connections.—Again, in the case of sidings and cross-overs, this same electrical and mechanical locking between points and plungers comes in. If a train has been plunged for—that is, the rear box starting signal electri-

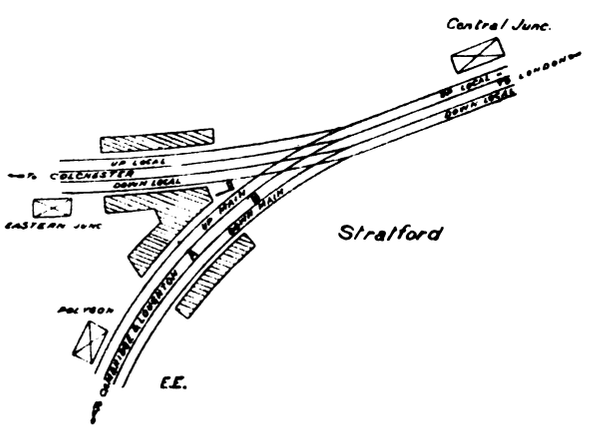

FIG. 25.

cally released—the points leading from the sidings to the up line are locked. But if the points are already over for a train from the sidings, then an up train cannot be accepted from the rear. And if the train from the sidings requires to cross over to the down line, if the points are so set, a down train cannot be accepted, but if a down train *has* been accepted, the cross-over points to the down road cannot be got until the accepted train has passed and the road is clear.

Crossing Trains from Down to Up or Up to Down Lines.—Here, again, is another application of interlocking between points and section plunger. A small Sykes's lever is fixed in the up plunging instrument, which, pulled from right to left, locks the up plunger and unlocks the points. Pulling over the points locks this small Sykes's lever, as previously explained, in this position. If a train is to be crossed from the up to the down road, the signalman must go through the reverse motions. If, however, an up train *has been* accepted, he is unable to move the cross-over points from down to up; and if a down train *has been* accepted, he is unable to move the cross-over points from up to down, until such trains have passed clear of the section concerned. The small lever normally controls the points. Moved over, it controls the plunger and releases the points, and, the points being moved, locks the small lever in that position. And here I think I ought to point out why it seems to me Sykes's system lends itself most effectually, in the simplest manner, and at the least expense, to sidings, junction, and cross-over working. I have heard it said, even by those for whose opinions on the subject I have the greatest respect, that they have not, and do not require, in their interlocking any back lock for keeping the signal off until the train itself arrives and releases it. They can, it is claimed, always put the signal to danger with their systems. Quite so, and, unfortunately, the lever right back in the frame. It is, I submit, just that which they ought not to be able to do, because, as the lever can be put back in the frame it releases conflicting point levers and signals otherwise held locked at danger by the ordinary mechanical locking. For instance, at a junction of converging lines, and where an up train for one road would cross the down road for the other, and *vice versâ*, and the locking of which is on the two home signals, it only requires one of the rods or blades in each Sykes's instrument to be about 1½in. longer than usual to prevent plunging until the home signal is taken off. When it *is* off it is electrically back-locked in that position, and you may safely plunge for a train, because it has itself locked, by the mechanical locking, the other contrary signals. There are many variations of this combination of the locking instrument, the plunger, and the points, together with the small Sykes's lever, to effect different purposes and facilitate traffic generally, whilst ensuring that every train is within the protection of one or other of the stop signals; sometimes between home and starting signals, and sometimes between the latter and the advance starting signals, the back motion of the leading signal taking the front lock out of the rear signal, and separate rail contacts taking the back locks out of both. Within the limits of this paper it would not be possible to give, however interesting it might be, the details of the electro-mechanical devices

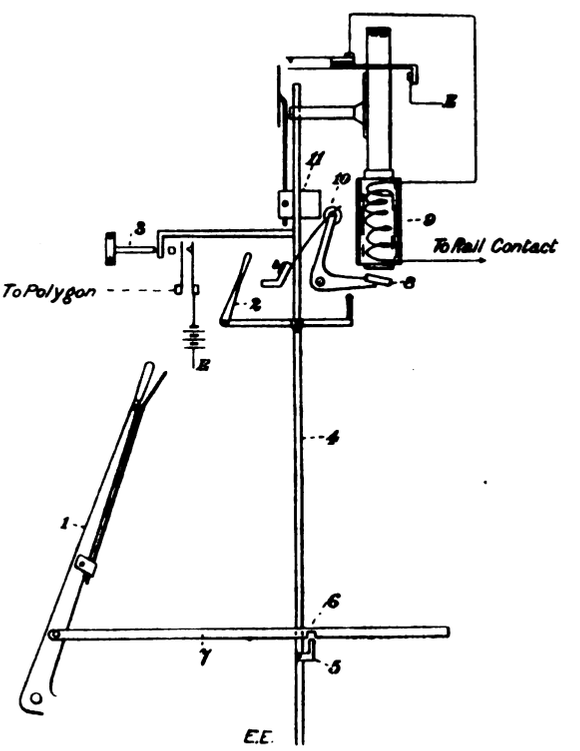

FIG. 26.

in use for safely facilitating the traffic in busy stations like Waterloo, Cannon-street, and Liverpool-street Stations. A lucid description of the electrical devices and combinations for checking and controlling, advising, and reminding, and generally assisting the signalmen in safely working the enormous amount of traffic at the different London terminal stations, would be amply sufficient to warrant a most interesting paper on this subject alone.

Cancelling Trains and Resetting Apparatus.—Unfortunately, in all systems of electric interlocking, the exigencies of the traffic seem to necessitate the provision of a key, or switch, or other means, to release in cases of emergency. A train which has been accepted may not have to pass through the section, and requires to be cancelled; a defective plunge may not have released the lock (through no defect in the apparatus), or the rail contact may occasionally fail to release the plunger, releasing key, or back lock of the signal lever; or for other reasons. Then the instrument requires to be reset. Undoubtedly, the possession of this key in the hands of signalmen, whatever form it may take, is a distinct menace to the security of electric interlocking. Used for its legitimate purpose, only when justified, it is, of course, an advantage in facilitating traffic; and some means *must* be provided to meet such cases, if disastrous delays are to be avoided, on busy lines. It seems to me that neither the key, nor its equivalent, should be available for use at any one box without the sanction and concurrence of the signalman in advance or the signalman in the rear, just according to the purpose for which it is wanted. There are two advantages in this—the concurrence

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of two men at a distance equally responsible, and *proof of the fact of its being used.* I suggest it can be done without extra line wire by using the bell or locking wire, or both. In the case of cancelling, where the plunger or key only is locked and requires releasing, after accepting a train, it is the sanction of the signalman in the rear that should be necessary. Where the train does *not* pass through the section, and over the rail contact, or the rail contact fails to release the back lock after the signal has been lowered, it is the signalman in advance whose sanction and concurrent action should be essential. With the Sykes instrument, unlock the shutter, so that the plunger may be reset in case of cancelling or a defective plunge, are marked D, and are in the locking circuit. The corresponding keys or switches to be depressed in order to *receive* and divert that current to the little shutter locking coil are marked E, and the coils themselves are marked F. In practice, unless the shutter is completely covering the keyhole (in which case the key must be out), the locking circuit is broken down at X. Of course, this is only one way of applying the principle, and it is applicable to any system, and by a separate wire, or otherwise, as desired.

Fig. 27

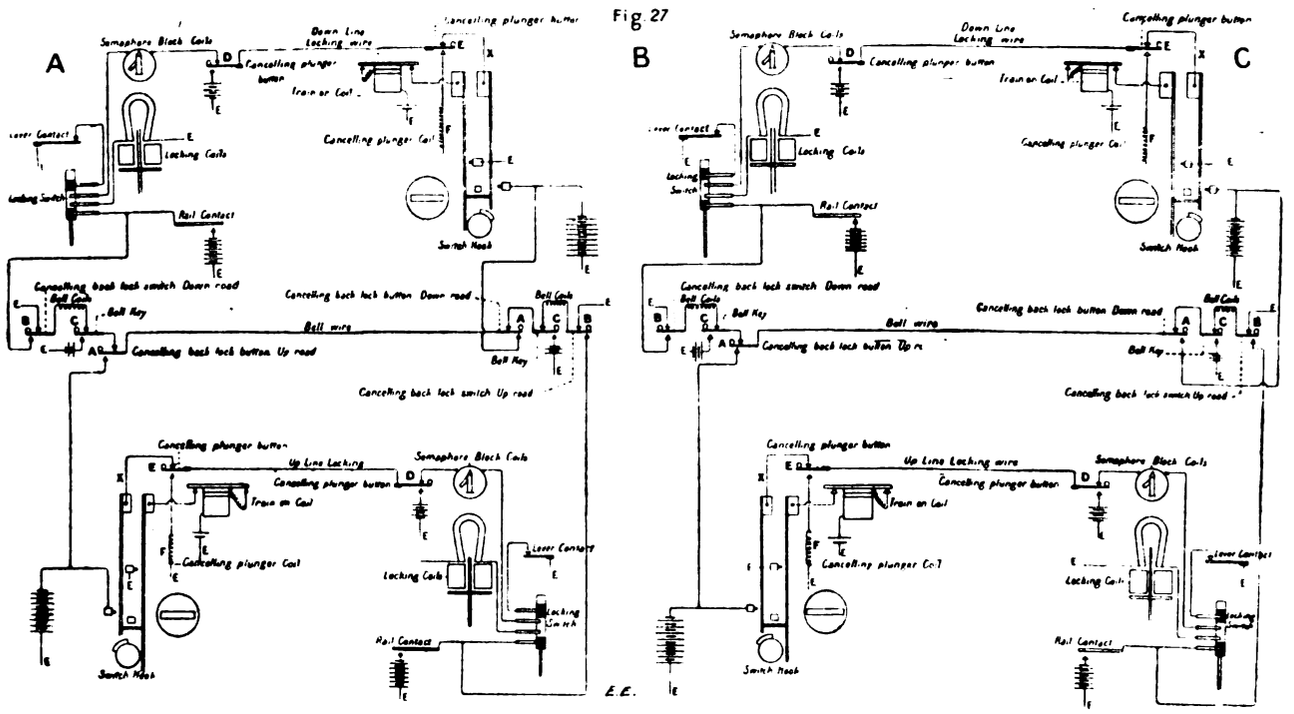

FIG. 27.

to release the plunger a small electromagnet may be fixed, normally locking the shutter over the keyhole, and thus preventing the key from being put into the instrument, to raise the "Train accepted" disc, without a current from the rear box. In addition to this, the arrangement provides that, unless the key is withdrawn from the instrument and the shutter placed over the keyhole, the block bell circuit, or the locking circuit, shall be broken down. This arrangement, necessitating the permission by current from the rear, also limits the use to the occasion, and the particular instrument for which permission is given. To ask for the release of the back lock (or the plunger, or accepting key, in other systems), a bell signal may be given to the box in advance, indicating that a current is required to release the back lock or accepting key. The signalman asking would then depress his receiving key, to switch the current to the locking coils. The actual current would not only unlock the lever, but ring the bell, indicating that the current had passed to the locking instrument. A record of this at both places could be made in the train-book. Diagram Fig. 27 indicates the complete electrical connections of Sykes's system, and the arrangement applied thereto. The coils to be acted upon for the back lock being polarised, these permissive currents on the bell wire would be of opposite polarity to the bell currents, as the bell battery is joined up with the reverse pole to earth, so that its current would not actuate them. This ensures that the current transmitted shall be the one *intended for the purpose.* I have brought a model installation of Sykes's system, representing three stations, "A," "B," and "C" (it was used for teaching our signalmen the system of working); and it is fitted with the arrangement for "B" to be respectively released, as regards the plunger, from "A," and, as regards the back lock, from "C," so as to practically demonstrate its applicability. It will be seen by Diagram Fig. 27 that the plunger releasing is done on the locking wire, and the back lock releasing on the bell wire. The whole additional fittings for each box, with Sykes's system, is a small coil for each locking instrument, and one or two good keys or three-way press buttons. In Diagram Fig. 27 the keys, or press buttons, or switches, to *transmit* a current to the rear to release the back lock (equivalent to actuating the rail contact) are marked A; the keys or switches requiring to be depressed to *receive* and divert that current to the coils required are marked B; and the ordinary bell keys—which are, of course, in actual practice a structural part of the bell itself—are marked C, all in the bell wire. The keys or switches to *transmit* the current to the box in advance, to

Sykes's Selector.—Mr. Sykes has recently brought under my notice an electrical selector for signals (one form of which is in use at Waterloo Station), which is a device to be applied where several arms are attached to one post, so that one lever and one signal wire can operate any one of the arms upon that post according to the points which have been set. It is thus a point

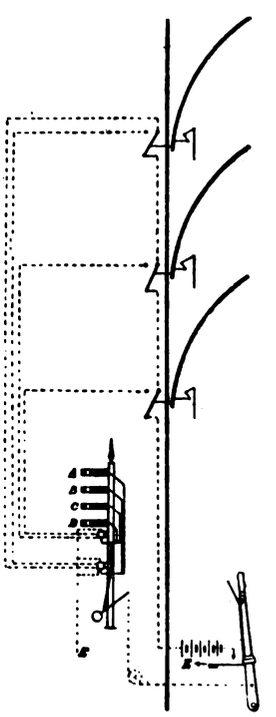

FIG. 28.

detector combined with a signal selector, and none of the arms can be operated except in the signal-box. Neither pulling the signal wire outside or lifting the rod at the signal moves any of the arms; *the points must be set and the lever in the box operated.* Pulling the particular point lever that is wanted (providing the points are properly closed) operates the selector, and

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pulling the signal lever lowers the signal for that road only for which the points are set. The one upright road on the signal, operated by the signal lever, is coupled to the middle of as many sway beams as there are arms, one end of each of which is attached to the rod belonging to each arm. Normally pulling the lever without first operating the points lowers the arm for the through road only. If any particular points are operated this actuates the corresponding selector, the loose end of the sway beam belonging to the signal arm for that road is held down, and if the upright rod is now moved up it becomes the fulcrum which raises the end of the sway beam attached to that arm and lowers the signal. Diagram Fig. 28 further clearly shows the electrical arrangement, and a model is on the table.

In conclusion, the question may be asked, "Who was the first and true inventor of electrical interlocking?" The extended application and importance of the subject suggests there being more than one claimant. If we may assume absolute block working to be the only real block working, and that electric interlocking is not absolute without a rail contact, then Mr. Edward Tyer has an early claim. In 1852, and 1854 also, he devised and had in use a rail contact depending upon the deflection of the rail by an engine or train to automatically and electrically indicate the passing of such train over certain points. In 1869 he patented a complete system of electric interlocking and block for controlling the signal and point levers in combination with the block, and he proposed to do electrically what is now done by mechanical interlocking—namely, prevent levers of all kinds being used except such as were required for the train being signalled, *and for the signalman in advance to have control of the section signal in the rear.* In 1870 Mr. W. H. Preece (and I think Mr. Langdon was associated with him in the invention) introduced an electric lock on the South-Western Railway, to be worked in connection with his system of block. Mr. W. R. Sykes claims that he, in 1872, introduced a rail contact to electrically manipulate railway signals, and in 1875 he introduced the first complete system of electric interlocking, making it necessary to have the concurrence of three stations—"A," "B," and "C"—to get two trains into one section. Mr. Spagnoletti was also early in the field with his arrangement of electric interlocking on the Metropolitan Railway, which I think was put in about 1882. Mr. Spagnoletti, however, in 1873, patented his system of clearing the road, or resetting the instrument, by a rail contact. Simplicity, efficiency, and reliability are to us, however, of more importance than questions of priority of invention of such apparatus; and the point may be left, I hope, to the friendly rivalry of the gentlemen named, all of whom deserve the most ungrudging and generous acknowledgment of what they have done in the cause of electric block signalling and electric interlocking on our railways.

APPENDIX I.

SYKES'S SYSTEM OF ELECTRIC INTERLOCKING IS IN USE AS UNDER.

Railway.	Number of levers locked.
Dublin, Wicklow, and Wexford	8
Great Eastern	1,022
Glasgow and South-Western	26
Hull and Barnsley	254
Liverpool Overhead	21
London and South-Western	1,051
London, Brighton, and South Coast	648
London, Chatham, and Dover	1,320
Metropolitan District	136
Mersey	121
South-Eastern	283

APPENDIX II.

DESCRIPTION OF BLOCK AND INTERLOCKING IN USE ON PRINCIPAL ENGLISH AND SCOTCH RAILWAYS.

Line of railway.	Description of block.	Electric interlocking and to what extent in use.
Caledonian ...	Tyer's three-plunger semaphore block.	Modified system of interlocking in combination with Tyer's three-plunger semaphore block on 50 sections of new City and Suburban lines.
Great Eastern.	Tyer's one-wire double line. Tyer's one-wire single line. Tyer's tablet block. Sykes's lock and block. Single-needle block on joint line, March to Doncaster.	Sykes's. Metropolitan District. Liverpool-street and Fenchurch-street to Ilford; on Colchester line; to Tottenham on Cambridge line; Woolwich and Enfield branches, and to Leyton on Loughton branch; in all, 50 signal-boxes and 1,022 levers.
Great Northern	Three-wire single needle and bell. Blakey & O'Donnell's apparatus. Sykes's electric slots and signal reversers.	Electric locking applied to 13 sections in various places.
Great Western	Spagnoletti's three-wire disc. Electric train staff, Webb and Thompson's. Tyer's one-wire block.	Spagnoletti's at about 12 different points. Spagnoletti's one-wire on Hammersmith and City joint lines.
Glasgow and South-Western	Tyer's one-wire. Tyer's train tablet.	None.
Lancashire and Yorkshire ...	Three-wire absolute and Tyer's one-wire.	Nicholson's electric locking at one or two boxes.
London, Brighton, and South Coast.....	Tyer's semaphore, 373 miles. Sykes's, 43 miles. Webb and Thompson's train staff, 50 miles.	Sykes's system, 43 miles. 11 miles (country district) Saxby and Farmer's.
London, Chatham, and Dover	Sykes's double-arm bell. S.N. instruments with bells (Metropolitan and Extension, and main line to Swanley).	Throughout. Sykes's, with 80 treadles. 67 Sykes's fouling bars. 57 Sykes's electric shunting signals. 76 electric facing-point detectors, etc.
London and North-Western	Three-wire constant current, and small portion one-wire.	None, except (in a few instance) electric interlocking between sidings at a distance from station, with controlling signal.
London and South-Western.....	Three-wire (Preece's). One-wire (Preece's). Tyer's tablets. Needle block and bells, three-wire.	Three-wire block and Sykes's interlocking, 111 miles. Tyer's tablets and Sykes's interlocking, 141 miles.
Hull and Barnsley	Webb and Thompson's tablet on branch line, 12 miles. Sykes's, about 60 miles.	Sykes's, 60 miles.
Manchester, Sheffield, and Lincolnshire..	Single needle three-wire.	Evans's interlocking for about 10 miles. Sykes's at Hawarden Bridge, and special arrangement of Mr. Hampson's at the two swingbridges at Keadley.
Metropolitan District	Sykes.	Sykes's system in use nearly throughout.
Metropolitan..	Spagnoletti's three-wire.	Spagnoletti's throughout.
Midland..	Single-needle three-wire.	Langdon's interlocking, about 12 to 15 sections.
North British.	Three-wire needle (Tyer's). One-wire needle (Tyer's). Tyer's tablet.	None.
North-Eastern	Three-wire single-needle. Webb and Thompson's train staff.	None.
North London	Pryce and Ferreira's three-wire throughout.	None.
South-Eastern.	Walker's one-wire semaphore improved	Sykes's throughout Charing Cross and Cannon-street lines. Safety bars at Cannon-street.
North Staffordshire	Tyer's one-wire and Neale's single-needle three-wire.	None.

At last night's meeting of the Institution the following candidates were balloted for:

Associates—J. H. C. Brooking, care of Messrs. W. T. Glover and Co., 39, Victoria-street, Westminster; Walter Wm. Crawford, 91, Pitt-street, Sydney, N.S.W.; William Cross, 69, Ravensdale-road, Stamford Hill, N.; Arthur Dennis, 23, Billiter-street, E.C.; John William Hame, 31, Crewdson-road, Brixton, S.W.; J. R. Hewitson, 12, Whitworth-road, Plumstead; J. Fraser Lister, Rivers, Dursley, Gloucestershire; Ernest Dinsdale Phillips, Central Technical College, Exhibition-road, S.W.; Norman Staniland, 33, Hartham-road, N.; Kenneth Watson, 10, Sparrow-hill, Loughborough; Burkewood Welbourn, Electro-Chemical Company, St. Helens, Lancashire.

Students.—Archibald Thorpe Crosher, 1, Richmond-villas, Walton-on-Naze; Otto Max Constantin Heyl and Herbert William Ottaway, Faraday House, Charing Cross-road, W.C.; Elias Marcuson, 13, Pyrland-road, Canonbury, N.; William Middleton, Oriel House, Chelmsford; E. A. Parkinson, Arc Works, Chelmsford; Ferdinand Edward Reiss, Hillside, Moulsham-street, Chelmsford.

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TO CORRESPONDENTS.

All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notice of Meetings, Issue of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

All communications intended for the Editor should be addressed C. H. W. Biggs, *139-140, Salisbury Court, Fleet Street, London, E.C Anonymous communications will not be noticed.*

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CHARGES FOR ELECTRICITY.

The problem what is a fair and reasonable charge for the supply of electric energy in a given time, has often been discussed in our columns. The question, of course, chiefly arises in respect to municipal stations, which have been equipped by moneys guaranteed by the general ratepayers. In electric lighting companies the shareholders have found the capital, and in many cases taken the risks of development, and hence have a right to a return at more than bare investment rates. In a municipal undertaking the two interests to be considered are: first, those of the general ratepayers; and, secondly, those of the ratepayers who become consumers. If the electric light department pays the charges for interest and sinking fund on the loan which was raised to provide for the first outlay, the ratepayers as a body have no further claim on any balance of revenue over cost of supply. Any application of such balance to the relief of the general rates is clearly a tax on the electric light consumers. Even on the above-mentioned basis these consumers will in about twenty-five years give to the town the valuable asset of an electric light station in full working order and free of capital charges. Hence the consumers may justly expect to be charged only a sufficient amount to keep the station in thorough working repair, besides paying all outgoing and capital charges. The question as to how much each individual consumer should be required to pay is even yet an open matter. Mr. Arthur Wright, of Brighton, has taken a most active part in this controversy, and the recently revised tariffs at Brighton show that he is ably supported by his committee in his views on the subject. The gist of his reasoning is as follows: The capital outlay on the station is determined by the maximum output demanded by the whole of the consumers. A large number of the other charges in connection with the supply are also functions of this maximum output. The other part of the cost is made up of coal, water, etc., which is proportional to the units actually supplied. This portion of the total cost is in all English electric light stations much smaller than the former. The following facts are then required about the consumer's demand for electric energy: first, what is his maximum demand at any time throughout the year; and secondly, how many units does he consume per annum? The charge is then made at two rates per unit, the first approximately sufficient to cover the standing and capital charges if the consumer takes his maximum demand for an average of, say, one hour per day. Having then paid his due share of these charges, any electricity required in excess is charged at the lower rate, which covers the outlay cost only. At Brighton, until recently, these two charges have been 7d. and 3d. respectively, but the charge for the extra units has now been reduced to 1½d. Hence, the shopkeeper who burns his lights for four hours per day regularly will be charged at an average price of 2·87d., and the users of electric motors which run continuously will receive at an even lower rate. This method of reduction is in every way

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fairer than that of charging a uniform rate and giving discounts varying with the total quantity consumed, irrespective of the number of lights fixed. It also has not the tendency which a system of discounts, varied as the unit supplied per lamp, has of keeping the lamp connections down. Both these last systems have the disadvantages that consumers in certain cases by burning their lights to waste for a few hours at the end of the quarter may get a considerable reduction in their bill.

We trust that the new tariff in Brighton will have the desired result of increasing the output per unit of generating plant, and also of securing for the electricity works all the regular consumers of artificial light in the borough. We shall await with interest the balance-sheet of this undertaking for the present year.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

THE PRINCE OF WALES'S JUBILEE FUND.

SIR,—Permit me to send you a copy of a letter which I have addressed to the President of the Institute of Electrical Engineers.—Yours, etc., S. FLOOD PAGE.

10*a*, St. George's-square, S.W.
February 8, 1897.

Dear Sir,—Scientific electricity, as we now know it, is essentially a product of her Majesty's reign, while commercial and industrial electricity have had their rise in very recent years. No more important application of science to industry has been achieved during her Majesty's reign than that which we are witnessing day by day in the application of electricity to effect work in many forms.

This being so, I venture to address you, as the President of the Institute of Electrical Engineers, to suggest that the above facts form sufficient ground for united action on the part of the whole of those connected with electricity, whether in its scientific, commercial, or industrial aspect, in supporting the appropriate effort of his Royal Highness the Prince of Wales to relieve the hospitals of London from their burden of debt, and to place these most useful and valuable institutions on a sound financial footing. I beg, therefore, to suggest that you should convene a meeting of all those who are engaged in any branch of electrical work in the Metropolis, whether with cables, telegraphs, telephones, light, or traction, and that as our president you will place yourself at the head of this movement, with a view to enlisting the hearty co-operation of all electricians in assisting this proposed fund; for if we can avail ourselves of the present effort to place the hospitals of London on a sound financial footing, we may rest assured they will remain permanently, and be of the same great advantage to future generations as they are now and have been in past years.

I am impressed with a strong belief that if you would initiate such a movement, and will give the influence of your high official and personal position in support of the proposal of the Prince of Wales, electricians of all ranks will subscribe a sufficient annual amount as to repay your efforts, and to manifest their liberality and loyalty. The wages classes already prove their interest in our hospitals by the amount they collect for the Saturday Hospital Fund, and I hope that arrangements will be made not only for annual subscriptions of pounds, but also in our electrical workshops and central stations for annual subscriptions of one or more shillings.

I trust that, as this is a matter of public interest, you will pardon my sending a copy of this letter to the electrical Press, as well as to the chairman of the Electrical Section of the London Chamber of Commerce.—I remain, dear Sir, yours faithfully,

S. FLOOD PAGE.

Sir Henry Mance, President of the Institute of Electrical Engineers.

Cadiz.—It is stated in *Electron* that an electric tramway will shortly be in work at Cadiz. It is to run from the Parque Genovés to San-José without. The preliminaries are concluded and the work is in progress.

FORTHCOMING EVENTS.

The following are some of the announcements for forthcoming week:

TO-DAY (FRIDAY).—Institution of Civil Engineers' Students' meeting ("Cooling Reservoirs for Condensing Engines," by Mr. Harold W. Barker). Mr. Henry Davey, M.I.C.E., will take the chair.—Junior Engineers, at Westminster Palace Hotel, at 8 p.m. ("Bridge and Girder Work").—Royal Institution (Prof. John Milne, F.R.S., F.G.S., on "Recent Advances in Seismology"), 9 p.m.—Physical Society ("Galvanometer Mirrors and Thermo-Electricity of Liquid Metals"), Burlington House, 5 p.m.

TO-MORROW (SATURDAY).—Royal Institution (Mr. Frewen Lord, on "The Growth of the Mediterranean Route to the East," first lecture).—Birkbeck Institute conversazione.

MONDAY, FEBRUARY 15.—Society of Arts, Cantor lecture ("The Industrial Uses of Cellulose," by Mr. C. F. Cross, F.C.S.), John-street, Adelphi, 8 p.m.—Western and Brazilian Telegraph Company's meeting.—Imperial Institute (Prof. Ayrton on "Submarine Telegraphy"), 8 p.m.

TUESDAY, FEBRUARY 16.—Institution of Civil Engineers (Discussion of Mr. Donaldson's paper).—Royal Institution (Prof. A. D. Waller, M.D., F.R.S., on "Animal Electricity," fifth lecture), 3 p.m.—Junior Engineers ("Dynamo Design").—Society of Arts (Mr. Colmer on "The Progress of Canada"), the Marquis of Lorne in the chair.

WEDNESDAY, FEBRUARY 17.—Institution of Electrical Engineers' Students' meeting (Mr. Lemmens on "Incandescent Lamps").—Meteorological Society (Mr. Mawley on "Phenological Observations," and Mr. Rollo Russell on "Haze at Haslemere"), at the Civil Engineers, 7.30 p.m.—Society of Arts ("Light Railways," by Mr. Everard Calthrop). The Attorney-General will preside.—Also at Manchester, meeting of the Federated Institution of Mining Engineers, Town Hall, 12 noon.—And at Liverpool, Liverpool Engineering Society (Mr. Pierce on "The Rating of Engineering Works").

THURSDAY, FEBRUARY 18.—Royal Institution (Dr. J. W. Gregory, F.R.S., on "The Problems of Arctic Geology, Lecture II.), 3 p.m.—Society of Arts, Howard Lecture (Prof. Ewing on "The Production of Cold").—Institution of Civil Engineers' Students' visit to the Locomotive Works of the Great Eastern Railway Company at Stratford (train leaves Liverpool-street at 2.8 p.m.).—London Chamber of Commerce (Mr. F. Begg on "The Colonies"), 2.30 p m.

FRIDAY, FEBRUARY 19.—Royal Institution (Dr. G. Johnstone Stoney on "The Approaching Return of the Great Swarm of November Meteors"), 9 p.m.—Also at Paris, meeting of the French Civil Engineers.

SATURDAY, FEBRUARY 20.—Royal Institution (Mr. Lord's second lecture)—Junior Engineers' visit to the Fire Brigade Headquarters, 3 p.m.

HAND-FEED ELECTRIC LAMP FOR LANTERNS.*

BY GEORGE M. HOPKINS.

While a good automatic lamp is undoubtedly preferable to a hand lamp for uses necessitating the absence of the operator from the vicinity of the lamp, it is certain that an ordinary hand lamp is not to be despised, and when the hand feed is supplemented with a magnetic device for striking the arc, the difference between the two types of lamps referred to is not to the disadvantage of the hand lamp when the latter is used in a lantern or for some other purpose which permits the operator to remain near the lamp, so that he may adjust it at intervals of about four or five minutes.

The lamp shown in the illustration has been used for an entire evening without a flicker. The upper, or positive carbon, is cored, and the lower, or negative, is solid, hard Carré carbon. On the threaded rod extending upward from the base-plate is placed the sleeve, *a*, which is connected with the slide-holder so as to have a slight inclination, as is usual in lamps for lanterns, in order to expose more of the face of the crater of the upper carbon. The slide-holder contains two slotted slides—the one holding the upper carbon being 7½in. long, the one holding the lower carbon being 5½in. long, each being 1¼in. wide. To the lower end of the lower slide at *b* is pivoted an arm extending outwardly and supporting the lower carbon-

* From the *Scientific American*.

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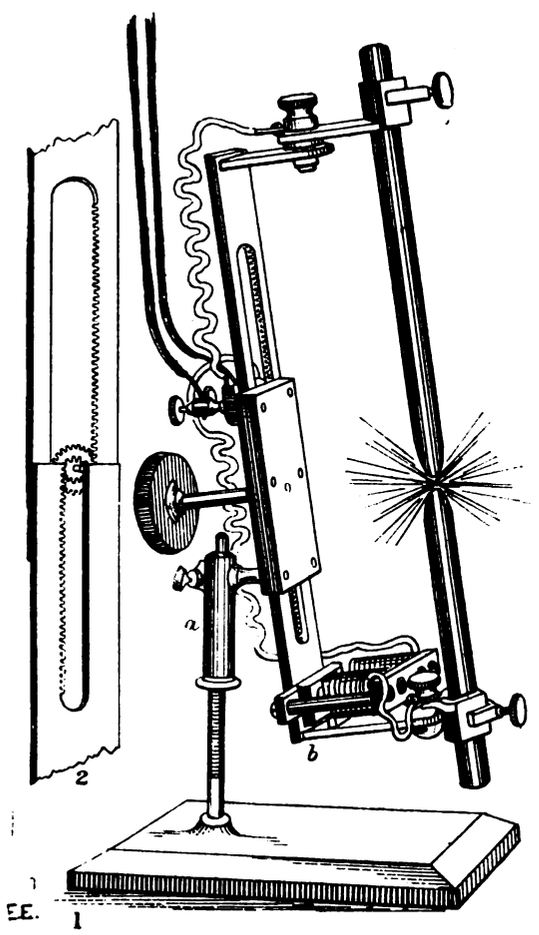
holding socket. To the arm near the joint thereof is secured an upwardly extending stud carrying an armature. An electromagnet having an elongated yoke is supported in front of the armature by brass studs attached to a brass cross-arm fixed to the lower slide. A curved brass spring fastened to the armature bears on the poles of the magnet and serves the double purpose of throwing the armature back and the carbon upwardly when the armature is released, and of preventing the armature from sticking to the magnet. The upper carbon-holding slide is provided with a fixed arm extending outwardly and supporting an insulated carbon-holding socket. These sockets are connected with their respective arms by bolts, which are surrounded with soap-stone insulators provided with flanges which separate the sockets and the arms. The heads of the bolts are insulated by means of mica washers. The holes through which the bolts extend are made oblong to permit of adjusting the carbons in a way to secure the best results—that is, by arranging the point of the lower carbon so that it will be slightly in front of the axial line of the upper carbon when



Hand-Feed Electric Lamp.

the lamp is in operation. In the slots of the carbon-holding slides are secured racks, which engage pinions on the spindle journaled in the slide-holder (Fig. 2). The pinion for the lower carbon slide has half as many teeth as there are in the pinion for the upper slide, so that when the spindle is turned by the rubber handwheel the carbons are moved in proportion to their relative consumption. To an insulating strip attached to the back of the slide-holder are secured two binding posts for receiving the wires connecting the lamp with the current supply. One binding post is connected with one terminal of the magnet, and the other terminal of the magnet is connected with the lower carbon socket. The other binding post is connected with the upper carbon socket. The magnet is wound with coarse wire (No. 16 or No. 14), and the armature is adjusted to pull down the lower carbon about $\frac{1}{8}$in. The carbon-holding sockets are formed of square brass tubing, with a screw at one angle which forces the carbon toward the opposite angle, and thus centres and aligns the carbons.

The Edison direct current is suited to this lamp when about 15 ohms resistance is introduced in series with the lamp. A suitable range of current is eight to twelve amperes. The great advantage of the arc-striking device is that after the carbons touch the arc is instantly formed of the right length, thus saving the trouble of any fine adjustment by hand, and avoiding the possibility of any long continuance of a heavy current on the circuit. A very slight turn of the adjusting spindle once in about four minutes insures perfect steadiness. It is well to form a habit of thus regulating the arc after each change of slides. The illustrations are approximately one-third size.

NORTHERN SOCIETY OF ELECTRICAL ENGINEERS.

The following discussion took place upon the reading of the paper by Mr. L. Andrews on "A Few Practical Notes on Alternate-Current Switch-Gear" at the meeting of the above society held on January 25:

The President said it was greatly to be regretted that Mr. Andrews had had to leave his seaside home, where he hoped the water was warm enough to turn his thermometer red, to come up North, where the weather was bad enough to cause such a very small attendance. They had been extremely interested with the various ingenious contrivances and devices described, and he was pleased to see that the author recognised that the ethics governing a central station were those that should always obtain where two or three were gathered together working for the commonweal. It would not do at all if a large generator for some reason took it into its head to strike work, and call out the other men in the shop by blowing their fuses. Just because the machinery of an old goose had got out of order, it was not at all right that she should turn round on the young healthy ones, who were prepared to go on at an increased rate, if necessary, laying the golden eggs of supply. However, as there were several gentlemen in the room who were connected with alternating stations (Mr. Mountain had unfortunately just left to catch his train), they would be very pleased to hear their remarks on the best way of getting over the evils by keeping the generator up to its work. He was afraid that as they had such a small meeting, he must also ask those gentlemen who had not charge of alternators to give them their impression as to what they would do if they had.

Mr. Ferranti said unfortunately he was not connected with an alternating station or any other station, but he would give his opinions as an outsider, or one who was connected with an alternating station once upon a time. He did not know whether in listening to the author's paper any of the members realised the immense amount of work that must have been done by Mr. Andrews to get at the results which he had described. It showed a very distinct train of thought, which had been carried over a long period, and which was undoubtedly engendered by certain special circumstances of the case he had had to deal with. There were other stations in the country working on somewhat the same system, but different in their detail, where he thought that, if Mr. Andrews had been in charge, he would never have devised the ingenious system which he had shown them that night. He believed, with regard to the first point, that it was customary at a good many stations to synchronise with small fuses. These were the stations employing alternators without iron in the armature of very low self-induction, and where the machines could give a dangerously large rush of current if the synchronising was badly done. He thought that stations such as those put up by the Electric Construction Company and Fowler's had in no cases attempted those fuses, as the current on putting into parallel badly was not such a serious matter as with the other type of machine. For his part, he did not think that if stations had reasonably good plant they should think of the synchronising fuses. With regard to synchronising, he would say that, so far as he had seen, the nicest way of getting into parallel was to have the revolving part of the machine painted with as many white lines or spots as there were field poles. If they then lighted the station with alternating arc lamps, fed from the 'bus bars, the lines would be seen to revolve backwards when the machine was at less than synchronous speed, forward when it was above, and to stand still when the speed was synchronous. The great advantage of this method of synchronising—of course, assisted by voltmeter and lamps—is that one can see if one is running too fast or too slow. The engine-driver has the most perfect knowledge of what is actually taking place with the plant of which he has charge, and he regulates it accordingly. The switchboard attendant need not bother himself whether it is going too fast or too slow. The switchman regulates the exciting current, and the driver regulates the actual speed at which the plant is being run, in accordance with the moving diagram which tells them in plain language what the plant is doing. This method is already in use at the Portsmouth station, and it is being introduced into several other stations where the switchboard was so far from the dynamos that it was difficult to communicate. With regard to what Mr. Andrews said about Mr. Raworth having devised a sort of zero arrangement, one which discriminated whether the current was going the right or wrong way, he found that a good many people had taken it up independently and had said nothing about it. Struggling with the same question, about

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10 years ago he constructed apparatus for accomplishing this work, and he believed the method was exactly the same as Mr. Raworth's, but he never put the apparatus into use, as he had quite enough things about the station without producing any more. Mr. Andrews mentioned a most important question about danger on the switchboard. There was no reason why a switchboard gallery should be particularly dangerous, but he thought, on the other hand, one might err on the side of enclosing it too thoroughly. So far as he could see, the only arrangment which lent itself to complete enclosing was that where the switchboard had a back to it, which involved far greater danger to life and also risk from fire. It was at the back of the switchboard that the unfortunate man was killed at Hampstead. Water-break switches were very interesting. He was at Paris last week, and had the pleasure of seeing some water switches which had been in use for many years. They broke one of the switches on 2,400 volts continuous current, which was far more difficult to break than alternating. He did not see any sparking at all and it worked most beautifully. With regard to the arrangement in Diagram 3, with one exception it was almost identical with Mr. Rider's arrangement at Bolton. The switchboard there was, he thought, made by the Manchester Edison-Swan Company to Mr. Rider's design. It was quite possible Mr. Andrews may have found his arrangement (after sufficient experimenting) to be a satisfactory means of stopping the arcing from the switch, and it might be that the combination of adding this piece to it would cure the difficulty which would otherwise exist with that form of switch. Mr. Andrews had called their attention to the connections of his switch-gear, and showed that he used a supplementary 'bus bar. An arrangement of something of that kind had been put into use upon most of the switchboards similar to those at the House-to-House Company, West Brompton. It consisted of two complete 'bus bars, and the machines and circuits were arranged so that they could be put on to either. They could then have their station working on two separate circuits. The Leeds House-to-House Company had that arrangement for one. A recent case was that at Edinburgh, where he believed it was devised quite independently by Prof. Kennedy, so that if he could not synchronise machines quickly enough when fog came over, he would then be able to throw any circuit on to the spare bar or a couple of circuits, and then run up a new machine on it. That was precisely the same idea, but without the special gear to bring the extra parts into action. It was purely a system of two 'bus bars, and they could work the results by hand instead of automatically. There was one point which he did not agree with at all, and that was the exciting of alternators by one common exciter. He very much preferred to get each machine with its own exciter, and he had bought exciters from different makers, and he was pleased to tell them that he had never had a failure on an exciter of any alternator which he had had at work. He had bought what he thought the best machine he could buy; had allowed probably 50 per cent. margin; he had never had a single failure with exciters. There was one point in which he agreed partially and, perhaps, disagreed with the author also, and that was the question of a diagram on the switch gallery. He thought it was a most vital thing that anyone coming into the station should know at once exactly what the connections of the switchboard were. He did not like to understand a switch-gear one day and a year hence have to lock it up again. He thought, so far as possible, that the switch-gear should be absolutely its own diagram, and that upon the face of it they could see exactly the meaning of all parts. With regard to the question of alternators, why Mr. Andrews had put so much work in devising that ingenious and useful apparatus was because he had been unfortunate enough to have plant which required being dealt with in this delicate manner. Alternating electric supply was becoming very much more reliable than it used to be, probably due to the stations being equipped upon reasonable and engineering lines.

Mr. E. W. Cowan said he would like to make a few remarks on the paper, which he had listened to with very great interest. The first point was with regard to using the use of an auxiliary fuse for paralleling. Such an arrangement enabled the synchronising and paralleling to be done at the synchronising panel, supposing they had a separate panel for the purpose. He had tried using a coil with large self-induction instead of a fuse, and then switching this in between the two machines, and not troubling whether they were in phase or not, but letting the current flow between the machines through the self induction until they brought each other into phase, but it did not seem to be a very necessary apparatus for iron-cored alternators. Mr. Andrews said that he used a magnetic cut-out because it was quicker in its action than a fuse; he also looked upon it as being slower. The instrument which the author had described had a certain amount of inertia, and it seemed to him that it must be slower in its action than a fuse. Mr. Andrews had described his exceedingly interesting apparatus, which he thought it would be hard to beat for ingenuity. It had given him great pleasure to hear the way in which the author had overcome the difficulties of dealing with the effect of short-circuits on the mains, especially the way in which he had got over it without any complications; it was an exceedingly good arrangement, and very much to his credit. Mr. Andrews considered that for the prevention of accidents the design of alternating switch-gear should be such that injury from shocks would be practically impossible, and that all parts carrying high-tension current should not be exposed; he heartily agreed with him. He believed that almost from the first his firm had tried to design all their fittings so that there would be no parts exposed. With regard to the high-tension switch which Mr. Andrews referred to as one which he was experimenting with, and which Mr. Ferranti spoke of, he might say that that switch was designed in their drawing office a few years ago, and was proposed to Mr. Rider, of Bolton, as an alternative to the Fowler switch which he had specified. Mr. Rider accepted the switch, and they had made a good many for use throughout the country. There was no doubt that, as Mr. Ferranti pointed out, the switch had a possible tendency to arc, but at the same time he might say they had not had any arcing, and he considered they were quite safe at the full current, though not on a short-circuit. The switch was similar to that shown by Mr. Andrews; the contacts were not mounted on marble, but on ebonite. In their later designs they had added a shutter, and it had an advantage in preventing the switch being closed when it ought not to be. On the whole question of using this apparatus he was inclined to agree with what Mr. Ferranti had said, that this apparatus had been devised for special circumstances; but it seemed to him that in cases where they had alternators which were not iron cored, that some sort of apparatus such as this, if it could be made with perfect reliability, and simplicity, and durability, was an apparatus which should be used in every station of that kind. Then a question which it was very difficult to decide arose in the case of iron cored alternators. They had an iron-cored alternator at Altrincham which probably would give, in proportion to its size, as much current in excess of the normal as a non-iron cored, and they consequently got excellent regulation with that alternator. They had other alternators only giving about 100 per cent. in excess of the normal current on short-circuits, and these alternators would hardly blow the fuses if they had a short-circuit on the mains. Which was the better machine? Suppose they had a breakdown on one of the machines running in parallel, the result was not disastrous, the light was very quickly steady again, and no harm was done by overloading the remaining machines. One question which Mr. Andrews had raised was the question of being able to switch any alternator on to any circuit. That he considered a very important and necessary arrangement, and they had got out an arrangement by which they could plug any alternator to any circuit; and when they had the machines running in parallel on the circuits all they had to do was to adjust the plugs, and then the opening of the alternator main switches left these machines running on different circuits. They had their plug connections made on the alternator side of the alternator switches and the circuit side of the circuit switches, and when they had the different machines plugged on to the different circuits the machines could be done very rapidly, taken out of parallel if there happened to be a breakdown of one of them. As to exciting alternators from separately-driven exciters, he quite agreed with what Mr. Ferranti said. One objection to the separately-driven exciter was that it meant two small additional auxiliary engines, one of which at least had to be kept running during the hours of light load, and there resulted all the waste which must accrue by the use of an auxiliary plant. As to using storage batteries, he considered it was very expensive, but a very good arrangement otherwise. He instanced a case which he knew of where the breaking of glass cell in an exciting circuit battery had caused a failure of the light.

Mr. Wordingham said he did not think he had very much to say on the subject, but he would like to make a few remarks on the paper. First of all, he thought they should congratulate the author on the practical nature of the paper; the whole thing was practical from beginning to end, and he was sure the members regretted the exceptionally small attendance. The design of switch-gear for central stations would of necessity vary with almost every station, and it must therefore be specially worked worked out in each case. It was no reproach to the author to say that this was a special arrangement. They had his assurance that all those apparent complications had worked without a hitch, but for his own part he always mistrusted automatic apparatus; it had such a way of wanting a man to work it. He did not think it was possible to have switchboards too simple, and Mr. Ferranti had used the very words that he (Mr. Wordingham) would have used in saying that the switchboard should be its own diagram. They did not want to be looking out diagrams while an armature was burning out; they wanted to look at the board, and not be able to make a mistake. They wanted an intelligent man, something between Mr. Andrews's specially-trained man and an ordinary labourer; they did not want him to have to spend a lifetime learning the switchboard. The author referred to the reputation of continuous current for continuity of supply over alternating. Perhaps that arose from other reasons than the zero cut-out, because some stations used fuses made of copper, and which were of the same sectional area as the mains themselves; that he thought tended towards continuity of supply. He quite agreed with the author as to the prevention of accidents to the attendants with high-tension switch-gear; the negligence in some stations was simply criminal. He had visited some in which any person might walk up against the apparatus. His own view of high-tension switch-gear and high-tension apparatus was that it should be so guarded as to make it impossible for any man to get a shock. He did not think too much money could be spent to attain this object. He thought that any part of the switch-gear which had to be handled should be connected to earth so that the man would be absolutely safe in whatever he took hold of. It was always a difficult matter to carry out this arrangement of safety and to allow at the same time for the proper cleaning of the switch-gear. The contact parts had to be cleaned, and special arrangements should be made to enable this to be done without risk to the attendant. The necessity for a man to stand on an insulated platform or stool ought, he thought, to be avoided as far as possible. There was one point about the switch and shutter: asbestos was a very treacherous material in his opinion—certainly he did not think it would prevent a man from getting a shock; it might prevent his poking his fingers between the contacts. The

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switch described by Mr. Cowan in which the contents were sunk below the surface of a piece of slate appeared to him to somewhat resemble the dynamite engine, in which a new engine was required with each explosion.

Mr. Andrews, in reply, said he was obliged by the kind way in which they had received his paper. He had come up, not only for their benefit, but for his own. He expected to learn a great deal which would more than repay him for his short journey. With regard to Mr. Ferranti's and Mr. Cowan's remarks about iron-cored machines, he would like to ask if, when these iron-cored machines are switched on very much out of phase, they do not make the lights jump? At Hastings they had Mordey machines to work with. Some engineers considered this to be a misfortune, but he did not agree with them. If these machines were switched in out of phase, they only made the lights jump. The machines were not injured, but it was just this jumping of the lights that they objected to. They would rather lose two or three coils than have the lights jump badly. He referred to a modern station where iron-cored alternators were used, and where quite recently an engine driving one of these machines had suddenly failed, this short-circuiting the omnibus bars and totally extinguishing a large number of lights. The machine was not damaged, but the supply company's reputation was, which he considered far more important. This was a specimen of many recent interruptions which might have been prevented by the use of a return-current cut out. As regards exciting in parallel, he had always been accustomed to run alternators excited in parallel until he went to Hastings, where they were then excited from separate machines. The first day or two he was there he wanted to change over from a 50-kilowatt machine to a 100-kilowatt set. He thought they had only about 30 amperes maximum load on the station at that time. He got the 100-kilowatt plant in parallel, and run it up slowly, letting the other one down. The current came up on the 100-unit machine pretty quickly to about 70 amperes, and on the other it went up to considerably over 30 amperes, and he could not get the current lower on either machine anyhow. He ran up the engine of one and then the other and looked at the ropes to see which was motoring and which was generating, but could not tell. At last the little machine began to smoke, and he thought the only thing to do was to switch out. He switched out at about probably 40 amperes. The arc did not break, but burnt the whole board up, and all the lights went out. He found afterwards that the whole trouble was caused by the machines being unevenly excited. He promptly had arrangements made for exciting the fields in parallel, and since then he had experienced no further trouble. With regard to the diagram on the wall, he quite agreed in having the switch-board on the diagram itself, and he had spent a great many hours in designing the Hastings switch-gear in order to get the wires in that way, so that they could be instantly traced out. Each of the wires at Hastings was run up the surface of the wall. Nevertheless, he liked the diagram, because they could not always see the connections under the instruments; and, if as sometimes occurred, things went wrong, he did not think that the diagram should be far away from the switchboard. He himself found it exceedingly useful, and he could not see any objection to it. Mr. Cowan spoke of fuses being quicker in their action than magnetic cut-outs. He had found that fuses took a perceptible time to go, whereas magnet cut-outs cut out instantly. They could see from the Diagram A and B (Fig. 7) how very rapidly it acted: it clearly showed only one-tenth of a second had elapsed between the rush of current and the circuits being interrupted—a fuse could not go quicker than that. With regard to magnetic cut-outs being easy to reset, they could be reset at the rate of 30 times per minute, and he did not think fuses could be reset any anything like so rapidly. If they wished to get machines in in a hurry, they simply stood at the switch and pumped it indiscriminately until it stayed in: this enabled them to get machines into parallel under very difficult conditions. Mr. Cowan referred to the question of synchronising after they had got past the steady phase. He said he did not think this method would apply to machines with heavy revolving parts. He (Mr. Andrews) did not think any machine had heavier revolving than the Mordey machine. He referred to C (Fig. 7), which he thought clearly showed there was absolutely no rush of current when machines were switched in in this way, and they never got the slightest flicker in their lights. It was not necessary that the asbestos shutter criticised by Mr. Wordingham should be a perfect insulator to prevent accidents, because it did not touch the high-tension contacts. It merely served as a guard to prevent the contacts being touched. The author had suggested asbestos because it would not burn—at least, he had not yet experimented with it far enough to burn it. He mentioned just now that it was only a crude idea. The arrangement he was now experimenting with was almost precisely the same as that described by Mr. Cowan—viz., a guarded shutter working with a spring.

On the motion of the **President**, a hearty vote of thanks was accorded to Mr. Andrews for his paper.

Pendulums.—Mr. G. Lippmann has devised and demonstrated to the Paris Académie des Sciences a method of making pendulum observations by means of instantaneous photographs taken of them by means of an electric spark. The method is applicable to the case where the synchronism is so near that observation in the ordinary way becomes tedious and difficult. It is obviously applicable to other cases of close synchronism.

COUNTY COUNCIL RULES AND FEES FOR TESTING.

The London County Council on November 6, 1894, upon the recommendation of the Highways Committee, laid down a scale of fees to be charged for the testing of electric meters, to which scale certain additions were made by the Council on February 26, 1895. Experience has led the committee to the conclusion that some revision should now be made of the fees hitherto charged, and on their recommendation the Council have now made rules which will give the public certain necessary information as to the method of dealing with meters which their owners or users desire to have tested. These rules are as follows:

Upon any application being received by the Council of any difference arising between any consumer and the undertakers, an appointment will be made with the consumer and the undertakers for an inspector to attend at the premises of the consumer. The inspector will take charge of the meter, which is not to be disconnected from the circuit except in his presence, and then only by the undertakers. The inspector will, as far as possible, ascertain before such disconnection takes place whether the meter is properly fixed and connected with the circuit, and whether it appears to be in good working order. If the meter be not one requiring to be tested for synchronism, it will then be removed under the supervision of the inspector to the Council's office, 42, Cranbourne-street, to be there tested for accuracy. If the meter be of a type requiring to be tested for synchronism, it will, if necessary, after disconnection from the circuit, and before removal from its position, be sealed up by the inspector and run for at least 24 hours without current being allowed to pass, and at the end of such time or of such longer time as may be convenient, the result will be ascertained by the inspector and the meter then removed in the manner before indicated. Before removing the meter, the inspector will ascertain as accurately as possible the total current which may be taken if all the current-consuming devices connected with the installation are put on to the circuit; also the average and the maximum normal current. If the inspector considers it desirable, he will also, with the concurrence of the applicant and upon payment of the prescribed fee, test the insulation resistance of the meter as fixed, and of the whole installation connected therewith. In the case of meters which can, under certain circumstances, register without useful current passing through the main coils, the inspector will make a careful examination to ascertain whether such registration is effected. The tests for accuracy will be made at the Council's meter-testing station, 42, Cranbourne-street. In the case of meters which before being fixed shall have been tested by the Council and passed as correct meters, the meters will be tested for starting current and at one or more quarter loads, and if the results be approximately the same as those obtained in the previous tests the meters will be considered correct. (A meter shall be considered to be "correct" when the registration shown by the dials is within 2½ per cent. of absolute accuracy at all points above one-twentieth load or 1¼ amperes.) In the case of meters which have not been tested and sealed by the Council before fixing, the tests will be made at the average load used by the consumer, if this can be ascertained. In cases where the meter has been removed from the consumer's premises before any application for testing is made to the Council, it may nevertheless be tested for accuracy, but a note will be attached to the report stating that the meter was removed from the consumer's premises before it was tested, and that the Council has no means of ascertaining whether its condition is the same as it was when so fixed. At least one test will be made of every meter by a dial reading, and the dial works will be further examined to ascertain that the gearing is properly proportioned. The report of the inspector, or a copy thereof, will be sent both to the consumer and to the undertakers by the officer in charge of the Council's meter-testing station. All fees for testing shall, unless the Council otherwise order, be paid in advance by the applicant to the cashier of the Council at its office in Spring-gardens. Within one week after the completion of the test the meter will be handed to the representative of the owner, unless circumstances shall have arisen which render a further test desirable. For all meters of a pattern approved by the Board of Trade, any recommendations made by that Board with regard to testing will be followed so far as circumstances admit.

Scale of Fees for Testing Electricity Meters, etc.

Single or disputed meters used, or to be used, in any district for which the Council is the statutory authority.

Testing a single meter of any description up to 50 amperes capacity				10s.	0d.
Do.	do.	of capacity of 50 to 100	amperes	20s.	0d.
Do.	do.	do. 100 to 200	do.	25s.	0d.
Do.	do.	do. 200 to 400	do.	30s.	0d.

For testing each "disputed" meter the charge shall be as above, and no reduction shall be made if a number of disputed meters be sent in together.

Batches of Meters.

For testing meters, delivered at and removed from the testing station free of cost to the Council, any work necessary for adjusting inaccurate or defective meters being charged for extra;

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Class 1.—Meters without shunt coils, and not requiring to be fixed for testing, up to 50 amperes capacity, if sent in in batches of not fewer than 10 of the same size and make, each ..... 6s. 6d.
Do. do. from 50 to 100 amperes capacity, each 9s. 0d.
Do. do. from 100 to 200 do. do. 12s. 0d.

Class 2.—Meters with shunt coils or requiring to be fixed for testing, up to 50 amperes capacity, if sent in in batches of not less than 10 of the same size and make, each ..... 7s. 0d.
Do. do. from 50 to 100 amperes capacity, each 10s. 0d.
Do. do. from 100 to 200 do do 13s. 0d.

Class 3.—Meters requiring fixing and synchronising, up to 50 amperes capacty, if sent in in batches of not less than 10 of the same size and make, each ..... 8s. 0d.
Do. do. from 50 to 100 amperes capacity, each 12s. 0d.
Do. do. from 100 to 200 do. do. 17s. 6d.

Class 4.—Meters for multiple circuits will be charged for according to the number of circuits.

Class 5.—Meters which require to be tested on a circuit absorbing considerable power will be charged for at special rates.

A reduction of 10 per cent. from these prices to be allowed when 20, and of 25 per cent. when 50, meters of the same make and capacity are sent in at the same time. Partial retests made on any meter after adjustment will be charged according to amount of work involved at one-half to three-fourths of the fee charged for the first test.

Inspection in Situ.

For examining in position after fixing and certifying, if found correct, any single meter which has already been tested for accuracy at the Council's testing station within a radius of three miles from Cranbourne-street... 2s. 6d.
Do. do. any distance from three to six miles 3s. 6d.

For examining in position after fixing, where a number of meters in the same district, and within a reasonable distance of each other, can be inspected on the same day, £1 for the services of the inspector for the entire day, or 15s. for half a day; a further charge of 6s. will be made for each certificate.

Electric Pressure.

For taking a record of "pressure" at any consumer's house within three miles of the testing station, such record extending over 24 hours ..... 10s. 6d.
If such record extends over two or more consecutive periods of 24 hours, for each such succeeding period ... 5s. 0d.

Service Lines.

For testing a single pair of service lines ..... 10s. 0d.
In difficult cases (in addition to the fee of 10s.) for every hour or part of an hour occupied after the first two hours ..... 3s. 6d.
For testing any installation for insulation resistance to earth for every 50 lamps (of not exceeding 16 c.p.) installed ..... 10s. 0d.

Note.—The above fees are to include omnibus fare for the inspector, but all other travelling expenses to be charged in addition.

All communications with reference to the above should be addressed to the engineer, London County Council testing station, 42, Cranbourne-street, W.C.

TRAMWAY TRACTION.

[An elaborate report on this subject has been issued by a committee of the Sheffield Corporation. In the present issue we give the conclusions of the report, reserving the detailed evidence on which these conclusions are founded for the future.—ED. *E. E.*]

GENERAL CONCLUSIONS.

The following summary deals not only with the subject of traction, but also with many other points connected with tramways, and it may be advisable to state that, in addition to the information obtained as to the various systems of mechanical traction, the deputation have learned a great deal as to general management, which cannot fail to be of use, and which could not have been obtained without personal investigation.

On reference to the statistics given in the detailed reports, and also in tabular form herewith, it will be seen that in many of the towns visited the mileage of the tramways is far greater in proportion to the population than in Sheffield.

The streets through which the various tramways inspected by the deputation pass are widely different in character, some of them being finer and much wider than any of the Sheffield streets, and others being narrow—so narrow, in fact, that here they would be considered nearly impracticable for tramways. The gradients are often steep in Remscheid; there is a gradient of 1 in 9·5, equal to the top end of Granville road, but the steepest of them are easily surmounted by both the electric and

Name of city.	Population.	Street mileage of tramways.	Population served per mile.
Berlin	1,750,000	176	10,000
Birmingham, including Balsall Heath	478,113	21 5	22,237
Blackpool	120,000 * / 30,500 †	6	20,000* / 5,083†
Bristol	230,000	16·5‡	13,975 / 10,725
Brussels	482,000	30·5	15,800
Budapest	506,000	44	11,500
Dresden	334,000	42	7,952
Edinburgh	250,000	18·5	13,513
Elberfeld and Barmen	260,000	10	26,000
Hamburg	626,000	67	9,343 Hamburg
Altona	280,000		13,500 Hamburg and Altona
Liège	150,000	9	16,666
Milan	450,000	26	17,300
Paris	2,500,000	230	10,870
Remscheid	48,000	6 25	7,680
Rouen	112,000	23	4,869
Sheffield	350,000	9·3§	37,500 present lines. / 9,633 with extensions.
Vienna	1,364,548	69	19,776

* Summer. † Winter. ‡ With extensions, 21·5. § With extensions, 36·3.

cable cars, which have also no difficulty in taking sharp curves. In some of the cities visited the rails and paving are well laid on a concrete foundation, and here the travelling is smooth and pleasant. In constructing many of the Continental tramways, however, cheapness appears to have been one of the principal considerations, and the rails have been laid on macadam or gravel without proper foundation. On such lines the cars oscillate a great deal, and the whole result is very unsatisfactory. In some cities the rails have been laid with a row of setts on each side, the remainder of the track consisting of macadam. The result of this system of construction, too, is unsatisfactory, and the engineers and others who were consulted by the deputation seemed to be almost unanimously of the opinion that, in order to make a permanently satisfactory job, the track must be paved right across, including at least 18in. beyond the rails, and have a good concrete foundation. The general paving material is granite or basalt. There is a moderate amount of asphalte in some of the most important cities, but very little wood.

Except where conduits are used, and rails of special section are required, the girder rail (which is nearly similar in section to the one recently laid in Westbar) seems to be almost universal for new work, and the old light rails are being rapidly replaced by rails of this section. Though the deputation saw—on the Continent—several lines of metre gauge (3ft. 3in.), the broad gauge (4ft. 8½in.) is generally adopted, and seems to be preferred both by the engineers for the municipalities and the representatives of the tramway companies. In Birmingham and the Walsall district, however, the gauge is narrow, being 3ft. 6in. Where possible, double lines are much preferred to single on account of convenience, cost, and expedition in working.

The Continental tramways are generally worked, and in many owned, by companies. It will be noticed that the terms upon which concessions are granted in many of the cities visited are much more favourable to the municipality than was the case in Sheffield under the terms of the lease to the old company. In nearly all the cities it was proposed eventually to do away with the horse and steam tramways entirely, as soon as circumstances permitted.

The following is a list of the systems of traction inspected:

The "Serpollet" system of steam traction is in many respects a great improvement on the old form, but that it has disadvantages will be apparent from the description given in the Paris report.

With regard to the compressed-air system, as seen in Paris, it is evidently not adapted for the steep gradients which prevail in Sheffield.

Although enquiry was made in every likely direction, the deputation saw no tramways worked by gas traction except those in Blackpool.

A detailed description of the cable system is given in the Birmingham and Edinburgh reports. The chief advantages of this system are: (1) the absence of overhead apparatus from the streets; (2) the regular speed, and the freedom from accidents which might be caused by the driver losing control over the cars; (3) the adaptability of a cable line to the demands of an increasing traffic; if extra cars are required at any time the extra cost and power required are comparatively small in proportion to the number of cars so required; (4) the economy of working; (5) cleanliness. The principal disadvantages are: (1) the "inflexibility" of the system: if time is lost it cannot be regained, the speed of the cable limiting the speed of the car; it is also impossible to reverse a cable car: it must travel with the cable unless the men in charge push it back, and if it moves at a less speed it causes the gripper to unnecessarily wear the cable; (2) the third rail, forming the slot, which is in the centre of each

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track, and the slot itself, although much narrower than with the electric conduits, is still objectionable ; (3) the fact that any breakdown of the engines or cable stops the traffic entirely on that particular section ; (4) the heavy initial cost ; (5) the great disturbance of traffic and interference with business during construction.

It may be pointed out that even in England one or more of the cable lines have not been successful, and it is stated that in America many cable lines have been and are being converted to the overhead electric system. On the Continent a cable tramway was only met with in one case.

Electricity seems to be the prevailing motive power used in the various cities visited, and, as will be seen by the foregoing notes, this form of traction is developing very rapidly. The deputation saw this motive power applied in four different ways—viz. : (1) overhead, by means of suspended trolley wires ; (2) underground, in open conduits ; (3) in the form of accumulators carried on the cars ; and (4) by means of surface contact (in Paris). This system appears to be in quite an experimental stage, but is being considered by the Birmingham Corporation.

All the systems mentioned in this report have their own advantages, but electric traction has certain merits which are not possessed in so great a degree by any of the other mechanical systems—viz. : (1) power of the cars to accommodate themselves to the state of the traffic by running slowly, or quickly, or backing ; (2) in case of any accident to any part of the system, only that section immediately affected is thrown out of use, and even if the engines should break down accumulators can be brought into use which will keep the traffic going for some hours ; (3) every car can be used in case of emergency caused by sudden increase of traffic, etc., instead of being dependent on the number of horses, as is the case with horse cars ; (4) much less space is taken up than by a car with horses or engine attached, and the interference with the general traffic is consequently less ; (5) greater cleanliness of the cars and the streets, the latter caused by the removal of the horses. The last three advantages are also common to the cable system.

The special advantages of the overhead electric system, as compared with other forms of electric traction, are : (1) cheapness and simplicity, the latter enabling any necessary repairs to be affected with a minimum of trouble, delay, and expense ; (2) the rapidity with which the lines can be constructed or converted from horse system (as in Rouen, where the conversion is said only to have occupied 10 months), and the comparatively small interference with the surface of the streets and traffic as compared with the conduit system.

The chief objection urged against the overhead system is its appearance, but the deputation, from their own personal observation, have come to the conclusion that very little objection can be taken from an æsthetic point of view. In several places where at first the people had strong objections to the overhead system on account of the alleged unsightliness of the wires, poles, etc., they soon became reconciled to the appearance of the streets, and now have no objection to the apparatus In some of the places visited, the poles were ornamental rather than otherwise. This is not merely the opinion of the deputation, but careful enquiries made from the officials of the various municipalities (who may be said to represent public opinion), as well as from the managers and engineers of the tramway companies, prove this to be the general view. An instance of the popularity to which the system attains is given in the Rouen report. In many cases poles are not used, the trolley wires being suspended by means of rosettes attached to the houses, etc., and span wires. Obstruction of the footpath is thus avoided, and if it is decided to adopt the overhead electric system in Sheffield, there is no reason why this course should not be largely followed. In roads where there are trees, the wires, etc., are scarcely visible. The poles can be used with much advantage for the electric lighting of the streets, thus removing the necessity of another set of poles on the causeways or roadways.

The only other objection to the overhead system is the alleged danger of overhead telephone wires, etc., breaking and falling on the highly-charged trolley wires, or of the latter breaking themselves and coming into contact with persons passing near them. These dangers can, however, be completely guarded against by the exercise of due precautions and the use of proper appliances. No difficulty need be caused in connection with the fire-escapes, which can now be constructed to travel horizontally as at Hamburg. In the latter place the firemen are provided with shears and india-rubber gloves with which to handle and cut the wires if necessary. Ingenious apparatus is also in use in that city to enable the hose to be carried across the routes without interruption of traffic.

The sole advantage of the conduit system seems to be that the overhead wires and poles are removed, while the principal objections to it are as follows : (1) the great expense ; (2) the prolonged interference with the streets during construction and repairs ; (3) the difficulty in locating any defect in the underground part of the system ; (4) the difficulty and expense of carrying out any sewerage works in streets in which there are conduits ; (5) the danger to traffic through the presence of a slot in the street varying in width from ⅛in. to 2in ; (6) the difficulty in keeping the conduit clean and maintaining satisfactory insulation ; (7) the liability to stoppage through storms.

The time occupied in the construction of conduit lines was variously stated at the cities visited, but that the inconvenience is very great and real may be judged from the fact that in Berlin, although the police authorities will not allow overhead apparatus in the centre of the city, it has been decided not to allow the construction of any more conduit lines on account of the inconvenience arising in this way. If the apparatus in the conduit should need repairing the work is of necessity much more difficult and expensive than with the overhead wires, which are so readily accessible, and in order to get access at all a very large number of manholes, etc.. are necessary. If a conduit system, whether cable or electric, should be decided upon, it would be necessary first to efficiently sewer all the streets affected (where not already done), as such work, if carried out afterwards, would involve great expense on account of the interference with the underground work. The danger arising to carriage and other traffic, by reason of the presence of the slot, especially on steep gradients, is so apparent that no more need be said about it. The same remark to a certain extent applies to the sixth objection. When it is considered that any moisture or dampness in the conduit affects the insulation, it will be readily understood that with an open slot through which water or dirt can freely make their way, the work of keeping the conduit clean and maintaining efficient insulation must be very difficult. It is necessary, too, to provide numerous drains to convey the water getting into the conduit to the sewer. That with the conduit system there is a certain liability to stoppage through snow is proved by the fact that in Budapest the lines have for two entire days been so blocked, and the traffic has had to be carried on by horses.

The advantage of accumulators is that by their use the necessity for either the overhead wires, etc., or the objectionable slot of the conduit system is obviated. At present, however, this system cannot be looked upon as satisfactory, because of (1) the extra weight of the cars (two to three tons) for which power has to be provided, in addition to the normal weight ; (2) the great expense of maintenance ; (3) the constant recharging which is necessary ; (4) the objectionable smell of the acids used and the possibility of injury to passengers' clothing, with consequent claims for damages ; (5) the comparative ineffectiveness of the accumulators as compared with other forms of electricity, which has the effect of slowing the cars very much when ascending even slight gradients.

With regard to the first objection, it will be understood that the more power there is provided, the more the weight of the accumulators is increased, and all this dead-weight necessitates further increased power. In towns like Dresden, where the overhead system is allowed, except within a limited area, an additional disadvantage is that the accumulators have to be carried for the greater part of the journey simply as dead weight, and are then supplying no power. The most important facts regarding the accumulator system are those contained in the Birmingham report.

Many of the power stations are very fine buildings, and some of them not only generate the power for the tramways, but also for the electric lighting of the respective towns, and in one or two cases, as at Remscheid, power is supplied to a large number of manufactories, thus securing an additional revenue to the municipality. As a rule the voltage allowed is 500, and the current is direct. It is said this voltage is not dangerous to life.

The deputation found various kinds of cars in use, both two-storeyed and single, and on the Continent in many cases open cars were used as trailers, some of them being reserved for smokers only. On the electric tramways abroad the small cars with no top seats are very generally preferred, except for long journeys with few stoppages. The services are generally so quick and the stoppages so short that it is a great advantages to have a car which can be unloaded and started again practically in a few seconds. This can be done with the small cars, but not with the larger or two-storeyed ones. On the English electric lines inspected by the deputation, however, the cars were two-storeyed. Each car is, as a rule, provided with double brakes, and occasionally with electric brakes in addition. There is a loud-sounding bell, in some cases attached to the brake and rung by a movement of the brake handle, and at night brilliant head-lights in addition, to warn persons or drivers crossing the track. Many of the cars are beautifully constructed and fitted, and in most cases they are lighted with the electric light. The cars used on the electric lines are comparatively heavy, the usual weight being about seven or eight tons (though in some of the English towns the weight was much less), and the cost generally ranges from £500 to £700 or £800 per car. This, of course, is very high compared with the cost of horse cars, but the difference is accounted for by the fact that the motors are included. The motorcars used on the English electric lines are, as a rule, cheaper than those in use abroad.

On the Continent there are two forms of trolley in use, the "fishing-rod" pattern, fitted with a pulley which is in contact with the trolley wire, and the "bow" pattern, which simply rubs along the wires. The advantage of the first pattern is that it does not wear the wires, and of the second that it is less liable to leave the trolley wire in rounding curves. If the trolley leaves the wire the car stops, and, if it is night, the lights go out, but this is a rare occurrence, and the pulley can be replaced in a few seconds. Both forms of trolley are largely used. On the English electric lines the trolleys were of the "fishing-rod" type, but with radial action, which is an improvement on the other form, as explained in the Bristol report. In some towns the cars are all one class, in others they are divided into first and second class, the difference being mainly that the first-class seats are cushioned, while the second are not. Rapid improvements are taking place in the manufacture of motors, etc , and when in Brussels the deputation were told that by the substitution of an improved armature the efficiency of a 15-h.p. motor is increased so as to give 25 h.p., and at the same time a slight saving in weight is effected.

The result of investigations and enquiries made tends to prove that when the public have become accustomed to the altered speed, etc., of the cars, electric traction is not more dangerous than horse traction, and not so dangerous as steam. The steam-cars often startle horses on account of their noise and appearance, but there is scarcely any noise from the electric cars, what there is being of

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TABLE A.

Name of town.	Price per mile of overhead electric.	Price per mile of conduit electric.
Berlin (given by company)	£2,400	£6,450
,, (given by Messrs. Siemens and Halske)	Conduit about £4,000 or £5,000 more per mile of double line than overhead	
,, (given by the Union Electric Company)	Conduit costs about four times as much as overhead.	
Blackpool	—	Single track, £7,084
Brussels (given by the municipal engineer)	Construction of line proper ..... £1,400 Electrical apparatus ..... 1,150 Engines, cars, etc, but not including buildings 2,860 £5,410	£19,600, double
Budapest (given by one of the companies)..	£2,900	£4,587 to £6,944.
Dresden (given by company)	With poles, £1. 3s. to £1. 12s. per yard run; with rosettes, about 14s. per yard run.	£4 to £4. 10s. per yard run.
Milan	These prices do not include paving and rails, estimated at £4,500 per mile of single line. Conduit about four times as much as overhead.	
Rouen (given by Union Company).....	£1,300 to £2,000 per mile average cost, single and double.	—

a humming or slightly hissing nature, and the appearance is much better than that of the steam-cars. In a few cases people have been run over, but nearly always within a short time of the opening of the line, and it is very generally stated that what accidents there have been were the result of carelessness.

Accidents from falling wire seem to be almost unknown, and can be guarded against by using a suitable wire, and seeing that it is not overstrained. Where telephone or other wires cross over the trolley wires, it is necessary to provide a casing or guard over the latter; but an ingenious coupling has now been devised by means of which, if a telephone wire should break, the length crossing the street at once separates into short lengths, not long enough to reach from the trolley wire to the ground. In Hamburg, as previously stated, the conductors are supplied with shears and indiarubber gloves, so that if necessary they can cut a fallen wire.

The generating machinery fixed in the power stations is now so developed that a breakdown is of very rare occurrence; in fact, the deputation heard of scarcely any, and in many stations there is (as previously mentioned) a system of accumulators which takes up the current when there is only a light load, and is sufficient to keep the traffic going for some hours if a breakdown should occur, or when the engines are not running. It is proposed that accumulator sub-stations shall to some extent be utilised in connection with the Leeds overhead electric tramways when the system is completed. The overhead routes are very little affected by rain or snow, except that the rails must be kept clear, as in any system of tramways, and it is said that a snowstorm will only interrupt the working of the conduit lines if the snow is small and it is freezing.

There is no doubt a considerable amount of trouble has been caused by electrical disturbance in the towns where the earlier lines were laid, and especially with the overhead system, where the return is by rails. An improved method of bonding the rails is, however, now in vogue, and with proper precautions it is probable that trouble of this kind could be altogether prevented; indeed, the English Board of Trade has laid down such rules for the construction of the electrical portions of the tramways as will make it impossible for electrical disturbances to be felt. In Hamburg, the city which has the largest system of electric traction in Europe, it is said there is now no complaint on this ground.

The fares vary, but it may be said that on the Continent they are a little cheaper than in England. This, however, is qualified by the lower wages that are paid. Fixed stopping places are very general. They are usually indicated by poles painted differently to the others or by tablets attached to the poles. No inconvenience seems to be felt, and the advantages of the system are apparently appreciated.

Attention is called to the information on the point of speed given in the detailed reports. The maximum limit of speed is settled by the regulations of each municipality, and on the electric lines practically any speed consistent with safety can be obtained. The usual course in a large city like Sheffield is to allow only a low speed in the centre, gradually increasing, according to the amount of traffic and other considerations, until in the outlying parts the rate is perhaps 12 miles per hour. No hard and-fast line can be laid down, however, and the speed on the different parts of each route should be varied to some extent according to the amount of traffic, both vehicular and pedestrian, which happens to be using the street. On some of the suburban routes inspected, the deputation travelled at speeds of 20 to 25 miles per hour. It is nearly impossible to accurately ascertain the cost of the different systems, as the conditions vary so much in each town, and none of the figures obtained are likely to prove an accurate estimate of the cost of similar work in England on account of the very different prices paid for labour and also for materials. In Budapest, for instance, the wage of a labourer is only about 2d. per hour, and of a rail layer 3d. or 3½d. The cost of running, too, must depend to a large extent on the price of coal and the wages paid to the employés, both on the cars and at the generating station.

The comparative costs as given in several towns are given in Table A, but the comparison must be regarded only as between overhead electric, conduit electric, and cable, and not as an indication of the cost of laying similar tramways in England.

YORK ELECTRIC LIGHTING TENDERS.

The following is a copy of the report prepared by Prof. Kennedy on the tenders for the electric lighting work:

Section A (Plant).—Eight firms have tendered for this section of the work—viz.: the India Rubber Works, Silvertown; Messrs. Siemens Bros. and Co.; Messrs Johnson and Phillips; Messrs. Greenwood and Batley; the Electric Construction Company, Limited; Thomas Parker, Limited; Messrs. Crompton and Co., Limited; and Brush Electrical Engineering Company, Limited. All these firms tender to specification, and several of them give alternative tenders according to the maker of the engines tendered for. The lowest tender is that of Messrs. Crompton and Co. The next lowest is that of Messrs. Siemens, with Belliss engines; and the next that of Messrs. Johnson and Phillips, with Willans engines. All the other tenders are higher, although they do not differ very greatly. All the firms who have tendered are of good reputation, and they all tender to specification, so that I do not see that there is any reason for passing over the lowest tender in this case, and should advise you to accept that tender. The only question in my mind is as to the most advantageous of the four alternatives submitted by Messrs. Crompton, which differ only as to the proposed makers of the engines. I have tested the Davey-Paxman engine (Peache's patent) and found it satisfactory on test. I do not personally know the Browett and Lindley engine, but believe that this firm are good engineers, and they undertake to work to specification in every respect. No doubt Messrs. Belliss and Co., and especially Messrs. Willans and Robinson, have greater experience in this class of work, but considering the standing of the firm tendering, I think you need not hesitate in this case to accept Messrs. Browett and Lindley as Crompton's sub-contractor. If you do this, the amount of the contract will be £8,176, which, with £307 for the electrical pump, makes a total of £8,483.

Section B (Mains).—For this section there are seven tenders—namely, those of the India Rubber Works (Silvertown), Messrs. Siemens, Messrs. Henley, the British Insulated Wire Company, Messrs. Glover and Co., Callender's Cable Company, and the Fowler-Waring Company. The tenders are to schedule prices, the lump sum being made up to quantities stated in the specification, and approximately representing the whole amount of the work. Thus, although the actual cost may vary from the totals given, according as the quantities are greater or less, the figures are strictly comparable one with another. The tender includes not only the supply of cables, but the roadwork and the laying and jointing of the cables complete, as well as the making of house services and the supply of meters. Taking the whole of these into consideration, the tender of Messrs. Callender is the lowest, and as this firm has probably had more experience in this class of work than any other, and as they do excellent work, I advise you to accept their tender.

Section C (Arc Lighting).—For Section C of the work there are nine tenders, the following firms tendering—viz.: the India Rubber Works, Silvertown: Messrs. Siemens Bros.; the Brockie-Pell Company, Limited; the International Electric Company; Messrs. Drake and Gorham; the Davy Electrical Company; Callender's Cable Company, Limited; Messrs. Crompton and Co., Limited; and the Brush Electrical Engineering Company, Limited. The totals of these tenders, placed in order, are given in Table C. All these tenders are subject to modification according to the lamp-post used. Several firms give different designs of posts, and mention the corresponding prices. The two most important tenders are those of Messrs. Crompton (the lowest) for their own lamps and Messrs. Drake and Gorham for Jandus lamps. Messrs. Crompton's lamps are satisfactory, and this class of work is one in which they have much experience. The Jandus lamps, although dearer, are claimed to have the very great advantage that the carbons last 180 hours instead of 18. This is not only a very important saving in cost of carbons, but also will make a very great reduction in wages for lamp cleaning and trimming. I have asked Messrs. Drake and Gorham to send one of these lamps to me to test in my office in comparison with a Crompton lamp which I have already in use here, and I shall be glad if your committee see their way to postpone the

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acceptance of any tenders under Section C until I can report to them the result of my tests in this matter. Meantime it would be desirable that the question of the design of lamp-posts should be considered, and I would suggest that when the committee has come to a conclusion on this matter a single lamp-post of the approved design should be erected on trial in order that its exact effect might be seen before the posts were actually ordered. In conclusion, I am glad to notice that the amounts of the tenders are distinctly below the estimate which I put before you in my report of February last. I then gave the probable outlay for plant and mains as £12,000. The totals for Sections A and B—which cover this work—amount to £11,252, so that my estimate covers ample allowance for contingencies and additions in connection with the cables and roadwork, which are priced to schedule, but the exact quantities of which cannot be settled beforehand. The schedule prices for the first hundred services and meters come to £695, so that my allowance of £1,000 covers ample margin. For Section C I mentioned the sum of £600 to £700. The actual outlay will depend largely on the design of the lamp-post chosen, but in any case it will be below this estimate.—I remain, yours faithfully, ALEX. B. W. KENNEDY.

Tabulated details of the various tenders follow, and these are succeeded by an appendix, which consists of the consulting engineer's preliminary report dated February 29, 1896.

LEGAL INTELLIGENCE.

CLAIM FOR ELECTRIC LIGHT.

In the Westminster County Court, on Tuesday, his Honour Judge Lumley Smith, Q.C., had before him the case of the London Electric Supply Corporation *v.* Norton, in which the plaintiffs sought to enforce payment of a sum of £2. 10s. in respect of electric light supplied.

The debtor was stated to be in possession of offices at a rental of £100 a year, and yet he would not pay the bill for his electric light.

His **Honour** said if people wanted such luxuries as electric light they must pay for it, and unless the amount due was not paid within six weeks the debtor would have to go to Holloway for 12 days.

CLAIM FOR ELECTRICAL FITTINGS.

In the Westminster County Court, on Tuesday, his Honour Judge Lumley Smith, Q.C., tried the case of Gardiner *v.* Wood, in which the plaintiff (an electrical engineer) sued the defendant (an accountant, residing at Queen Victoria-street) to recover payment for work done in fitting up the electric light in his flat.

Defendant said the work was done to the order of his wife, whose flat it was, and that she was liable for payment.

Plaintiff said the wife did give some of the orders, but the defendant said he was to be looked to as being liable for payment.

His **Honour** gave judgment for the plaintiff for the amount claimed, with costs.

UNLAWFUL POSSESSION OF ELECTRICAL FITTINGS.

At the Marlborough-street Police Court, on Monday, George Cox was charged with being in the unlawful possession of a quantity of electrical appliances supposed to have been stolen.

The prisoner said he purchased the goods from another man, but as he was unable to give a satisfactory explanation, he was remanded for a week for enquiries.

EXETER ELECTRIC LIGHT COMPANY.

In the Chancery Division on Saturday, before Mr. Justice North, the case Franklin *v.* the Exeter Electric Light Company, Limited, came on for hearing.

Mr. C. E. Jenkins said the plaintiffs were the trustees under a debenture deed of the company. Previous to the commencement of the action the Corporation of Exeter under statutory powers had entered into an agreement to purchase the whole undertaking of the company. There had been the usual judgment in the action, and a declaration that the trust of the deed ought to be administered, an account was directed, and a Mr. Knill was appointed receiver. The chief clerk had found that the amount due on the debenture was £12,000 odd. There was, however, deficiency. The contract with the Exeter Corporation had been carried out, but no money had been paid into Court. The receiver was empowered to distribute £7,000 amongst the debenture-holders, and that payment had been made. This had reduced the amount in the receiver's hands to a very small amount.

The **Judge**: Have the Corporation paid all they have to pay?

Mr. Jenkins said they had. What was proposed to do now was to tax the costs, then to discharge the receiver, who should pay the costs out of the balance he had in hand, and distribute the remainder amongst the debenture-holders, and so put an end to the action.

His **Lordship** thought the best plan would be for the receiver to make an affidavit showing how much he had in hand, and the way in which he proposed to apply it, and what had been done with the other money. Subject to that being done the order would be issued.

COMPANIES' MEETINGS AND REPORTS.

ANGLO-AMERICAN TELEGRAPH COMPANY.

The half-yearly meeting of the Anglo-American Telegraph Company was held on Friday last at Winchester House, E.C., Mr. Francis A. Bevan in the chair.

The directors' report showed that the total recipts for the half-year, including the balance of £1,803 brought forward from the last account, amounted to £171,869. The traffic receipts showed an increase of £10,823 as compared with the corresponding period of last year. The total expenses of the half-year, including the repair of cables, etc., amounted to £58,000, being an increase of £3,204. Under the powers conferred upon them by the articles of association, the directors had, before declaring the net profits, set apart the sum of £12,000 to the renewal fund, leaving a balance of £101,869.

In moving the adoption of the report and accounts, the **Chairman** referred to the retirement, through pressure of other engagements, of the Marquis of Tweeddale and Sir Albert Cappel, which vacancies on the Board had been filled by the appointment of Sir Gerald Fitzgerald and Mr. Robert Benson. He (the speaker) could not accept the chairmanship of the Company permanently. The decrease in their receipts for the last quarter was almost entirely owing to a sum of £5,850, earned by their repairing ship, the "Minia," for the contract of the United States cable, which had not been earned in the present quarter. On the other side of the account there was a slight increase of expenditure of £1,900. Of that £1,197 had been expended in the maintenance of land-line instruments and the duplex system, which had to be renewed, and they considered it better to take that out of income than the renewal fund. Looking at the past year, they had been able to pay 4s. more in dividend than in the year previous. They must recollect, however, that at the beginning of the year they had very large receipts owing to the sensation produced by President Cleveland's proclamation about Venezuela, which gave rise to a great deal of telegraphic communication, and this being followed by the Presidential election also gave them a good deal of extra receipts. They were not, he thought, too sanguine in expecting that the business of the United States with European countries might improve during the present year. They hoped that the new President would not be too hard with his tariffs, because if he were he might check business considerably. They were glad also to note that the new Secretary to the United States Treasury (Mr. Gage) appeared to be a man of enlightened views. The report alluded to the breaking of the 1880 cable, but that was not really a serious matter. It was true that one of their four cables was broken, but it was broken in comparatively shallow water, and there was not the smallest doubt that when the fine weather came round they would be able to repair it. It was always important for them to have three cables in working order if their proportion of the receipts from the "pool" was to be kept up, and it was in view of such breakages as these that the directors had very strong opinions on the subject of the renewal fund. The 1869 cable had done long service, and while he did not say they were likely to fail, still he thought it would be very foolish on the part of the directors if they did not maintain the renewal fund at its present figure (£673,000), which was very little more than would be sufficient to provide for a cable were one rendered necessary. After suggesting that the shareholders would do well to contribute 100 guineas to the fund being raised to perpetuate the memory of the late Sir John Pender, he said, in conclusion, that if his anticipations were at all realised they might be enabled to produce for the benefit of the shareholders such an income as would yield them even a more satisfactory dividend than that which they now proposed.

The resolution was seconded by **Mr. C. Burt**.

Mr. Goodsall wished to know at what depth the break in the 1880 cable had occurred.

Mr. John Newton was pleased that the Board intended to adhere to the policy of building up a renewal fund. He believed that the present break was in shallow water, and could be repaired in a few days.

The **Chairman** said the break had occurred at 200 fathoms deep. The 1873 and 1874 cables were working as well as when they were laid.

The **Solicitor**, in reply to a question as to the progress of the French lawsuit, remarked that he could add nothing to what he said at the last half-yearly meeting. One of their French counsel wrote that the case was ready for argument whenever it pleased the officials to set it down for hearing, but that any pressure would do more harm than good.

The resolution was then put and carried unanimously.

The retiring directors, Mr. Samuel Barber and Mr. Robert H. Benson, were next re-elected, and Mr. H. S. Leon was appointed to a seat on the Board, and the auditors were also relected.

NEWCASTLE AND DISTRICT ELECTRIC LIGHTING COMPANY, LIMITED.

Directors: John D. Milburn, Esq. (chairman), the Hon. C. A. Parsons (managing director), Sir B. C. Browne, Colonel W. M. Angus, Colonel H. S. Dyer, and John B. Simpson, Esq. Secretary: Jas. Patterson. Engineer: W. D. Hunter.

Report of the directors submitted to the shareholders at the tenth ordinary general meeting held at Newcastle-on-Tyne on February 9:

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The directors have pleasure in again reporting that the supply of current continues to give satisfaction to the Company's consumers. The installations connected to the Company's mains during the year are equal to 3,500 10-c.p. lamps, bringing the total up to about 28,000, and 541,139 units of electrical energy have been supplied, as against 471,662 units supplied in 1895. During the past year 862 yards of main and branch piping have been laid, together with 3,403 yards of main and branch cable. The condensing plant continues to work satisfactorily, and extensions having been made to this plant during the past year your directors anticipate a still larger saving in the consumption of fuel in the future. The gross earnings during the year amount to £4,771. 4s. 2d., and after paying interest, and making provision for depreciation, your directors are able to recommend a dividend of 4½ per cent. for the half-year ending December 31 (less income tax), which, together with the interim dividend paid in August last, makes the dividend 7 per cent. for the year. Mr. John D. Milburn and the Hon. C. A. Parsons retire by rotation, but are eligible, and offer themselves for re-election as directors. The auditors, Messrs. Strachan and Co., also offer themselves for re-election.

Dr. BALANCE-SHEET, DEC. 31, 1896.	£	s.	d.
Capital—10,000 shares of £10 each	100,000	0	0
5,000 shares, £8, called up	40,000	0	0
4,918 ,, £3, ,,	14,754	0	0
	54,754	0	0
Add calls paid in advance	290	0	0
	55,044	0	0
Debentures	8,900	0	0
Loans £200 0 0			
Creditors 869 19 6			
Bankers 760 1 4			
	1,830	0	10
Reserve fund, as per last balance-sheet	718	0	0
Profit and loss account—Profit for year ending December 31, 1896, as per statement 3,054 3 6			
Add balance from last year 116 17 11			
3,171 1 5			
Deduct interim dividend paid 1,000 0 0			
	2,171	1	5
	£68,663	2	3

Cr.	£	s.	d.
Buildings and plant, pipes and cables (including cost of laying), meters, transformers, electrical instruments, etc.—Amount expended to date	67,350	2	8
Less amount written off for depreciation	4,000	0	0
	63,350	2	8
Office furniture	152	15	10
Stock of stores, etc.	236	19	3
Cost of license, provisional order, etc.	581	16	10
Debtors for current, etc., supplied to December 31, 1896 (less reserve for discounts, etc.)	4,333	11	5
Cash in hand	7	16	3
	£68,663	2	3

PROFIT AND LOSS ACCOUNT FOR THE YEAR ENDED DEC. 31, 1896.

Dr.	£	s.	d.
Wages, salaries, rent, rates, taxes, directors' fees, etc.	2,873	3	5
Stores, fuel, water, etc.	1,804	2	8
Repairs and renewals	285	0	6
Stationery and general expenses	207	9	3
Balance carried down	4,771	4	2
	£9,941	0	0

Cr.	£	s.	d.
Electric energy supplied, less discounts	9,326	12	9
Meter and transformer rent	611	17	3
Transfer fees	2	10	0
	£9,941	0	0
Interest on loans	£717	0	8
Written off for depreciation	1,000	0	0
Balance carried to balance-sheet	3,054	3	6
	£4,771	4	2
Balance brought down	£4 771	4	2
	£4,771	4	2

The annual meeting of the shareholders of the Newcastle and District Electric Lighting Company, Limited, was held on Tuesday in the Station Hotel, Newcastle. Mr. J. D. Milburn (chairman) presided.

The **Chairman**, in moving the adoption of the report and the declaration of a dividend as recommended, said it had afforded the directors very much pleasure to be able to increase the dividend. They had extended westward almost to the utmost limits of the borough boundary, beyond which they could not go without some special permission, which might be difficult to get. They had been rather disappointed in the amount of energy demanded by Elswick-road, Westgate-road, and Arthur's-hill, but they were now thinking of pushing along Scotswood-road, and hoped to secure additional customers there. Last year they mentioned that they had one or two undertakings in hand, and amongst those was the lighting of Gateshead. They were called the Newcastle and District Company, and from the beginning it had been in their minds that they might light Gateshead. For that reason probably, among others, they secured their present station at Forth Banks, whence they could very easily get across the river. Unfortunately, the Gateshead people did not seem to want the light. They did not seem to want anybody to produce it nor to set about producing it themselves. Therefore that matter was at present in abeyance. Every possible care had been taken to keep the mains dry, and for that reason they had had no accident and no trouble.

Sir Benjamin Browne seconded the motion.

Councillor Fox asked if the time had not arrived when the directors might consider a reduction of the price of the light? Might a reduction not be the means of getting a good deal more consumption?

The **Chairman** said they hardly thought the time had yet arrived for that.

Mr. J. B. Simpson said that, according to the arrangement with the Corporation, the Company must reduce the price of the light when their dividend reached 8 per cent. He did not think that at present an average price of 4½d. per unit was too high.

The motion was carried.

On the motion of **Mr. Alexander Laing**, seconded by **Mr. Thomas Scott** (Sunderland), the retiring directors, Messrs. Milburn and Parsons, were re-elected.

On the proposition of **Mr. W. H. Knowles**, the auditors were reappointed.

A vote of thanks was passed to the chairman.

LIVERPOOL OVERHEAD RAILWAY COMPANY.

The half-yearly general meeting of the shareholders of the Liverpool Overhead Railway Company was held on Tuesday, Mr. Richard Hobson, deputy chairman, presiding, in the absence of Sir William Forwood.

The **Chairman**, in moving the adoption of the report, said the number of passengers carried during the last half-year showed, comparatively speaking, only a moderate increase over that of the corresponding period last year. But they had carried during the past year 7,658,000 passengers, which was equivalent pretty nearly to carrying the whole population of Liverpool, men, women, and children, some 12 times over during the year. Dealing with the southern extension, the Chairman said the difficulties had been overcome, and the railway was now carried out to the full extension of its parliamentary powers.

The motion was then adopted.

An extraordinary meeting was afterwards held for the purpose of considering a resolution empowering the issue of debentures for £65,000.

The **Chairman**, in moving the resolution, explained that the money was required on account of the southern extension. It was proposed to offer the debentures for tender, and it was expected that a premium of £9 or £10 would be given. At this rate the debentures would be somewhat over 3 per cent.

Mr. Edward Lawrence seconded the motion, which, after some brief discussion, was unanimously passed.

WESTMINSTER ELECTRIC SUPPLY CORPORATION, LIMITED.

Directors: the Right Hon. Lord Suffield, K.C.B.; Edmund Boulnois, Esq., M.P.; W. Hayes Fisher, Esq., M.P.; Sir Douglas Galton, K.C.B., F.R.S.; J. Browne Martin, Esq.; James Heslop Powell, Esq.; R. W. Wallace, Esq., Q.C. General manager: Captain Edmund I. Bax. Engineer-in-chief: Prof. Alex. B. W. Kennedy, LL.D., F.R.S., M.I.C.E. Secretary: Frank Iago, Esq.

Report of the directors to be presented to shareholders at the ordinary general meeting of the Company, to be held at the offices of the Corporation, Eccleston-place, S.W., on Wednesday, February 24, at 11 a.m.:

The directors, in presenting their report and accounts for the year 1896, are pleased to state that the business of the Corporation continues to make satisfactory progress. The supply of current, which on December 31, 1895, was provided for the equivalent of 210,982 lamps of 8 c.p., had increased by December 31, 1896, to the equivalent of 249,318, and at the present time there are on circuit the equivalent of 253,383 lamps of 8 c.p., and applications have been received for a further 4,624. The length of roadway in which mains have been laid now exceeds 41 miles, making about 170 miles of ways, into which upwards of 141 miles of copper (strip and cable) have been drawn. The plant and machinery have been working satisfactorily throughout the year, and have been fully maintained from revenue, and a further reduction has been effected in the cost per unit, in generating, distributing, and general expenses. In consequence of the increase in the business of the Corporation, the directors have made a contract for the extension of the central station in Millbank-street upon the additional ground acquired, as reported at the last general meeting. The Board are glad to report that they have also been able to arrange for additional land at Davies-street on which to provide for further boiler power rendered necessary by the greatly-increased load at Davies-street station. In dealing with the revenue of the past year, your directors have, after writing off bad debts, the balance of preliminary expenses, and placing £1,000 to credit of sinking fund, added a sum of £12,100 to the depreciation account. The net

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revenue of the year amounts to £33,973. 6s 7d. As stated in the last annual report, after payment of 7 per cent. the holders of the founders' shares become entitled to a share of the profits. The net revenue, after payment of the 7 per cent., shows a balance of £10,208. 6s. 7d., of which one quarter, or £2,552. 1s. 8d., is due to the founders' shareholders, which added to the sum of £334. 14s. 9d. brought forward from last year, makes a sum of £2 886 16s. 5d. due to the founders or £28 17s 4d. per share, less income tax. An interim dividend at the rate of 6 per cent. per annum for the half-year ending June 30, 1896, has been distributed. The balance to the credit of the ordinary shareholders including the sum of £1,004. 4s. 5d. brought forward from last year, is sufficient for payment of a dividend of 9 per cent. for the past year; the Board therefore recommend the payment of a dividend at the rate of 12 per cent. per annum, less income tax, for the past half-year, making 9 per cent. for the year ending December 31 last, carrying forward a balance of £1,646. The directors have for some time had under consideration the question of the advisability of redeeming the founders' shares, and recently came to the conclusion that it was greatly to the interest of the ordinary shareholders to endeavour without further delay to come to terms. They therefore approached the founders' shareholders, who have held a meeting and stated to the Board that they are willing to accept 80 ordinary shares of £5 each fully paid in exchange for each founder's share of £5. The Board at their meeting on January 20 decided to recommend the shareholders to accept this offer, and an extraordinary meeting will be held to consider the matter in accordance with the notice sent herewith. In accordance with the articles of association, two of the directors, W. Hayes Fisher, Esq., M.P., and R. W. Wallace, Esq., retire, but, being eligible, offer themselves for re-election.

REVENUE ACCOUNT, YEAR ENDING DEC. 31, 1896

Dr.				£	s.	d.
A.—To Generation of Electricity.						
Coal, carriage, unloading, etc.	£7,838	9	7			
Oil, waste, water, and engine-room stores	1,394	1	9			
Proportion of salaries of engineers and officers	1,700	6	1			
Wages, etc, at generating stations	4,849	10	1			
Repairs and maintenance: (1) buildings, £274. 9s. 2d.; (2) plant, £2,502. 6s. 10d; (3) instruments, £9. 5s. 1d.	2,786	1	1			
				18,568	8	7
B.—To Distribution of Electricity.						
Repairs and maintenance of mains—materials, etc., £206. 4s. 2d.; proportion of salaries of officers, £121. 17s. 6d.; wages, etc., £478	806	1	8			
Repairs and maintenance of meters—materials, etc., £320. 11s.; wages, etc., £360. 12s. 9d.	681	3	9			
				1,487	5	5
C.—To Rents, Rates, and Taxes.						
Rents	965	17	2			
Rates and taxes	2 754	17	3			
				3 720	14	5
D.—To Management Expenses.						
Directors' fees	1,500	0	0			
Salaries of manager, engineer-in-chief, secretary, clerks, etc.	4,282	14	8			
Stationery and printing	269	10	9			
General charges and office expenses	443	1	6			
Wages of meter readers, inspectors, etc.	1,057	0	2			
Depreciation on office furniture	57	0	9			
				7,609	7	10
E.—To law and parliamentary charges				46	9	7
F.—To Depreciation, etc.						
Sinking fund	1 000	0	0			
Depreciation account	12 100	0	0			
Amount allowed for loss on coal stored	49	2	1			
				13,149	2	1
G.—To Special Charges.						
Insurance	502	8	6			
Board of Trade audit	72	14	0			
Cost of supplying steam	1,043	17	5			
				1 618	19	11
Total expenditure				46,200	7	10
Balance to net revenue account				40 431	13	0
				£86,632	0	10

Cr.	£	s.	d.
Sale of current by meter	81,536	9	10
,, contract	23	10	0
	81.559	19	10
Less bad and doubtful debts	346	2	6
	81,213	17	4
Supply of steam	1,638	11	5
Rental of meters, etc., on consumers' premises	3,717	12	1
Transfer fees	62	0	0
	£86,632	0	10

GENERAL BALANCE SHEET, DEC. 31, 1896.

Dr.				£	s.	d.
Capital account				440,000	0	0
Temporary loan from bankers				5,000	0	0
Sundry creditors				5,609	17	10
Creditors for debenture interest accrued, £2,323. 10s.; less income tax, £77. 9s.				2,246	1	0
Unclaimed dividends				3	12	6
Depreciation account				30,575	12	0
Sinking fund				5,972	1	11
Reserve fund				8,676	10	8
Undivided profit account—ordinary shareholders, £1,004. 4s. 5d; founders' shareholders, £334. 14s. 9d.				1,338	19	2
Net revenue account	£33,973	6	7			
Less interim dividend to June 30, 1896, at the rate of 6 per cent. per annum, £10,185, and less income tax, £339. 4s. 1d.	9,845	15	11			
				24,127	10	8
				£523,550	5	9

Cr.				£	s.	d.
Capital account				478,870	12	3
Stores in hand—Coal	£724	18	2			
Stores	187	5	8			
General	184	19	11			
				1,097	3	9
Sundry debtors for current supplied to Dec. 31, 1896				30,321	19	4
Other debtors				2,094	19	7
Cash at bankers (Messrs. Barclay and Co., Limited)				1,683	17	4
Deposits with vestries, etc.				316	12	0
Preliminary expenses and suspense account	£3,055	12	7			
Less amount written off for 1896	3,055	12	7			
Investments at cost				9,165	1	6
				£523,550	5	9

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC., YEAR ENDING DEC 31, 1896.

Board of Trade units generated		4 069,184
Quantity utilised—		
Sold to consumers	3,503,054	3,554,803
Used on works for lighting, meter testing, etc.	51,249	
Quantity expended in distribution—		
In batteries	17,904	477,396
In feeders	459,492	
Total quantity accounted for		4,031 699
Quantity unaccounted for		37,485
Number of lamps on circuit, Dec. 31, 1896		249,318

NATIONAL TELEPHONE COMPANY.

The report of this Company states that the income accrued in respect of the business of the half-year amounts to £439,978, as compared with £422,649, being an increase of £17,328. The working expenses amount to £245,278, being an increase of £28,741. The net result for the half-year (after deducting the Post Office royalties, amounting to £39,717) is a profit balance of £154,982, being a decrease of £12,891, a consequence of the loss to the Company of the revenue derived from trunk lines transferred to the State. The rentals carried forward for unexpired terms of running contracts amount to £414,714, an increase of £60,078. Out of the available balance of £137,306 the Board will recommend the payment of a dividend at the rate of 6 per cent per annum, less income tax, on the first and second preference shares, 5 per cent. per annum, less income tax, on the third preference shares, and 6 per cent. per annum, free of income tax, on the ordinary shares. The Board also propose to transfer £35 000 to the reserve fund, and to carry forward the balance of £5,713. The directors say that previously to the commencement of the half-year the whole system of the Company's trunk lines had been transferred to the State, which has involved a diminution of gross revenue for the six months of about £40,000. Against this may be placed the reduced cost to the Company of the wayleaves, the repairs and maintenance of the trunk lines themselves, and the Post Office royalty on that revenue, besides which the Company are gainers by the interest accruing upon the purchase-money. A further compensating advantage may be found in the more rapid development of the exchange business to be anticipated from the considerable extension of the trunk system erected and in process of erection by the Post Office. Naturally the change of system involved in a dual control has led to some temporary inconvenience, of which the public may reasonably complain, but this was inevitable under the circumstances. The Company are loyally co-operating with the Post Office in view of as speedily as possible bringing the trunk-line service of the country to the highest state of efficiency.

Cuba Submarine Telegraph Company, Limited. — The directors recommend a dividend on the ordinary shares at the rate of 8 per cent. per annum, tax free, for the half-year to December 31.

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CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Lyons.—Tenders are wanted by March 10 for installing the electric light at the lunatic asylum at Bron. Application should be made at the Prefecture of the Rhône, Lyon.

Brussels.—Tenders will be received on the 18th inst. at the Railway Offices, Rue de la Station 38, Arlon, for the construction of an electric generating station building at the Marbehan Station.

Cannes.—Tenders will be received on February 20, at the Mairie at Cannes (Alpes-Maritimes), for the erection of a postal, telegraph, and telephone building. There are five separate contracts.

Tarragona.—The Local Authorities of Tarragona will receive proposals on February 23 for the establishment of electric lighting for the city, on the basis of an annual payment (estimate) of 28,000 pesetas (£1,120).

Bucharest.—The Roumanian State Railway Department will receive tenders at Bucharest up to February 20 for the supply of telegraphic insulators and earthenware pipes. Particulars, in French, can be seen at the Musée Commercial at Brussels.

Berlin.—The State Railway Authorities will receive tenders on February 17 for about 275 tons of line wire, 33,000 insulators, and 15,000 screwed pins. Particulars for 50pfg. (6d.) from die Königl. Eisenbahn-Direktion, Centralbureau, Schoneberger ufer 1, Berlin.

Altona.—The State Railway Authorities will receive tenders on February 20 for the supply during 1897-98 of 179,000 electric lighting carbons, and 4,000 incandescent lamps for continuous and alternating current. Particulars for 50pfg. (6d.) from die Königl. Eisenbahn Direktion (Centralbureau), Altona.

West Ham.—The Council will receive proposals from persons or companies willing to undertake the free wiring of premises in the streets in the borough about to be provided with mains for the supply of electric light by the Council under their provisional order. Further particulars appear in our advertisement columns.

Ashton-under-Lyne.—The Corporation are prepared to receive tenders for the supply and erection complete of continuous current steam dynamos, motor-generator, balancing transformer, switchboard, cables, street-boxes, etc., arc lamps and columns, accumulators, etc. Full particulars can be seen in our advertisement columns.

Hanover.—Tenders are wanted by the Prussian State Railways for 32,600 telegraph insulators, with and without screwed attachments; 260 tons of wire (not line wire), 2½ tons of insulated wire, and 1¼ ton of wire rope. Particulars for one mark from the Railway Authorities (Königliche Eisenbahn Direktion), Hanover, Joachimstrasse 7.

St. Pancras, N.W.—The Vestry require tenders for supplying and fixing at the King's-road electricity works two Lancashire boilers, feed-pumps, steam-pipes, and accessories. Copies of specifications, conditions of contract, and form of tender in duplicate to be obtained upon application to the Electricity Department Offices, 57, Pratt-street, N.W., on payment of a deposit of 10s., which will be returnable on receipt of a bona fide tender and specification. Tenders to be sent to Mr. C. H. F. Barrett, vestry clerk, Vestry Hall, Pancras-road, London, N.W, endorsed "Tender for Lancashire Boilers, etc.," by 12 noon on 23rd inst.

Wallasey.—The Urban District Council are prepared to receive tenders for the supply and erection of a 200 kilowatt alternator, with engine combined, and for the requisite switchboard extensions. Copies of the specification may be obtained on application to the engineer, Mr. J. H. Crowther, at his office at the Great Float, near Birkenhead, on payment of the sum of £2. 2s, which be returned on receipt of a bona fide tender. Sealed tenders, on the form provided for the purpose, addressed to the Chairman of the Gas and Water Committee, and endorsed "Tender for Steam Alternator, etc.," to be delivered to Mr. W. Danger, clerk to the Council, Public Offices, Egremont, Cheshire, not later than 4 o'clock in the afternoon of Thursday, February 18, 1897. The contractor will be required to enter into a bond with approved sureties for the due performance of the contract.

Fareham.—The Urban District Council require tenders for the following: insulated high-tension twin twisted cables and low-tension concentric cables, earthenware conduits, and laying, including excavation and making good, and sundry house and public lamp connections. Specification and form of tender can be obtained from the consulting engineers, Messrs. Kincaid, Waller, and Manville, of 29, Great George-street, Westminster, S.W., on payment of a fee of £1. 1s., which sum will be returned on receipt of a bona fide tender. A map of Fareham, showing the several streets in which the mains will be laid, can be seen either at the offices of the Urban District Council, Fareham, or at the offices of the engineers, from whom further information can be obtained. The contractor whose tender is accepted must enter into a formal agreement, under seal, with sufficient sureties, for the fulfilment of contract. Sealed tenders, endorsed "Tender for Conduits and Cables," to be sent at or before 4 p.m. on February 15, to Mr. Leonard Warner, clerk, Fareham.

Hampstead.—The Vestry of St. John invite tenders for (*a*) oils for machinery at the electric lighting station; (*b*) tools, implements, and other electrical engineer's stores; (*c*) carbons, lamps, and other stores for the electric lighting station for one or two years from March 26 at the option of the Vestry. Forms of tender may be had, and further particulars obtained, on application to the Surveyor, Vestry Hall. Tenders to be addressed to the Vestry Clerk, and endorsed "Tender for ——," as the case may be, and to be delivered at the office of Mr. Arthur P. Johnson, vestry clerk, Vestry Hall, Hampstead, by 4 p.m. on 17th inst. No tender will be received unless each be accompanied by £10 in cash or bank notes—not to be enclosed—as an evidence that the tender is made bona fide, and the amount will be returned to each person whose tender is not accepted, but will be retained in the other case until the contract (and bond if necessary) is duly signed. Each contractor will be required to enter into a written contract, and with respect to certain contracts to provide two good and sufficient sureties, in such sum as the Vestry may determine. The expenses of preparing and stamping contract (and bond where necessary) to be paid by the contractor.

Islington, N.—Tenders are required by the Vestry of St. Mary for the supply of electrical stores for one year from March 25. Persons tendering must give the names and addresses of two substantial householders as their sureties prepared to join them in the execution of the contract, and must attend the meeting of the Vestry at 8 p.m. on 26th inst. They must annex to their tenders a schedule of wages relating to their respective trades, and will be required to make a declaration that they do and will during the continuance of any contract they may enter into with the Vestry continue to pay the trades union rate of wages as in practice obtain, and observe the conditions and hours of labour prevalent among the several classes of labour they may employ; and they must also agree not to sublet or assign over their contracts or any part thereof without the consent of the Vestry. Forms of tender and further particulars may be obtained and the draft contract inspected by application between 10 a.m. and 12 noon, at the Vestry Hall, Upper-street, N. No tender will be received after 12 noon on 25th inst. Parties tendering must be prepared with a £10 note, to be deposited (not enclosed with the tender) as a guarantee of good faith until the execution of the contracts.

RESULTS OF TENDERS.

Blackpool.—The tender of Messrs. Maunde and Seed, of Southport, has been accepted for the wiring of the new town hall.

Dewsbury.—The Town Council received four tenders for the supply of electric lighting cable for New Bridge-street, and that of Messrs. Callender and Co., at £105. 10s. was accepted.

Mile End.—The Guardians have accepted the tender of the Thames Ironworks for lighting the Guardians' premises by electricity at £4,926. We published the full list of revised tenders in our last issue.

Swansea.—For the entire construction and equipment of the Constitution Hill Tramway, Swansea (Mr. Charles T. Ruthen, C.E. 24, Goat-street, Swansea, engineer), the tender of Messrs. G. Webb and Co., London and Portsmouth, has been accepted.

Worcester.—The Town Council have accepted the tender of Messrs. W. Cory and Co., Limited, of 52, Mark-lane, London, for supplying Aberdare smokeless coal at 14s. 9d. per ton, smokeless nuts at 14s. 9d. per ton, and Staffordshire washed nuts at 13s. 4d. per ton, for the Powick generating station.

Paris.—Contracts for the supply of telegraphic material to the French Government were awarded as follows on the 28th ult.: 300,000 galvanised iron screws, Veuve Silvert-Levent, Bavay, 14,100f.; 300,000 ditto, the same, at 13,500f.; 25,000 kilogrammes of bronze wire, the Usines Mouchel, Paris, at 47,462f.

Waterloo and City Railway.—The contract for the electrical plant in connection with this new line has been placed with Messrs. Siemens Bros. and Co. The specifications for this work were drawn up by Prof. A. B. W. Kennedy, and include all the necessary generating plant, mains, and electric locomotives.

Dover.—The Corporation have received the following tenders for the construction of about three miles of the tramways—single line with passing places—including a concrete road bed, the laying of rails, tie-bars, etc., and paving with granite setts:

J. J. Briggs, Blackburn (accepted)	£9,729	14	1
E. Nicholls, Morecambe	11,594	17	1
H. Hill, Maidenhead	11,794	6	0
A. Brunton and Son, Hull	11,796	13	7
W. L. Meredith, Gloucester	12,470	15	10
W. Wadey, Stoke Newington	12,499	8	0
Dick, Kerr, and Co., London	12,719	19	7
W. Griffiths, Kingsland-road, N.E	12,738	3	9
J. Dickson, St. Albans	13,162	14	7
Pauling and Co., Limited, Westminster	13,499	1	4
Callender's Cable and Construction Company, Cannon-street, E.C.	13,570	13	0
Mowlem and Co., Westminster	14,608	16	4
C. Munro, Dover	14,820	0	0
Fry Bros., Greenwich	14,927	16	9

Engineer's estimate, £12,075.

The following tenders were received for the supply and delivery of steel girder rails, fishplates, fishbolts, tie-bars, points, crossings, and other accessories for the above tramways:

Dick, Kerr, and Co., London (accepted)	£5,308	4	0
Rowell, Stuart, Kelman, and Co., London	5,177	19	8
Pauling and Co., Westminster	5,186	0	0
Leeds Steelworks, Limited, Leeds	5,730	10	0

Engineer's estimate, £4,900.

Hampstead.—The Vestry have accepted the estimate of Messrs. Crompton and Co. for 28 Crompton-Pochin lamps, at £8. 11s. each. They have accepted the estimate of Messrs. Kershaw for 28 lamp-posts and carriers, at £8. 15s. each. They have also accepted the tender of Messrs. Siemens Bros. and Co. for a Siemens H H D. 24/9 constant-current dynamo coupled direct to a Willans D1)

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compound engine, including steam and exhaust branches, necessary switches, instruments, resistance frames, and cables for connections, all delivered and erected complete at the station, at a cost of £715.

Hull.—The Tramways Committee have received six tenders for the reconstruction and leasing of the street tramways. The tenders were from Mr. Nettleton, Hull; Messrs. A. Dixon and Co., Birmingham; Gas Traction Company; New General Traction Company; British Electrical Traction Company; and British Houston Company. The discussion of the tenders was postponed for a fortnight.

BUSINESS NOTES.

Western and Brazilian Telegraph Company.—For the past week the receipts were £2,375.

Brussels.—The horse trams are being replaced by electric traction on the underground system.

Aston.—The District Council have decided to petition against the City of Birmingham Tramways Bill.

Dundee.—The Gas Committee have recommended the Town Council to erect 12 electric lamps to replace 71 gas lamps.

Electric Light in Pall-mall.—The St. James's end of Pall-mall was lighted on Wednesday night for the first time by electricity.

Carlisle.—Prof. A. B. W. Kennedy has been retained as consulting engineer for the promotion of the electric lighting scheme.

Cork.—A Board of Works enquiry has been held by Mr. G. A. E. Hickson, C.E., in regard to the proposed Cork electric tramways.

Wells.—The Lighting Committee reported to the Town Council that progress was being made with regard to the public lighting by electricity.

The Newcastle Exhibition.—The Electrical and General Engineering Exhibition will be opened on Monday by the Mayor (Mr. J. Goolden, J.P.).

Swansea.—The fight over the municipalisation of the tramways is proceeding with great vigour, and meetings are being held daily in view of the forthcoming ballot.

Birmingham.—The fifteenth annual dinner of the Birmingham branch of the Postal Telegraph Clerks' Association was held at the Midland Hotel on Saturday night.

Catalogues.—We have received catalogues from the Edison and Swan United Company and Messrs. W. B. Haigh and Co., which we hope to notice in a future issue.

Burnley.—The Town Council have under consideration an alternative method of charging customers for current used. New accumulators are about to be put in.

Swinton and Pendlebury.—The Urban District Council have decided to support the Manchester Carriage and Tramways Company in their proposed provisional order.

Lambeth.—The Vestry have sealed the agreement transferring their electric lighting provisional order to the South London Electrical Supply Corporation, Limited.

Kingswood (Bristol).—The Western Counties Electric Light and Power Syndicate have accepted the offer of the Urban Council to purchase the installation at Kingswood.

Coventry.—The City Council have consented to the application of the Coventry Electric Tramways Company's application to Parliament for powers to extend their tramways.

Correction.—In mentioning Messrs. Davies, Kent, and Stewart's price-list last week we inadvertently gave their address as Haddon-street. It should have been printed Heddon-street.

York.—The City Council have approved the scheme and tenders laid down by Prof. Kennedy, and the committee are without further delay to submit to the Council a plan to give effect to it.

Queensbury.—The Town Council have referred to the Highways Committee the question of the advisability of applying to the Bradford Corporation for an extension of the proposed electric trams into their district.

Salisbury.—The Town Clerk reported at the Council meeting that the application to the Board of Trade to extend the Salisbury company's electric lighting order for a period of another six months had been acceded to.

Handsworth.—The Urban District Council are applying to the Local Government Board for sanction to borrow £2,200 for electric lighting plant to supply the Council House, technical school, and other buildings.

Grange.—The correspondence on the subject of electric lighting agreement was read at the District Council meeting, and the Council consented to an extension of time to make deposit for a further period of 12 months.

Nuneaton.—The electric light company have placed orders for the buildings, machinery, cables, etc., and it is hoped the installation will be working in about two months' time. Applications for the light are coming in well.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended February 7 amounted to £1,241, as compared with £1,090 in the corresponding week of the previous year, being an increase of £151.

London Lighting Extensions.—The London County Council have received notices of extensions from the Metropolitan Electric Supply Company, the Vestry of St. Pancras, and the House-to-House Electric Supply Company.

Bristol Tramways and Carriage Company, Limited.—The traffic returns for the week ended February 5 were £1,903. 11s. 3d., compared with £1,751. 19s. 9d. for the corresponding period of last year, being an increase of £151. 11s. 6d.

Ayr.—The Town Council have agreed to borrow an additional sum of £15,000 for the purpose of meeting the sums already borrowed in excess of the loans authorised, and also the cost of the new contracts and extensions contemplated.

Barrow.—At the Town Council meeting the Gas and Water Committee recommended that an electrical engineer be called in to prepare detail plans and estimates of a scheme for supplying electricity to the compulsory area. This was agreed to.

Telegraph Construction and Maintenance Company.—Subject to the audit of the accounts, the directors propose paying a dividend of 10 per cent. (£1. 4s. per share), in addition to the 5 per cent. already paid, making 15 per cent. for the year 1896.

Westminster Electric Supply Corporation.—Subject to audit, the Board recommend the payment of a dividend for the past half-year at the rate of 12 per cent. per annum, making, with the interim dividend already paid, 9 per cent. for the year 1896.

Hull.—The receipts in the Corporation electric light department for the past year amounted to £8,136, and the expenditure to £3,184, leaving £4,821 to be carried to net revenue account. The total capital expenditure to December 31, 1896, amounted to £46,985.

Calendars.—We have received a beautiful calendar from Messrs. Ernest Scott and Mountain, electrical and general engineers and iron and brass founders, Close Works, Newcastle, and also one from Messrs. Dorman and Smith, Ordsal Electrical Works, Manchester.

Glasgow.—The Corporation have decided that the new lamp arm and pendant which had been fitted on the eight pillars at the west end of Sauchiehall-street should be also fitted on the remaining pillars, and that when so altered they should be fitted with the Brockie-Pell lamp.

Bowness-on-Windermere.—At the Urban District Council meeting the Clerk said he had an official letter from the Board of Trade stating they had given the electric lighting company six months' additional time in which to carry out the provisional order, this dating from January 27.

Austria-Hungary.—The public streets of Hallein are now lighted by electricity. A committee has just been appointed to enquire into the electric lighting question at Niemes. An inter-urban telephone line has just been completed and put in operation between Vienna and Krakau.

Appointments Vacant.—The Morecambe Urban District Council require a resident engineer in connection with the electric light works.—The Burgh of Ayr require an electrical engineer to take charge of the whole undertaking. Full particulars are given in an advertisement in another column.

City and South London Railway.—The returns for the week ended February 7 were £1,123, compared with £972 for the corresponding period of last year, being an increase of £151. The total receipts for the half-year 1897 were £6,611, compared with £5,997 last year, being an increase of £614.

Chislehurst Electric Supply Company, Limited.—This Company has been registered, with a capital of £15,000 in £5 shares, to carry on the business of electrical engineers and contractors, electricians, manufacturers of electrical apparatus, mechanical engineers, and suppliers of electricity.

Belfast Street Tramways.—The revenue account of the Belfast Street Tramways Company for the half-year ended December 31 shows a credit balance of £10,493. The directors recommend a dividend at the rate of 6½ per cent. per annum, and carry forward £1,248 The question of electric traction is completely at a standstill.

General Electrical Company of Roumania, Limited.—This Company has been registered, with a capital of £3,000 in £1 shares, to manufacture, construct, erect, lay down, establish, fix, maintain, buy, sell, and deal in machinery, engines, rolling-stock, cables, wires, lines, accumulators, lamps, apparatus, etc., connected with electricity.

Hammersmith.—A memorial signed by 48 ratepayers in Uxbridge-road, west of Percy-road, was submitted to the Vestry at the last meeting, asking that the electric lighting of Uxbridge-road should be continued to the boundary of the parish in that thoroughfare. This was referred to the Electric Lighting Committee.

W. T. Henley's Telegraph Works Company, Limited.—For the year ending December 31 the directors recommend a dividend of 7 per cent. on the ordinary shares, making, with the 3 per cent. already paid, 10 per cent. for the year, and on the preference shares 3½ per cent, making 7 per cent. for the year. The amount carried forward is £14,294.

Dewsbury.—At the meeting of the Town Council the balance-sheet was presented, showing the result of the working of the electric lighting plant during the year ended December 31, 1896, showing a net profit after defraying all expenses, including interest and sinking fund, of £19. 19s. 9d. Electrical energy discharged, 7,829 units, as against 6,910.

Ludlow.—A letter was read at the Town Council meeting from the gas company stating that the directors regretted that the quality of the gas during the last few days had been most unsatisfactory. After some discussion the Sanitary Committee were requested to consider the whole question as to purchase of the gasworks or the introduction of the electric light.

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Ramsgate.—The Town Council have decided to approve and support the application of the Isle of Thanet Light Railway (Electric) Company, Limited for an order authorising the construction of the proposed light railway from Pegwell through Ramsgate, Broadstairs, and Margate, to Westgate.

Tennessee Industrial Exhibition—An industrial exhibition is to be held this year in Nashville, Tennessee. The Congress of the United States has passed the necessary Acts providing for a display by the national Government, and for the admission of exhibits from foreign countries, under liberal conditions.

Leicester.—To meet the requirements of their greatly increasing trade, the Midland Electrical Wire Company, of River Mills, Leicester, are more than doubling their plant, and have secured the services of Mr. Walter Levi, late of the Northern Electric Wire Company, to take over the management of the covering department for bell, electric light, and instrument wires, etc.

Hampstead.—The Vestry have deferred the question of lighting the shops on the Willesden side of the High-road, Kilburn, with electricity until they hear from the Willesden District Council on the subject. They have also decided to erect 28 arc lamps for the lighting of High-street, Heath-street (south of High-street), Rosslyn-hill, and Haverstock-hill. The cost is estimated at £1,725.

West Bromwich.—The Town Council are awaiting the result of the appeal made by the Wolverhampton Corporation on the Standing Orders against the Wolverhampton and District Tramways Company's Bill before deciding whether they will have to petition against it. The Council consider that if electricity is to be supplied in the borough, it should be supplied by the Gas Committee.

Derby.—From the report of the last Town Council meeting there seems to be some difficulty with regard to the electric lighting of the market, which was wired for the light, but evidently so unsatisfactorily that the tenants unanimously petitioned for a return to gas. Their petition was granted. The Lighting Committee also appear to be far from satisfied with the arc lamps at present in use.

Rontgen Rays in Germany.—In this year's estimates for the kingdom of Prussia a sum of 50,000 marks is provided for assisting institutions and certain private individuals to obtain the necessary apparatus for investigations with the Röntgen rays. The sum is divided into two parts—for the purchase of apparatus and for working the same. A Röntgen apparatus complete costs there about 2,500 marks (£125).

Electricity Cheaper than Steam.—Mr. Alexander Siemens, who has had an opportunity of carefully comparing the relative initial costs of steam and electric power plants for driving their works, says that the capital expenditure in a new works is 30 per cent. less in the case of driving by electric motors. In the works of Messrs. Siemens, 11 steam-engines were replaced by 72 motors, representing a total of 1,400 h.p.

Edison and Swan United Electric Light Company, Limited.—The directors have resolved that a payment on account of the dividend of the current year be made at the rate of 5 per cent. per annum, less income tax, on the "A" shares in respect of the half-year ended December 31. This will work out at 1s 6d. per share on the partly-paid £5 shares (£3 paid), and 2s. 6d. per share on the fully-paid £5 shares, less income tax.

Glasgow and the Telephone—At the meeting of the Chamber of Commerce the following resolution was passed: "That this meeting resolves to urge the Government to take over as soon as possible, on such terms as they can best arrange, the telephone service of the country, and suggests to the Glasgow Corporation that permission should not be granted to the National Telephone Company to lay down underground wires."

Blackburn.—At the meeting of the Town Council, the minutes of the Gas Committee stated that a letter had been received from the secretary of the Blackburn Corporation Tramways Company, Limited, with reference to the size of the electric cars to be used on the Preston New-road and Witton sections, and suggesting that cars to carry 50 passengers should be allowed. The matter was referred to the sub-committee to consider and report upon.

Presentation.—An interesting gathering of the staff and employés of the Blackpool Corporation electricity works was held on Saturday at the works to take a farewell of Mr. J. H. Wray, who has been appointed one of the chief assistants for the Malaga electricity station. Mr. Wray was presented by the staff with a silver cigarette case, suitably engraved, and on behalf of the employés a presentation was also made of a dressing-case. Mr. Wray sailed for Malaga on Wednesday.

A Useful Example.—We are pleased to hear that a course of first-aid lectures of the St. John Ambulance has been given at the works of the Incandescent Electric Lamp Company by Dr. Denne, Sterndale-road, the works doctor, and that out of 16 men who presented themselves for examination, the whole number have passed. In a works of the size of the Incandescent Electric Lamp Works, employing so many people, the information imparted by the Ambulance Society to the pupils is often found very useful.

Bromley.—At the meeting of the Rural Highway Board another letter was received from Mr. Charrington, on behalf of the Chislehurst Electric Lighting Syndicate, asking for a list of roads not repairable by the Highway Authority in Chislehurst. The Clerk said they had declined to give any return which might involve them as a Council in any way. He thought, however, they might go so far as to ask the chairman (Mr. Willis), who was thoroughly acquainted with the district, to assist in the matter unofficially. This Mr. Willis consented to do,

St. Pancras.—The Vestry have decided to extend the electric mains to Park Village West, Regent's Park, in response to applications for the electric current. Dr. Walter Smith stated on behalf of the Electricity Committee that that committee never recommended extensions unless there was a certainty of realising 20 per cent. profit on the outlay incurred. This profit had been derived hitherto in regard to the extensions effected. The London County Council have completed with the Vestry the loan of £6,540 for further expenditure on the electric light installation.

Chiswick.—The Works Committee reported at the Urban District Council meeting that they had received a letter from the Bourne and Grant Electricity Supply Company, Limited, stating that the delay in the electric lighting works was caused by difficulties with respect to the joint ownership of the chimney shaft, and that a proposal thereon would be submitted next week. It was decided to adopt the committee's recommendation that the Law and Parliamentary Committee be requested to report on the Council's position anent the agreement with the company.

Walsall—At the Town Council meeting the Electric Lighting Committee reported that the accounts of the first complete year's working of the electricity department—viz., to December 31—showed that the total expenditure (exclusive of interest and sinking fund) was £1,130. 7s. 9d., and the total income £1,568. 7s. 6d, leaving a surplus of £437. 19s. 9d. to be applied to interest and sinking fund, which together amounted to £883. 3s. 7d., thus making the net total deficiency in respect to the year's working £445 3s. 10d. This result the committee considered very satisfactory.

Hastings.—The borough engineer, at the suggestion of the National Boiler, etc., Insurance Company, has been in communication with Babcock and Wilcox, Limited, with a view to having certain modifications made in the construction of the two boilers for the electric light station, their tender for which, at £854, was accepted at the meeting of the Council held on December 4 last. Messrs. Babcock and Wilcox were prepared to make the required modifications for an extra sum of £30, making the total contract sum of £884. The Town Council have decided that the proposed modifications be carried out.

Bristol Tramways and Carriage Company, Limited—The gross receipts for the half-year amount to £59,045, and the working and general expenses and renewals to £46,667, leaving a balance of £12,378. The directors propose to pay a dividend for the half-year at the rate of 6 per cent. per annum, and to carry a balance of £2 838 to reserve and renewal funds. The question of the adoption of electric traction over the whole system is in abeyance until the Corporation are ready to give their consent with unreasonable restrictions. Dividend warrants will be posted to the shareholders on February 26.

Canterbury.—A long discussion took place at the Town Council meeting on the Lighting Committee's report with reference to an offer which had been received from the directors of the gas company to place incandescent burners in the street lamps, at the price paid for the existing lights. It was argued that as they would not get the electric light for two and a half or three years, they might as well get the best light they could from the gas company. Therefore the gas company's letter was referred back to the Lighting Committee, with a recommendation that they should endeavour to make terms with the company.

Personal.—We understand that Mr. E. George Tidd, A.M.I C.E, A.I.E E., has severed his connection with Messrs. Paterson and Cooper, and his address will in future be care of Messrs. Morris, Warden, and Co., 25, Gordon-street, Glasgow. Mr. Tidd has been on Messrs. Paterson and Cooper's staff for upwards of 10 years, and has designed and carried out many of their most important installations. Four years ago he was appointed manager of their Northern department, with head office in Glasgow, where he had the sole superintendence and management of all contracts in Scotland and the North of England and Ireland.

Spain.—It is proposed to construct an electric tramway between Baeza and Ubeda (Jaen). An electric power generating station has recently been established near Alcay for the supply of electrical energy for lighting and power purposes at Alcay and Gandia (Valencia province). The water power of the Serpio River is utilised, the generating plant consisting of two 150-h.p. Gilkes turbines and two Siemens 110-kilowatt alternating dynamos. It is reported that an English syndicate has acquired the rights to some available water power at Flix (Tarragona province), and intends to establish works for the electrical production of carbide of calcium.

The Electric Lighting of Cheltenham.—On Saturday evening the Mayoress of Cheltenham (Mrs. Rogers) switched on the arc lamps which have been placed in the High-street, Clarence-street, and St. George's-place as a first instalment of the public lighting of Cheltenham by electricity. Alderman Norman mentioned that the 29 arc lamps which were about to be switched on would displace 25 Guildhall and 50 ordinary gas lamps. The arc lamps were on four circuits, two of which were all night circuits, and by means of the other two they would be able to reduce the quantity of the light after midnight by extinguishing every alternate lamp.

Bootle.—The Town Council have appointed Mr. T. L. Miller, of Liverpool, as an expert electrical engineer to advise the Watch Committee regarding the electric lighting of the borough, to prepare a scheme, and if such scheme is adopted, to act as engineer, the remuneration to be 5 per cent. on the cost of all works executed under his supervision; or if the works be not carried out, the payment of 100 guineas for the preparation of the scheme. Provision was also made for the reference of the

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scheme to another electrical engineer, the cost to be deducted from Mr. Miller's percentage if the scheme is carried out, or paid by the Corporation if not adopted.

Croydon.—The Local Government Board have sanctioned a loan for £9,900 for the purposes of electric light extensions, repayable in 25 years. The General Purposes Committee reported at the Town Council meeting that they had received a letter from Prof. Kennedy, enclosing his detailed report on the tests made of the electric lighting plant (except the arc lamps and rectifiers), in which the professor states that he is glad to be able to report that the plant passed the tests quite successfully, the results being in every respect very satisfactory. The professor has not yet tested the arc lighting plant, as the same is not yet complete or in any way approved. The report was adopted.

Western and Brazilian Telegraph Company.—The secretary of the Western and Brazilian Telegraph Company, in sending out to the shareholders notice of an extraordinary general meeting, convened for Monday, to sanction the conversion of the debenture debt, draws attention to a circular on this subject, which was sent to all the debenture-holders last month, and adds that in reply thereto assents to the extent of £245,000 have already been received, and that the directors anticipate no difficulty in obtaining the assent of most of the holders who have not yet replied. The directors do not propose to carry out this conversion unless not less than two-thirds of the debentures are exchanged for debenture stock.

Crewe.—At a meeting of the Town Council the Mayor (Alderman M'Neill) moved the confirmation of the proceedings of the Tramways Committee. The committee decided by 13 to 7 not to oppose the application of the Light Railways Commissioners and the British Electric Traction Company for an order to construct light railways in the borough. Alderman Latham said their London agents had drafted a series of amendments to the scheme in order to safeguard the interests of the borough, and he hoped they would have an opportunity of discussing them. The Mayor said the proposed amendments would be discussed before the visit of the Light Railways Commissioners, which was fixed for the 17th inst. The motion was carried.

Rochdale.—At the meeting of the Town Council Aiderman James Cheetham, the chairman of the Paving, Sewering, and Scavenging Committee, in answer to a question, said the Bury, Rochdale, and Oldham Tramway Company had made an application to the committee to run their tramcars to Littleborough by electric instead af steam traction engines, and they also wished to have another lease of 21 years granted to them. A Tram Sub-Committee, along with their surveyor and deputy town clerk, had visited Walsall, Bristol, and Coventry to inspect the systems of electric traction existing in those boroughs, and the majority were well satisfied with them. Their surveyor and deputy town clerk were instructed to prepare a report to bring before the committee.

Cardiff.—At the meeting of the Corporation Alderman Carey moved that a special committee be appointed for the purpose of considering the advisability, in the public interest, and for the convenience of the public, of establishing a system of electric tramways in various parts of the borough. He showed that the tendency was to adopt electricity as a motive power, stating that 41 electrical lines were established in the country during the past year. His idea was that electric lines should be laid along Castle-road to Roath Park, from Temperancetown into Cathedral-road, and along Clifton-street to the East Moors, and prophesied that it would mean an immense revenue to the Corporation in supplying electricity. Alderman Jacobs seconded the proposition, which was carried, and the committee formed.

Wallasey.—Mr. Ellery, in moving the proceedings of the Gas, etc., Committee at the District Council meeting, said the total cost of the installation of the electric light in the district was £10,483, about £2,000 less than was estimated. They would certainly have to go in for further extension before long. Among the chairman's communications was a letter from the secretary of the Wallasey Tramway Company, stating that the company had had under consideration the provision of better travelling facilities, and hoped that the Council would be willing to co-operate with them in measures which would secure the objects above mentioned. The company proposed certain extensions of the lines, and intimated their intention to use electricity as the motive power. The letter was referred to the Works Committee.

Coventry Electric Tramways.—The engineers to the Coventry electric tramways which are proposed to be constructed under the deposited Bill of the present session, have prepared, for the information of Parliament, a detailed estimate of the cost of the proposed lines, which are of an aggregate length of 6 miles 4 furlongs 2 chains, and which will connect with the existing tramways of the Coventry Electric Tramways The total cost of the proposed extensions is £47 892, of which £5,350 will be expended upon a generating station. These extensions are proposed to be constructed by a newly incorporated company, with a capital of £105.000, and with power to raise a further sum of £35 000 by the exercise of borrowing powers. This large capital is required in order to provide for a probable purchase of the existing tramways now owned and worked by the Coventry Electric Tramways.

Waterloo and City Railway.—The length of single tunnel driven during the past six months has been 370 yards, the greater portion of which has been under compressed air, and the total length of single tunnel driven since the commencement of the work now amounts to 4 306 yards. The site of the arrival and departure platforms of the low-level station is ready for the platform walls, and the inclined roads from these low-level platforms to those of Waterloo Station are in hand. The area of the terminal sidings on the south side of Aubin-street are now being excavated. Tenders for the electrical equipment of the line have been invited. Eight firms tendered, and the Board are considering them. The tenders of all these firms differ very little from the original estimate of the engineers. The contract time allowed under the Act for the completion of the railway was July, 1898, but it will be completed and in working order long before that period.

Newington.—The Vestry have, in answer to petitions forwarded by 1,478 persons to the Board of Trade protesting against the Vestry taking up the question of electric lighting, submitted to the Board, as a a reply to these petitions, a long report, in which they say: "Whilst admitting that the Board of Trade might have had grounds at the last enquiry for not proceeding with the Vestry's order through the engineering part of the scheme not being fully considered, the committee believed that the Board would hesitate before putting the parish to the expense of a second local enquiry on the facts now placed before them, and that even if they did, the Vestry could and would support the committee by producing evidence to show that the scheme as now prepared by Messrs. Kincaid, Waller, and Manville was practicable, and not likely to throw any burden upon the parishioners, and, what was of equal importance, it was the intention of the Vestry to give effect to the order if granted."

Wardle.—The General Purposes Committee reported at the meeting of the District Council that a deputation from the tramways company had explained their scheme for converting the Rochdale and Littleborough section from steam to electrical traction. It was pointed out by the deputation that the principal advantage to the district would be that the steam trams would be removed, the cars would be wider and better lighted, there would be more frequent service, and the roads would be repaved. It was proposed to have the overhead system, and the Council would be allowed to hang their lamps on the poles. It was also intended to run early workmen cars. It was unanimously resolved that the sanction required for the extension of the company's powers for 21 years be granted, subject to poles being erected and kept in repair to the satisfaction of the surveyor. A letter was read from the tramway company thanking the Council for the manner in which they had received the deputation.

Bristol.—The Electrical Committee have resolved to make a reduction in the charges for energy supplied for motive power and for heating. The new charge will be £6 per kilowatt per annum demanded and 2d. per unit of electricity used, instead of the present charge of 4d. per unit subject to a discount. A main is to be laid in Whatley-road to the new church, and it was decided to canvass Lawrence-hill to the borough boundary line. The accounts of the year ended December 31, 1896, show that the number of the Board of Trade units generated was 861,165, public lamps took 167.231 units, and private consumers 483,527. making a total of 650,758. The quantity used at the works was 196,746, making 847,504 units accounted for, and leaving unaccounted for 13,661 units. The number of public lamps supplied by electricity is 105. The balance-sheet shows that the capital stood at £110,000 in December, and there had been expended on works £109,968. There is a balance brought forward to net revenue account of £5,790. 11s. 2d.

Crosby.—It appeared from the minutes of the General Purposes Committee which were adopted at the Urban District Council meeting, that a letter had been received from Mr. Holme, of Messrs. Holme and King, railway contractors, Liverpool, as to bringing electric tramcars into the district. It was decided that the law clerk should write to Mr. Holme asking for detailed particulars and plans of his company's proposals, and that upon receipt of same the Council would take the matter into further consideration. Mr. Dean (the law clerk) stated that he had had an interview with Mr. Holmes, and that gentleman sent his representative with a plan of the proposed route along which the company purposed to go. The plan submitted was inspected at length by the Council, and it was ultimately resolved, on the motion of Mr. Gleaves, seconded by Mr. Manning, that the Council ascertain the mode of working and other particulars in connection with the proposed tramway, when the subject would receive the consideration of the Council.

Worcester.—The following resolution was adopted at the meeting of the City Council: "That while anxious to meet the convenience of citizens living in the suburbs of the city, the Council cannot consent to the tramway extending from the Cross through High-street and College-street to Sidbury. That conditionally upon the insertion and retention in the provisional order of such clauses as the Council thinks necessary, and on the promoters agreeing to pay the Council's costs whether the provisional order is made and confirmed or not, the Council to consent to the following tramways: (No. 1) from Lowesmoor along the Astwood-road to Brickfields-road; (No. 2) in Ombersley-road from Vine-street to Checkett's-lane; (No. 4) from Edgar-street along Sibury and London-road to Foxwell-street; (No 5) from London-road along Bath-road to Stanley-road; (No. 6) from the Cross along St. Swithin-street, Mealcheepen-street, Corn Market, New-street, Friar-street, and Sidbury to Edgar-street." The clauses inserted by the Council state that the electric power for these tramways shall be obtained from the Corporation.

Cheltenham.—The Streets Committee reported at the Town Council meeting that they had held a consultation with Mr. T. A. Nevins on the proposed light railway, and they had no objection to his stipulation as to a communication with the premises of the Great Western Railway, provided it be confined to parcels, and, with regard to the times of running, there must be at least two

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services an hour. The committee also recommended an amended route—viz., from the Great Western Railway Station along Manchester-street, Clarence-street, North-street, Albion-street, Portland-street, Clarence-road to the Pittville Gates, and thence along the Prestbury-road to the borough boundary (whence it is proposed to be taken on to Winchcombe), provision being made that the cars shall be brought to a stand on each side of the High-street. Mr. Parsonage moved the adoption of the committee's report, and that the town clerk prepare a draft of the suggested amending clauses to be inserted in the provisional order. Mr. Nevins, he said, had undertaken that the gauge should be narrower than 4ft. 8½in., as originally proposed. The committee's recommendation was adopted.

Bath.—In the report of the gas inspector (Mr. J. W. Gatehouse), read at the Town Council meeting, reference was made to the unsatisfactory condition of the electric lighting, and it was stated that a breakdown was possible at any time. Alderman Sturges said that was no more than their engineer (Mr. Hammond) told the committee at their last meeting—that the machinery at the works was defective and not sufficient for the work it had to do. When the money granted by the Local Government Board for improved machinery and new standards had been expended and the new standards erected, he did not think they would have any report of that sort. They were in the way of making a great improvement, and he hoped they would make an improvement in the price too. He wanted to introduce what was called the Brighton system, under which different prices were charged for the different hours of the night, which was very economical to the user and productive to the Corporation. The public might wonder why nothing had been done since the committee had the money, but he could assure them that everything was being pushed forward as fast as propriety would allow. He wanted the public to have confidence in them and look forward to having a much better state of things in a short space of time.

Newcastle.—At the meeting of the General Purposes Committee the Town Clerk reported that the British Electric Traction Company, Limited, were making application to the Light Railway Commissioners for the grant of a provisional order to enable them to carry out tramway extensions to Chesterton, Silverdale and Wolstanton respectively. The Borough Surveyor reported that the total length of railways within the borough was 1 mile 4 furlongs 7·7 chains. The rails would be laid practically level with the surface of the roads through which they pass, and to a 4ft. gauge, as in the case of the tramways. No details or information as to construction and finish of the work were given, and if the space between the rails was not paved, but formed with macadam metalling or such material, the surveyor thought there would be great difficulty in maintaining the surface satisfactorily. The motive power would be mechanical or by means of eelctricity. The report was adopted and a committee appointed to consider the order, with the intimation that it was the wish of the Council to have reserved to them similar rights and powers as were contained in Section 28 of the Tramways Act, 1870. The committee at a later meeting recommended that the town clerk prepare a formal objection to the proposed provisional order and forward it to the Light Railway Commission. This was agreed to.

Association of Chambers of Commerce.—At the annual meeting of the Association of Chambers of Commerce to be held at the Whitehall Rooms on March 9, 10, and 11, under the presidency of Sir Stafford Northcote, the Oldham Chamber will bring forward a motion urging that the "Legislature should assiduously devote sufficient time and attention to secure without delay" the consolidation of the laws relating to limited liability companies and their amendment in several important particulars. On the subject of private Bill legislation the Dublin Chamber will invite the association to express the opinion that while the final control of Parliament should be retained, the course of procedure on local Bills should be conducted by an extra-parliamentary tribunal, which should be empowered to hold its sittings throughout the year at any place found most suitable. The Edinburgh Chamber will bring forward a resolution asking the Government to deal with the question in the present session of Parliament. A motion will be submitted on behalf of the Oldham Chamber in opposition to the Bill introduced by Sir A. Forwood on the subject of employers' liability for accidents to workmen, and requesting the executive council to take steps to prevent any alteration of the existing law whereby an employer would be made liable to pay compensation to an injured workman, except where the employer or his servant shall be guilty of neglect or default and the injured workman has not been guilty of contributory negligence.

St. Saviour's Board of Works.—The Paving and General Purposes Committee have reported that they had, as directed by the Board, considered the feasibility of lighting the streets in the St. Saviour's district by means of electricity. The surveyor had been in communication with the two companies supplying the district—namely, the London Electric Supply Corporation, Limited, and the City of London Electric Lighting Company, Limited—and had ascertained from them the terms upon which they would be willing to undertake the lighting of the five principal streets in the district. The mains of the former company were available for Borough High-street, Blackfriars-road, and Stamford-street only. Their charge would be about £32 per lamp per annum, the Board providing at its own cost all lamps, pillars, switches, boxes, etc., requisite for the installation. If they lighted Southwark-street and Southwark Bridge-road in addition—*i.e.*, all the five streets named—they calculated that the expense to the Board for the necessary plant of the two last-named streets would be about £5,000. This would not include the cost of current to the lamps, nor the lamps, etc., for the three other streets. The City of London Company had furnished a scheme providing for 86 arc lamps, placed about 120ft. apart. The company would require a contract for 21 years. The cost of these 86 lamps would be £2.408 per annum, and they would only displace 166 gas lamps. There were in St. Saviour's district 590 lamps altogether, the annual cost of lighting the whole of the district with gas being about £2,000. Therefore the cost of lighting the five principal streets by means of electricity would be considerably more than the amount incurred in lighting the whole of the district by gas. The committee, having regard to the enormous cost, could not therefore see their way to recommend the Board to undertake the lighting of the district by electricity. The report was adopted after it had been stated that to light the district by electricity would cost £11,000 a year.

Stirling.—The following letter in reference to the use of water power for the electric lighting has been sent to the Commissioners: "Dear Sir,—With regard to the above question which is now engaging your attention, I observe with considerable surprise that the question of the utilisation of water power for generating the electric current has been entirely overlooked in the report submitted to the Town Council. Knowing as I do the numerous advantages to be obtained from the employment of reliable water power, it seems to me to be a thousand pities that this valuable and economical method of producing the electric current should not have been considered. On Wednesday of last week several members of the Town Council put the question to me whether it were not possible to utilise water power for the lighting of Stirling. I therefore called on Mr. Holmes, the town engineer, and discussed with him what could be done in this direction. From the data with which he supplied me, I found that an excellent source of power was to be found in connection with the reservoirs forming the sources of your water supply. There is a fall of some 200ft. from the first two reservoirs to your settling-tank, this distance being already piped, and, further, from the higher, No. 4, reservoir to the settling-tank there is a fall of some 400ft I therefore informed those councillors interested in the question that ample power could be obtained from the above source for the lighting of Stirling, and I was advised by them to bring the matter before the members of the Lighting Committee. This I did, explaining how the power could be derived, and I further offered to send in a joint report with your engineer showing the cost of the lighting of Stirling by this method. I understood that a motion to that effect would be brought forward at the first meeting, but I am informed that this was not done. I now, therefore, make formal application for permission to submit this joint report to your committee or the Town Council, as may be preferred. Should there be any difficulty as to the question of fees, I am quite prepared to make no charge for the information, provided always that should my scheme be adopted I should be appointed by the town as their engineer. In any case should my offer to report be adopted, the town will then be in possession of full information regarding the lighting of Stirling by means of steam, and also by means of water power, and they can then decide which method they will adopt.—Yours faithfully, R. FREDERICK YORKE, A.I.E.E., electrical engineer, Glasgow."

PROVISIONAL PATENTS, 1897.

FEBRUARY 1.

2572. Improvements in and connected with electric accumulator and battery plates. Carrington Riddell Gordon Smythe and Middleton Crawford, 37, New Oxford-street, London.

2578. Improvements in the arrangement of field coils of shunt motors for use with storage or other batteries and method of connecting such coils with the batteries. Thomas Hugh Parker, Prince's-chambers, Wolverhampton.

2582. Improved means for use in operating successively two or more electrical switches or sets of switches. Thomas Hugh Parker, Prince's-chambers, Wolverhampton.

2592. Electric fuses for mines. Richard Linke, 62, St. Vincent-street, Glasgow. (Complete specification.)

2619. Improvements in electric current regulating and indicating appliances and instruments. Walter Rowbotham, 27, Vittoria-street, Birmingham.

2622. Improvements in the construction of arc lamps. Henry Leitner, 37, Chancery-lane, London.

2643. Improvements in electric lamps and electromagnetic apparatus. William Ernest Burnand, 75, Chancery-lane, London.

FEBRUARY 2.

2701. Improvements in electric propulsion. Lewis Hallock Nash, 15, Water-street, Liverpool. (Complete specification.)

2709. Improvements in and relating to the electro-deposition of copper and other metals. William Edwin Heys, 70, Market-street, Manchester. (Emilien Dumoulin, France.)

2710. Improvements in the method of and apparatus for the electro-deposition of copper and other metals on rotary mandrels. William Edwin Heys, 70, Market-street, Manchester. (Emilien Dumoulin, France.)

2737. An electric alarm sash fastener. John Hamilton Morgan, 115, St. Vincent-street, Glasgow.

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2711. Improvements in and connected with apparatus employed in the electro-deposition of copper and other metals. William Edwin Heys, 70, Market-street, Manchester. (Emilien Dumoulin, France.)

2712. Improvements in and connected with apparatus for the electro-deposition of copper and other metals. William Edwin Heys, 70, Market-street, Manchester. (Emilien Dumoulin, France.)

2721. Improvements in and relating to electric motors. Theodore van Heemstede Obelt, 1, Broad-street buildings, Liverpool-street, London.

2758. Improvements in electric meters. David Bradley Carse, 45, Southampton buildings Chancery-lane, London.

2789. Improvements in storage batteries. Herbert Samuel Lloyd, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

2790. Improvements in electric furnaces for use in the manufacture of calcium carbide, applicable also for obtaining metals from their salts. Louis Bresson and Paul Pacotte, 45, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents, etc, Act, 1883, Sec. 103, September 15, 1896, being date of application in France.)

2796. Improvements in electric batteries. Prosper Casimer Alphonse Laglenne, 4, South-street, Finsbury, London.

2801. Improvements in electrical t ansformers. Arthur Francis Berry, 46, Lincoln's-inn-fields, London.

FEBRUARY 3.

2818. Improvements in electricity meters. Sebastian Ziani de Ferranti Hollingwood, co. of Lancaster.

2873. An apparatus for obtaining bi- and multiphase alternating currents from a monophase current Walter Langdon Davies, 16, Red Lion-street, Clerkenwell, London.

2889. Improvements in the globe or shade holders of gas, oil, and electric lamps. John Westwood Lea and John Hall Perrins, 7, Staple-inn, London.

2904. Improvements in perforators for use in connection with automatic telegraph transmitters. Francis Lauder Muirhead, 323, High Holborn, London.

2905. Improvements relating to the transmission of signals through submarine telegraph cables. Francis Lauder Muirhead, 323, High Holborn, London.

2907. Improvements in the construction of electric incandescent lamps. Charles Bruce Miller, 37, Chancery-lane, London.

2908. Improvements in electric incandescent lamps. Benjamin Henry Edward McCrea and William John Mitchell, 37, Chancery-lane, London.

2935. Improvements in switches for electric currents. William Robert Rawlings and John Joseph Rawlings, 61, Carey-street, London.

FEBRUARY 4.

2940. An automatic method of intermittently applying electric energy. Benjamin Howard Thwaite, 29, Great George-street, Westminster, London.

2953. Improvements in or connected with conduits for electric railways and tramways. William Cope, 127, Bristol-road, Birmingham. (Complete specification.)

2967. Improvements in fittings for electric lamps. William Robert Clapcott Wakley, 40, Temple-chambers, Temple-avenue, London.

2968. Improvements in devices for wall plugs for controlling current for electric lighting, heating, or electric bells Frederich Charles Dafforn, 48, Temple-chambers, Temple-avenue, London.

2995. An improved battery applicable for electric lighting, telegraphy, telephones, and the like. Sigmund Hellmann and Siegfried Spiegel, 18, Fulham place, Paddington, London.

2996. Improved apparatus for automatically starting electric fire pumps and other electrical machinery. Thomas Rungay, 18, Fulham-place, Paddington London.

3015. Improvements in incandescent electric lamps or their connections or holders. Augustus Edwin Pope, 6, Lord-street, Liverpool. (Frederick Roberts Pope, Holland.)

3019. Certain improvements in joint pieces for electrical conductors. Ellwood Ivins, 47, Lincoln's-inn-fields, London. (Complete specification.)

3044. Improvements in the construction of spring-jacks or switches used in connection with telephonic switch-boards. Daniel Sinclair, Oxford-court, Cannon-street, London.

FEBRUARY 5.

25360A. Improvements relating to the coating or covering of metals and other substances with metals and other materials by the aid of the electric arc. Frederick Hall Snyder, 11, Southampton-buildings, Chancery-lane, London. (Date claimed under Patents Rule 19, November 11, 1896.) (Complete specification.)

3113. Improvements in electrical accumulators. Robert Ritter von Perks and Julius Benger, 70, Chancery-lane, London.

3053. Improved separator for the plates of secondary batteries. Ernest Sanford New, The Voltage, Woking.

3058. Improvements in apparatus for propelling and regulating locomotives, motorcars, carriages, cycles, applicable to steam, gas, electric, oil, or other mechanically-propelled vehicles. Henry Francis Joel, 74, Windsor-road, Forest Gate, London.

3067. New or improved magnetic and electric resistance shields. Thomas Holmes, George Sockett Holmes, and Robert Walker Stewart, 10, St. George's-crescent, Liverpool.

3115. Improvements in and connected with electrically-propelled agricultural implements. Hugo Schimpff, 4, South-street, Finsbury London.

3120. Improvements in incandescent electric lamps or their connections or holders. William Phillips Thompson, 6, Lord-street, Liverpool (Frederick Roberts Pope, Holland.)

FEBRUARY 6.

3177. Improved adjustable holder or rest for telephone receivers. James Marchant, Market-place, Huddersfield.

3235. Improvements in secondary batteries. Illius Augustus Timmis, 2, Great George-street, Westminster, London.

SPECIFICATIONS PUBLISHED.

1896.

1069. Electrical condensers. Pollak.

1249. Synchronising mechanisms for alternating-current generators. Parshall.

2248. Electrical cut-outs. Hirst.

2249. Fuses for electrical cut-outs. Hirst.

2944. Telegraphic and other electromagnetic instruments. Sullivan.

13520. Plates for accumulators for secondary batteries. Pollak.

23992. System of electrical propulsion for cycles and common road and other vehicles. Marples.

24554 Way of connecting electrical fittings. Jeboult.

26069. Electrical lighting or igniting apparatus. Oldenbourg.

27074. Electric cable disconnecting boxes. Nisbett and Boby.

28488. Electric arc lamps. Spencer and Toerring.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	£5	9-9½
Brush Company, Ordinary	£3	2-1½
—— Non. Cum., 6 per cent. Pref.	£2	1½-1¾
—— 4½ per cent. Debenture Stock	100	109-112
—— 4½ per cent. 2nd Debenture Stock	100	94-98
Callender's Cable Company, Debentures	100	104-109
Central London Railway, Ordinary	10	9⅞-10¼
——	£6	5¼-6
Charing Cross and Strand	£5	10-10½
Chelsea Electricity Company	£5	8½-9
—— 4½ per cent. Debentures	100	113-115
City of London, Ordinary	10	15½-16½
—— 6 per cent. Cumulative Pref.	10	16½-17½
—— 5 per cent. Debenture Stock	100	129-133
City and South London Railway, Consolidated Ordinary	100	59 61
—— 4 per cent. Debenture Stock	100	139-141
—— 5 per cent. Pref. Shares	10	15½-16
County of London and Brush Provincial Co., Ordinary	10	9½-10
—— 6 per cent. Cum. Pref.	10	14-14½
—— 4½ per cent. 2nd Debenture Stock	£5	10½-10¾
Crompton and Co., 7 per cent. Cum. Pref. Shares	£5	1⅞ 2⅛
—— 5 per cent. Debentures	—	93 98
Edison and Swan United Ordinary	£3	1⅞-2⅛
—— 5 per cent. Debentures	£5	3-4
—— 4½ per cent. Debentures	100	105-110
Electric Construction, Limited	£2	1½-1⅝
—— 7 per cent. Cumulative Pref.	£2	2½-3
Elmore's Copper Depositing	£1	⅞-1⅛
Elmore's Wire Company	£2	⅝ ¾
W. T. Henley's Telegraph Works, Ordinary	10	19-20
—— 7 per cent. Preference	10	18½-19½
—— 4½ per cent. Debentures	100	109-114
House-to-House Company, Ordinary	£5	5-5½
—— 7 per cent. Preference	£5	8¾-9½
India Rubber and Gutta Percha Works	10	21-22
—— 4½ per cent. Debentures	100	106-109
Kensington and Knightsbridge Ordinary	£5	10-10⅜
—— 6 per cent. Pref.	£5	8-8½
London Electric Supply	£5	1½-1⅝
Metropolitan Electric Supply	10	13½-14½
—— 4½ per cent. First Mortgage Debenture Stock	100	119-122
National Telephone, Ordinary	£5	7⅛-7⅜
—— 6 per cent. Cum. First Pref.	10	17-19
—— 6 per cent. Cum. Second Pref.	10	17-19
—— 5 per cent. Non. Cum. Third Pref.	£5	6⅛-6⅜
—— 3½ per cent. Deb. Stock	100	105-106
Notting Hill Company	10	11-12
Oriental, Limited, £1 shares	£1	1½-2
—— £5 Shares	£5	8½-9
—— £4½ shares	£4½	7⅞-8
Oriental Telephone and Electric Company	£1	11/16-13/16
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	103-105
St. James's and Pall Mall, Ordinary	£5	13-14
—— 7 per cent. Pref.	£5	9½-10½
Telegraph Construction and Maintenance	£12	40-43
—— 5 per cent. Bonds	100	102-105
Waterloo and City Railway, Ordinary	£8	9⅞-10½
Westminster Electric Supply, Ordinary	£5	11½-12¾
Yorkshire House-to-House	£5	8½-8¾

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NOTES.

Society of Arts.—The paper on Wednesday related to narrow-gauge railways in India, and there was not time for any effective discussion of the particular difficulties in the way of the rural line in this country. Next Wednesday is to be Sir Henry Trueman Wood's paper on "Colour Photography."

Meteorological Instruments.—The council of the Royal Meteorological Society have arranged to hold at the Institution of Civil Engineers, Great George-street, Westminster, from March 16 to 19, in commemoration of the Diamond Jubilee of the Queen, an exhibition of meteorological instruments in use in 1837 and 1897, and of diagrams, drawings, and photographs illustrative thereof.

Civil Engineers of France.—The Société des Ingenieurs Civils de France have been discussing the progress of the adoption of electric transmission of power in railway stations. Mr. G. Baignères and the president (Mr. Lippmann) expressed the opinion that in the matter of handling the work of a great terminus there was a considerable field for the utilisation of electricity. Some of the work already done in that direction was reviewed.

Telegraphs in Nyassaland.—At the beginning of the year another section of the African Trans-Continental Telegraph Company's line was opened between Chiromo and Chikwawa. This new piece fills in the blank which hitherto existed in the direct line of communication between the East Coast of Africa and Zomba. There is now an uninterrupted line from Chinde and Quilimane and the East Coast to Zomba. Owing to the troubles in Mashonaland there does not appear to be much prospect of the line from Salisbury to Tete being completed during the present year.

Meteorological Society.—At the meeting of the Royal Meteorological Society on Wednesday, Mr. Edward Mawley, F.R.H.S., president, read a report on the "Phenological Observations During the Past Year," and the Hon. Rollo Russell gave the results of some observations on haze and transparency which he had made at Haslemere in Surrey. From these it appears that the clearest hours at a good distance from towns are from about noon to 3 p.m. The clearest winds are those from S. to N.W. inclusive, and especially W.S.W., W., and W.N.W.; the haziest are those between N. and E. The smoke of London or the Black Country might interfere with country observations requiring clear views up to distances of 100 miles.

The Lighting of Madrid.—It is complained in *Madrid Cientifico* that the electric light goes out oftener and keeps out longer in that capital than can be reasonably put up with. The fault (unless for not foreseeing it) does not appear to be so much with the supply company—La Compañia Inglesa de Electricidad—as with the Municipality, because the underground conduits which were designed and are maintained by the municipal authorities are in such a condition as to be constantly flooded. *Madrid Cientifico* wants the present conductors changed for paper insulation concentric cables. It might be suggested that a better remedy would be to alter the state of things under which the conduits "are really sewers with a copious flow of water through them."

British Lights.—Offers of exhibits to the Yachting and Fisheries Exhibition are coming in to the Imperial Institute, and the yachting section is filling up fast. The north gallery of the institute is set apart for the fisheries. Coast illumination will be well represented, and the Duke of York, who is Master of the Trinity House, is anxious to have reproduced, in relief if possible, a model of the British Islands, showing by small electric lights each lighthouse in its position. If the lights could be arranged to give their proper flashes and to have something like a relative proportion to the illuminating power of the actual lights they represent, the exhibit would be not only a pretty but an instructive one. Where the French coast comes into the model it is to be hoped, for many reasons, that their lights will not be omitted.

Prof. Hughes.—On Tuesday last, at Marlborough House, the Prince of Wales, as president of the Society of Arts, presented to Prof. D. E. Hughes, F.R.S., the Albert Medal awarded him by the council of the society "in recognition of the services he has rendered to arts, manufactures, and commerce by his numerous inventions in electricity and magnetism, especially the printing telegraph and microphone." The following members of the council were present: Major-General Sir Owen T. Burne (chairman), Mr. J. Wolfe Barry, Sir George Birdwood, Viscount Cross, Mr. Joseph G. Gordon, Sir Charles M. Kennedy, Sir Stuart Knill, Mr. W. H. Preece, Sir Owen Roberts, Prof. Roberts-Austen, Sir Saul Samuel, and Mr. A. Siemens, with Sir Henry Trueman Wood (secretary), and Mr. Henry B. Wheatley (assistant secretary).

Technical and Scientific Teaching.—The report of the sub-committee on the instruction in chemistry given, under the auspices of the Technical Education Board of the London County Council, to science teachers in schools has occasioned a good deal of correspondence. To our readers the subject is in danger of becoming simply wearisome. It is otherwise, of course, with the general public, who do not yet understand what the technical education they talk about really means, and have still a long way to go before they realise that, though the positive value of a literary or classical training may remain much what it used to be, its relative value has been so changed by the new knowledge that the man who does not know the meaning of a chemical equation should now be considered more, and not less, illiterate than the man who does not understand the inscription on the obverse of a penny piece.

The American Pacific Cable Scheme.—A Reuter's telegram from Honolulu states that Mr. Hartwell has requested the Hawaiian Government to grant a contract in favour of the Pacific Cable Company, having just withdrawn his own application. The Pacific Cable Company does not ask for an exclusive "franchise," but has requested an annual subsidy of 40,000dol., and will establish telegraphic communication within the Hawaiian group, besides the Hawaiian United States submarine cable, provided the United States Congress passes the American Pacific Cable Bill. This probability is not nearly so immediate as it appeared some time ago, and if we can get the British cable really started within reasonable time is likely to become much more remote. It is obvious that where there is not too much business to pay for one cable, the prospect of the second to be laid is not a good one.

Institution of Electrical Engineers.—The abstracts in the current issue of the *Journal* of the Institution of Electrical Engineers (its other contents have been already noted) begin with Mr. Appleyard's results as to the influence of temperature on the resistance and inductive capacity of dielectrics described in the *Philosophical Magazine*, January, 1896. A full and valuable abstract from *Wiedemann's Annalen* describes Messrs. Jäger and Wachsmuth's investigation of Mr. Weston's cadmium standard cell. The description is sufficient for anyone who wishes to set up the cell. The E.M.F. at 20 centigrade is 1·019 volts, and the temperature coefficient is very small compared with that of the Clark cell. The substance of another abstract from *Wiedemann* we intend to reproduce. There is a description of some traction apparatus of the

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Fives-Lille Company, and the rest of the abstracts mostly relate to matters that have already been noted here, though not at equal length.

Science Teaching in India.—At the Imperial Institute last week, before the Indian section of the Society of Arts, Prof. Jagadis Chundra Bose, of Presidency College, Calcutta, read a paper on "The Progress of Science Teaching in India." Sir S. C. Bayley took the chair, and among those present were Sir Owen Tudor Burne, Sir George Birdwood, Mr. J. H. Gladstone, Prof. Armstrong, Prof. Wyndham Dunstan, and of course Mr. Bhownagree and Mr. D. Naoroji. It appears that the University of Calcutta, which was founded on the model of that of London, has so far worked like its original as to be open to the reproach of not being up-to-date. One remark made by Prof. Bose was that the great difficulty in the way of Indian students was that after finishing their university examinations they had to seek for a means of livelihood. They were thus obliged to give up their further studies and generally forced to the law, which men trained in the natural sciences did not, as a rule, find very congenial. In spite of the example of Sir William Grove to the contrary, to anyone who has any knowledge of the curious logic of the law-books this will not be very surprising.

The Bermuda and Jamaica Cable.—In the House of Commons last week, in reply to General Laurie, the Chancellor of the Exchequer, on behalf of Mr. Chamberlain, said he had reason to believe that the Government of Canada were disposed to contribute to the cost of providing direct telegraphic communication between Bermuda and Jamaica, but he was not aware that they had offered a subsidy of £3,000 for that purpose. The Government of Jamaica had expressed their willingness to transfer to a company providing such communication the subsidy of £2,000 a year which they paid to the company that now provided telegraphic communication between that colony and the United Kingdom, by way of the United States and Cuba. In dealing with the proposals which had been made for the construction and working of a cable between Bermuda and Jamaica her Majesty's Government had been obliged to take into consideration not only financial questions, but the provision of communication between Jamaica and other West Indian possessions. These questions had presented considerable difficulties, which had not yet been surmounted.

Obituary.—Prof. Charles Tomlinson, F.R.S., died last Friday at his residence in Highgate in his eighty-ninth year. Mr. Tomlinson was a Fellow of the Chemical Society, a Fellow of the Royal Society, and was one of the founders of the Physical Society, and, as will be seen from the fact that, as well as being for many years lecturer on experimental science at King's College, he held the Dante Lectureship at University College, 1878-80, he was one of those men who have shown that the pursuit of science is by no means inimical to the cultivation of literature. He was the author of several books, and, as might be expected from his scientific training, held the sound principle that the translation of a poet should reproduce the rhythm as well as the ideas of the original, even if it involves the adoption of the *terza rima* or of English hexameters. And as if the addition of German and Italian literature to science in general were not enough for one man, he had surplus energy to devote to the tactics of the chessboard.—On the same day (Friday last) the death is to be noted of Mr. Rothen, director of the International Telegraph Bureau, at Berne.

The Royal Institution.—Prof. Milne's discourse on earthquakes was decidedly enjoyable, and, as will be seen from another note, it was not altogether devoid of matter affecting telegraphic interests. Also, incidentally, he gave a warning to foreign newspaper correspondents not to take three days to decide whether an earthquake which cost more in lives and money than a first-class war was worth the cost of telegraphing; or, at any rate, if they did, not to alter the date of it to that of the message. For he (Prof. Milne), in his observatory at the Isle of Wight, ascertained the time of that earthquake in Japan to within a minute. Really, the misdated earthquake is nearly as bad as the "expanded" telegram. The Stewart Electrical Company sent specimens of their iron-clad rheostats for exhibition in the library, and Messrs. Nalder showed a really beautiful collection of instruments. The writer, whose reverence is unbounded for every instrument he has never used, was terribly shocked to hear an Ayrton secohmmeter called a grindstone—but that is by the way. This evening's discourse is on meteors. Lord Rayleigh's afternoon lectures on electrical vibrations begin early next month.

Block Working.—At the inquest held on the death of Florence Mouland from injuries received in the recent railway accident at Bremington Junction, Stockport, William Schofield, who was described as one of the best signalmen in the employ of the Cheshire Lines, admitted that he caused the accident by not adhering to the block system. He allowed the two trains to be both in one section at the same time. He thought he had despatched the Hull train, whereas it was still standing. This mistake was "due to the excessive number of trains he had to book in a few minutes." A solicitor, representing the Amalgamated Society of Railway Servants, examined the witness in order to bring out the statement that Schofield had 11 telegraphic and telephonic instruments to work in his box, and then suggested that three years ago the employés had objected to this. A railway official said the instruments were placed in the boxes to assist the signalmen. The jury returned a verdict of manslaughter against Schofield. In the present state of things comment would be improper, but the paragraph is reproduced as showing a possible point of view that may be put forward from the signal-box.

Electro-Harmonic Concert.—The Electro-Harmonic Society announce a ladies' night for Friday, February 26, 1897, at the St. James's Hall Restaurant, Regent-street, W., at eight o'clock. The following is the programme: Part I.—'cello and pianoforte duet, "Allegro" from Sonata in D Minor (Rubenstein), Mr. Prosper Burnett and Mr. Alfred E. Izard; song, "Mignon's Song" (Ambroise Thomas), Miss Sarah Gomersall; recitation, "The Romance of Britomarte" (A. L. Gordon), Mr. Ernest Meads; duet (mandoline and guitar), "Georgia" (Bozzi), the Misses Flora and Beryl Tullock; song, "Guides of the Night" (E. Solomon), Mr. William Davies; 'cello solos, "Berceuse" (Godard) and "Carnival" (P. Burnett), Mr. Prosper Burnett; Irish song, "The Exile's Return" (Alicia Needham), Miss Helen Saunders; mandoline solo, "Chanson Napolitaine" (Casetta), Miss Beryl Tullock; humorous musical sketch, Mr. Roland Henry. Part II.—mandoline and guitar duet, "Nadine" (Cottin), the Misses Beryl and Flora Tullock; song, "Thady O'Flyn" (Molloy), Miss Sarah Gomersall; recitation, "Chacun à Son Gout" (Theodore Hook), Mr. Ernest Meads; guitar solo, "Indian March" (Pratten), Miss Flora Tullock; song, "The Garden of My Heart" (F. Mullen), Mr. William Davies; Old English song, "The Banks of Allan Water," Miss Helen Saunders; humorous selection, Mr. Roland Henry.

The Birkbeck.—The Birkbeck Institute students' conversazione on Saturday was a great success. There were said to be about 1,300 people there. The writer did

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not count them, but judging from the crush at one place he can well believe it. Among the hundreds were Mr. Justice Gainsford Bruce (vice-president of the institution) and Lady Bruce, Mr. G. Armitage-Smith (the principal), Mr. J. C. N. White (chairman of the governing body), Mr. Francis Ravenscroft, Sir Henry Trueman Wood, Dr. Rentoul, M.P., Prof. Milne, Prof. Thorpe, Prof. Tilden, and Mr. Boulnois. What with curtains, carpets, lounges, and palms the severely utilitarian Birkbeck looked quite transformed. There were 30-minute concerts and 15-minute lectures, not to mention the Æolian Band, besides exhibits that went on all the time. If some of the experiments were not particularly recondite, that was all the better for the purpose of the conversazione. It was impossible to see all or even half, and a mere enumeration of the programme would take about a column. Mr. Wimshurst was there with his machine, and also exhibited his contribution to the problem of electric communication with lightships; it is to break the circuit at the cable swivel, the two parts of which contain a couple of coils whose induction transmits the signal. There was a telegraphic exhibit from the Post Office, Röntgen ray demonstrations, phonographs, and the electrophone, and, as has been said before, things too numerous to mention.

The Spanish Telegraphs.—The bitter cry of the *Times* correspondent at Madrid is published through the land. The telegraph system in Spain, he says, "has always been a crying scandal, and instead of improving with the times and advance of science it appears to get worse. The most ordinary atmospheric disturbance is sufficient to render unserviceable the greater part of the lines throughout the country, while a heavy fall of snow or gale of wind generally results in a complete paralysing of the whole service. Under this condition of things it might fairly be expected that the authorities would not place additional difficulties in the way and that the public convenience would be to some extent considered, but it is not so, and the inefficiency of the office is only on a par with the defective state of the *matériel*. Further, the senseless and useless censorship which is exercised by the Home Office, without the slightest discretion being used as to the nature of the contents of the telegrams detained, results in hours of delay." Yet this despatch appears to have got through intact, and was not even "delayed in transmission" so that when it reached the office it would be thrown away as "old matter." Possibly the state of things referred to by the correspondent has something to do with the fact that is complained of so loudly in one of the Spanish telegraphic journals—namely, that the inter-urban telephones are in danger of taking away all the business from the Government telegraph lines.

Skinburn from Rontgen Rays.—A remarkable case of dermatitis caused by Röntgen rays is described by Dr. E. Waymouth Reid, professor of physiology in University College, Dundee, in a recent number of the *Scottish Medical and Surgical Journal*. It happened to Dr. Reid himself, not to a patient. Having to deliver a popular lecture, he desired to obtain a photograph of his own chest or abdomen through the clothing to exhibit the contents of the pockets in addition to the skeletal structures. The exposures were in the aggregate an hour and an hour and a half, and the coil was one giving a 10in. spark, fed by 10 amperes. The Crookes tube was some 3in. from his waistcoat as he lay upon the table. On the evening of each exposure marked erythema of the skin of the abdomen and chest was noticed immediately beneath the position of the vacuum tube, and, in addition, slight redness of the skin of the back over an area corresponding to the exit of the rays from the body. In 17 days the cuticle began to peel off, leaving a surface which was "raw" but not very painful. In the end 30 square inches of cuticle were lost, but in 33 days healing was complete. There was apparently a complete immunity of structures deeper than the skin, there being no sign of lung trouble. But it is also obvious that the affected skin did not stop all the injurious rays, as enough of them were able to pass through the body to attack the skin of the back. One of the most curious things about this effect is that, though the action takes place in the immediate neighbourhood of the nerve terminals, there should apparently be no accompanying sensation to give warning of it.

National Physical Laboratory.—On Tuesday the Marquis of Salisbury received at the Foreign Office a deputation of representatives of physical science, who asked the Government to establish a national physical laboratory at a cost of £30,000 for buildings, and £5,000 a year for maintenance. The deputation consisted of Lord Rayleigh, Lord Lister, Sir J. Evans, Sir Douglas Galton, Sir H. Roscoe, Sir A. Noble, Prof. W. G. Adams, Prof. Silvanus Thompson, Prof. W. A. Tilden, Prof. Michael Foster, Mr. G. Griffith (secretary of the British Association), Mr. R. T. Glazebrook, Prof. W. M. Hicks, Dr. J. Hopkinson, Prof. J. V. Jones, Prof. J. Perry, Mr. W. H. Preece, Prof. Ramsay, Prof. Rücker, Mr. R. H. Scott (Meteorological Office), Mr. W. N. Shaw, Mr. J. W. Swan, Prof. Roberts-Austen (Iron and Steel Institute), Prof. W. E. Ayrton, Mr. J. Wolfe Barry (president of the Civil Engineers), Prof. R. B. Clifton, Prof. G. H. Darwin, and Mr. Francis Galton, and it will therefore be seen that it was an exceedingly strong deputation. Lord Lister introduced the deputation, Prof. Rücker explained the scheme, and the Prime Minister said he would be glad to consent if the Chancellor of the Exchequer (who was absent) would let him. He hoped it would be possible to grant all the deputation had asked for, but he could not give a definite pledge on the subject. At the same time a suggestion was thrown out that, instead of asking the Chancellor of the Exchequer to pledge himself to outlay to which no bounds were set, some limited scheme of standardising should be pressed upon the State, and the question of general research reserved and for the present allowed to depend on private munificence.

Earthquakes and Cables.—At the Royal Institution last Friday, in his "discourse" on recent advances on seismology, Prof. John Milne referred to matters which are not without a possible bearing on the permanence of submarine cables. Besides the gradual geological upheaval or sinking of continents, there appeared to be some evidence of a very slow lateral flow of the solid crust, which was greatest at the base of the upheaval. This would be accompanied by local slips and crushings. It was, therefore, not surprising to find that the majority of earthquakes appeared to have their origin in the sea, and that they were most frequent and severe where the transition from comparatively shallow water to the great oceanic depths was most rapid. Soundings made for cable-laying purposes, and even things that had happened to cables after they had been laid, had shown such severe slips as would be implied by a change in the depth from 100 to 300 fathoms. That such causes were occasionally responsible for cable breakages, was shown by the fact that three cables many miles apart might go simultaneously. He did not doubt, therefore, that if earthquake-observing stations were established about every thousand miles, say, along each side of the Atlantic, the information obtained would be of practical value to those interested in submarine cables and the best routes for them. Prof. Milne added that the

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expense would be quite trifling; presumably he meant of supplying the necessary recording instruments. But companies have many of the human weaknesses, and not all of them would be anxious to find out that after dodging a cable along a coast line in water conveniently shallow for recovery and repair, that they had very much better have chosen a deep-sea route.

Regulations in Spain.—The Spanish Government has drawn up a set of regulations, to which the undertakers of public electric supply must conform, similarly to our Board of Trade rules. The regulations are still under consideration, and may be subjected to further modification before they are put into force, but it may be taken that their general form is determined. The first 33 articles are published in full in the *Revista de Obras Publicas* of February 11, and the rest are promised in the next issue. The first three sections (21 articles) relate to the formalities to be complied with in order to obtain authorisation to break up the roads for electric tramways. The fourth legalises the units (only the ohm, ampere, and volt are specified). With the fifth section (Article 26) the safety rules begin. These appear to be modelled on the well-known French rules. The "naked hand" test is imposed for overheating. Special precautions are prescribed as to the insulation of accumulators from earth, and all accumulator rooms must be lighted with incandescent lamps. (It should be said that battery potentials above 500 volts are contemplated.) Fuses are to go at double current. Switchboards are to be of incombustible materials, and when the voltage is above 500 are to have a rubber mat in front of them. That is about as far as our contemporary has got with the regulations at present. There is no definition on the point, but the limit between "high" and "low" pressure appears to be intended to be fixed at 500 volts. So far as the rules have gone at present there is no distinction made between alternating and continuous current, nor is there any definition of the alternating currents and voltages, which are to be considered equivalent to the continuous-current units.

Water Power.—Mr. Swinburne, in a remarkable course of lectures on quite a different subject, some time ago brought home to electrical engineers the reasons why in this country, at any rate, the idea of getting current for nothing from a convenient waterfall is not likely to be pursued often with success. But the true state of the case has yet to permeate downwards into general knowledge, and consequently the collapse of the scheme for supplying Bingley with electric lighting from water power appears to have caused quite an amount of local disappointment. The Bingley people intended to light their streets by means of the water power of the overfall of some locks. As the *Bradford Observer* puts it: "With accounts in mind of what has already been done in various countries (without going so far away as the big Niagara enterprise) in utilising water power for electric supply, it is a disenchantment for the Bingley folk to be told that they would actually do better to put up steam boilers and engines for their dynamos than to utilise the water power at hand. This meant that the enterprise at Bingley would not pay either way in view of the probable demand." But our contemporary is not right in concluding from the fact that at Bradford the cost of coal may be only a fraction of a penny a unit, that water power is no good, and that "places of the size of Bingley must therefore apparently dispense with the luxury of a supply of electricity, whether they have water power or not." For if there does happen to be a convenient waterfall going for nothing (only there seldom or never is), the system of supply might be so arranged that a great many other charges would be minimised besides that of coal consumption. This is one of the cases where tabulated figures are decidedly misleading.

The District Deep Level.—We make no pretence to being in the secrets of the Board, but, going on what is public, the prospects of electric traction getting a trial on the Metropolitan District Railway appear to have decidedly improved. At the special general meeting of the company held last week for the purpose of considering four Bills in Parliament, Mr. J. S. Forbes, who presided, seemed inclined to adopt the deep level if he can get favourable terms. That, he said, was the most momentous meeting of the company he had ever attended. The most important measure concerned the deep-level railway between Earl's Court and the Mansion House, running immediately under their present system, a distance of four miles seven furlongs. The proposal involved the elements of the unknown; he could not say whether it would succeed in passing Parliament, or in what form it would pass. After noticing that the new line would cost less than half what it had taken to construct the old one, some lingering relics of the old dislike came out. It was to be worked by electricity, and that constituted to a certain extent an unknown element. It was to be an express line, saving 12 to 15 minutes on the journey, with a possibility of some mode of discomfort differing from the present underground railway. Of course, the question was how to raise so large a sum of money, but for the present he asked for a large draft of the shareholders' confidence to enable them to take this Bill to Parliament. The Bill would also empower them to work the inner circle of the present system by electricity. It was estimated that they could convert their portion of the circle for £500,000, and, of course, if the atmosphere of the railway could be made pure and cool it would be an enormous gain to the concern. Mr. J. S. Forbes ended by moving a resolution approving the Bill, and it was carried with practical unanimity. The question is, now that he has crushed Mr. Pond (or Pattle), will he really put his heart into it?

Electrical Fuses in Austria.—Mr. J. von Lauer, writing in the *Oesterreichische Zeitschrift für Berg und Hüttenwesen* on the electrical firing of the blasting "shots" in mining work, has a good word to say for the old-fashioned "static electricity" machines, which "present the advantage of supplying a current of small quantity but high tension, capable of overcoming numerous small interruptions and permitting a cheap conducting wire to be used together with fuses unlikely to get out of order too easily." Some of these used in the Austrian army are described: "A safe type of electrical fuse is that devised by the Austrian Military Committee, and consists of a brass wire bent to a crank and embedded in a block of fused sulphur and pulverised glass, or sulphur and cement. At the crank part the wire is then filed in two, leaving a space of 0·04mm. to 0·2mm. between the two ends for the spark to traverse. An inflammable priming is then applied to the spot and covered with touch paper, the whole being inserted into one end of the detonator corresponding in strength to the explosive to be fired. This mode of preparation obviates any risk of alteration in the space to be crossed by the spark, the wire being filed only after the block has been cast 48 hours." Mr. von Lauer then returns to his influence machine, and sums up its advantages as follows: "Portability, combined with sufficient power to fire a large number of fuses (250 to 300) at a time (in series). The machine needs no expensive repairs. Any kind of metal wire will do for conduction, and the length of the circuit is a minor consideration; and in spite of the difficulty of working in a damp atmosphere, it is contended that the drawbacks of the system are practically non-existent." If

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a battery and induction coil are used, Mr. von Lauer prefers storage cells charged from a dynamo to any primary battery; but it is evident that the influence machine is his own true love.

Animal Electricity. — Dr. Waller on Tuesday last reached a result to which his previous lectures on the investigation by electrical methods of the action of the isolated nerve have been tending. Briefly, it is that the transmission of a stimulus in a nerve is accompanied (as, physiologically speaking, it should be) by a dissociation (Dr. Waller thinks possibly only a partial one) of CO_2, and the presence of this gas in small quantity has been shown experimentally to cause an increased activity or excitability in the nerve. The problem is quite beyond attack from the chemical standpoint, since the quantities to be dealt with are hopelessly minute; in fact, it has been found quite impossible to get any evidence as to what are the products which accompany nervous action at all. The evidence, therefore, is the strict correspondence of the electrical behaviour of the nerve after tetanisation—*i.e.*, after a period of intense working—with that of a similar nerve supplied with a small quantity of carbonic acid from an outside source. Or, as Dr. Waller summarises it, "CO_2 in very small quantity produces an augmentation of the negative deflection, and the delicacy of the reaction is extreme. If, then, tetanisation of nerve is attended with any CO_2 production, we may expect that such CO_2, arising within the nerve itself, will effect the characteristic augmentation. The negative deflection should be greater after a prolonged tetanus, the augmentation should gradually diminish with the presumable dissipation of CO_2; moreover, the negative deflection of the tetanus itself should increase with the presumable evolution of CO_2 during its progress"—all of which were shown by diagrams and by an experiment conducted during the progress of the lecture to be actually the case. The importance of the matter is not in the proof that the transmission of energy is accompanied by a perceptible amount of protoplasmic degeneration, but in the increased activity which follows. For in the above result Dr. Waller thinks he has found the physical interpretation of what is to some extent a general law with living matter, but which is shown in its highest degree in the nervous system—namely, that (within the limits of fatigue and exhaustion) every excitation raises the tissues to a greater expectancy and greater activity. This covers the fundamental law, which hitherto psychologists have had to postulate without explanation, and which, in plain English, comes to the result that every time a thing is done it is done easier and better. Dr. Waller presses the conclusion to the end, and finds here the physical explanation of the development and differentiation of nerve tissue from the homogeneous protoplasm—the *bahnung* of the Germans, or the canalisation of tracks of transmission. In plain language, if anyhow a stimulus has passed along a given line in the undifferentiated protoplasm, the carbonic acid generated along the track makes that line more sensitive for the transmission of any succeeding impulse than is the rest of the protoplasm, and so on progressively. Apart from these rather remote consequences, the only weak point in the demonstration appears to be that the effect which is undoubted may turn out to be not identical with, but only superposed on what must be (though one knows not how) the typical reaction of nerve matter; but if further comparison finally establishes it, it will be a discovery of which the scientific value can hardly be over-estimated. That it should have been attained by electrical methods must be the excuse for giving so much space in our columns to what is really a physiological problem. The chemical explanation of the increased activity caused by CO_2 is still to seek, as, indeed, is the entire process of reintegration of the cell material. The next lectures will deal with results obtained by electrical investigation as to the action of the muscles and the heart.

The Interlocking Discussion.—At the meeting of the Institution of Electrical Engineers last week there was a short attendance but a long discussion. In fact, the whole evening was not enough for it, and though several gentlemen who were expected to take part in it were from various causes unable to be present, and communications sent to be read were abridged in the most ruthless manner, it was impossible to find time for Mr. Hollins's reply. The tables were covered with models or specimens of signals and instruments—in one place were signal levers, in another a train treadle life-size; also there were diagrams on the walls. A summary is given elsewhere of so much of the discussion as would be comprehensible in the absence of the actual working models. Doubtless all the railway experts understood each other. The ordinary electrical engineer need not be considered, as he mostly stayed away. Mr. Langdon's remarks on hydrostatic contact-makers relate to a point of general interest, apart from the special subject. There can be little doubt that at any rate for considerable speeds the actual depression of passing is reinforced by waves of depression propagated from other points of the rails. At first sight this would seem to open up rather undesirable possibilities, but investigation will probably show that the conditions for them are such as cannot occur in ordinary practice. Mr. Spagnoletti's statistics showed that treadles could be really depended on in the very place where they are most wanted. Major-General Webber, if he did not add anything of great value to the information already given, decidedly enlivened and brightened up the debate at a moment when it showed a tendency to fall below par. One gentleman read his speech (which was rather a polemical one) in such a manner that some of the most interesting and probably really valuable parts of it were as good as lost to a large proportion of the audience. All that the writer could gather as to the current and leakage on rail circuits was that he had entirely misheard the figures. After some more statistics about the Metropolitan and the City and South London Railway, Mr. Gray produced a communication describing a new system which, even with the aid of a diagram, he confessed he had not yet mastered himself, and therefore did not read it to the audience. The last speaker looked forward to the coming by-and-bye, when not only the City and South London but all railways would be worked by electric traction. The train would then be brought into the interlocking, and running past signals at danger would cut off the supply of current. An eminent designer of interlocking apparatus is understood to have at once considered the problem of automatically cutting off the steam from the locomotive. He is not expected to have it ready for next Thursday's meeting. If the writer had to do the thing, he would prefer to act on the continuous brake (only half the trains do not carry one, which rather spoils the idea). But seriously what has up to the present been done in the way of preventing the engine-driver overrunning the signals, and the difficulties yet to be surmounted in that direction, were among the last subjects dealt with in the articles on block working by Mr. Pigg which appeared in these columns. When one sees the beautiful and effective mechanism that has been already devised to obviate the possible effect of inattention or perversity on the part of a signalman, it really looks as though the point which is now the weak one is the danger, not so much of a wrong signal, as an unregarded one.

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THE MECHANICAL CONSTRUCTION OF ELECTRICAL MACHINERY.

BY F. M. WEYMOUTH.

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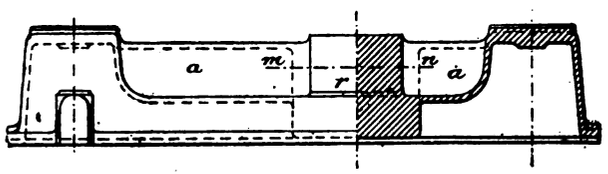
THE DYNAMO.

(Continued from page 168.)

Bed-plates (*continued*).—Through the courtesy of Messrs. Crompton and Co., Chelmsford, whom we have to thank very much, we are able to illustrate herewith one of their standard pattern bed-plates having the yoke cast within it (Figs. 67 to 70). This is the more valuable, inasmuch as



Half Elevation. Section on *A B*.

FIG. 67.

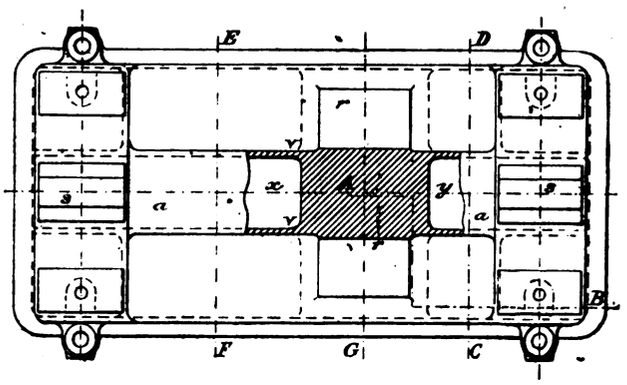
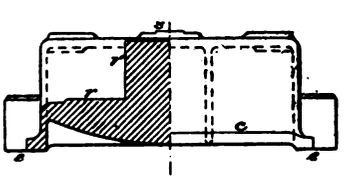


FIG. 68.—Plan with Section on *m n*.

Messrs. Crompton and Co. have had considerable experience in making this class of bed-plate. We may thus, with special advantage, note its shape and form, as being such as has been found by long practice well suited to withstand with sufficient effectiveness the peculiar bending and warping strains liable to be set up after casting by the cooling of the yoke.

An earlier form of bed-plate by this firm was shown (Figs. 60 to 61). On comparing the present with the latter, we find that the conical pedestal is supplanted now with one of rectangular section; also, what were then shown as ribs running from the yoke to the pedestals, either way, are here represented by hollow channel sections lettered *a a*. On referring to Fig. 70 it will be seen that this channel section is carried the whole depth of the bed-plate, and (as shown, Fig. 68) it is continued lengthways through the pedestals, so that there are thus four vertical parallel walls between the yoke and each end.



Section on *A G*. Half End View.

FIG. 69.

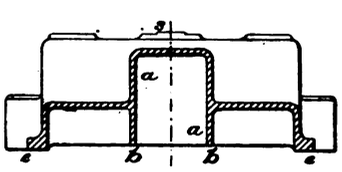


FIG. 70.—Section on *E F* or *D C*.

This particular size of transverse sections (Figs. 69 and 70) is for three different sizes of machines, having bed-plates from 3ft. 6in. to about 4ft. in length. The thickness of the metal is $\frac{3}{8}$in., which practically accords with our earlier remarks on the subject of the proportion between thickness and length. It will be noted as to planing the bottom, that the sides, *e e*, only are so treated; and the ends are set up between the sides, as shown clearly at *c* and *b b* in Figs. 69 and 70, and also evident in Fig. 67, like some other bed-plates we have discussed. Where the thin sides of the channel section leave the yoke, as at *v v*, they are led off with a large $\frac{5}{8}$in. radius each side, so as to ease the passage from massive to thin metal. The facings, *r r*, are the same as shown in Figs. 60 and 61, and afford contact with the magnets both below them and at their interior sides. A transverse section through the yoke is clearly shown in Fig. 69, where the bottom will be seen rising up in a curve toward the side, so that its longitudinal sectional area becomes reduced as it approaches the outer limit of the contact surface. To make due allowance for the inferior magnetic permeability of the cast iron as compared with the wrought iron of the magnets, the longitudinal section, *x y*, is made ample by its being extended downwards as well as lengthways towards the pedestals. On the top of each pedestal there are three facing strips to take the bearings, the central strip having a raised portion, *s s*, which, by fitting into a corresponding flat groove in the bottom of the bearing, will maintain the latter in proper alignment. As may be perceived on reference to Figs. 60 and 61 once more, the magnets are held on by horizontal bolts passing through them and the upstanding central portion of the yoke. It will be noted, finally, that as regards simplicity of patternmaking, with the exception of a radius where each pedestal joins the base, there are no curved surfaces, and the sides of the pedestals and the base are in one plain. We thus find that this principle of construction in the casting is what may be described as being, in some measure, a shell within a shell; and the heavy flange round the lower edge is not an unimportant item in conserving to the general stiffness. Though a further example of this type of bed-plate will engage our attention later on, in this present instance of Messrs. Crompton and Co.'s machine we have a case which is the more interesting, and has the advantage, as intimated, of being the production of electrical works of long standing—one, in fact, of the earliest that were started in the country.

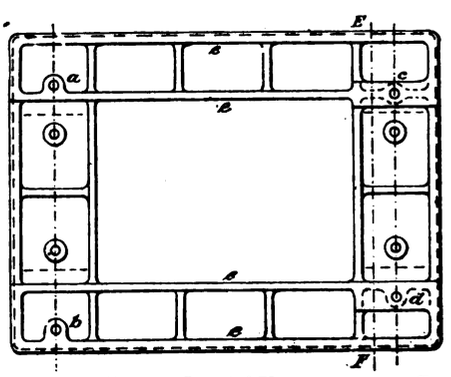


FIG. 71.—Inverted Plan.

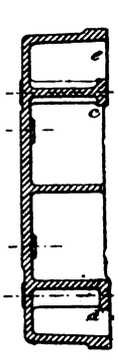


FIG. 72.—Section on *E F*.

With Fig. 71 we return once again to the subject of four-sided channel section bed-plates. This, an inverted plan, shows how by a system of webbing the strength of such a form of bed-plate may be considerably increased; for when any side is exposed to a bending strain acting vertically so as to put the lower edges of the sides into compression, these will tend to collapse. Hence the webs by their support assist the sides to resist this tendency; and thus a greater strain can be borne with safety than would otherwise be the case; or, for any given strength, a lighter casting may be made. The bosses for the holding-down bolts can be incorporated in, or cast on, such webs, or be cast on the sides, as shown respectively at *a*, *b*, and *c*. When on the web this may well be strengthened with a flange, as shown at *c* and *d*. Such a flange would be made loose in the pattern, and remain behind in the mould after the pattern is lifted out, and be removed subsequently. As here shown, the bottom will be faced only on the two sides, as at *e e*; though this does not appear to represent invariable practice with this kind of bed-plate.

We may add that it would be useless to cast a long boss merely projecting from a web of metal, as shown in full lines in Fig. 73. With a very little strain, as indicated by

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the arrow, fracture would take place at or about *m m*. Ribs are needed, shown *c c c* dotted, which thereby increase what we may term the periphery of fracture, having a diameter *n n*. The metal at *n n* at that extended radius has thus a greater mechanical advantage for resisting the strain.

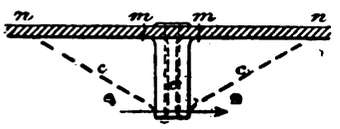

FIG. 73.

On some previous pages we have descanted on bolts and fastenings and facings. We interpolate here some more remarks on the same subject. For though facings for nuts enhance the appearance of a machine, they are, when they multiply, an expense in the patternmaking, especially those of the horseshoe shape. The circular kind are easily turned in a lathe; but the horseshoe pattern must be carved out by hand. Beyond this there is the labour of affixing them to the pattern, not to say the further delay also in getting the pattern into the foundry. Hence, to avoid this expense, sunk facings are used, as shown in Figs. 74 to 76, a method very common in marine engineering practice. As a revolving cutter has to be used in any case, it is here applied simply to knife out a seating from the body of the flange, and no extra patternmaking is involved. It will be observed that here, as in Figs. 42 and 43, the bolts are shown of a diameter slightly larger than the thickness of the walls, *f f*; and in Fig. 42 the flanges had a thickness equal to the diameter of the bolt. This is about usual. But in Figs. 74 to 76, where

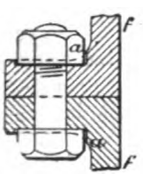

FIG. 74.

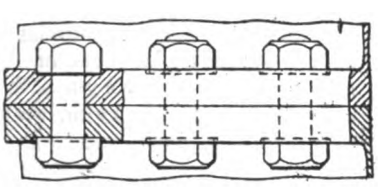

FIG. 75.

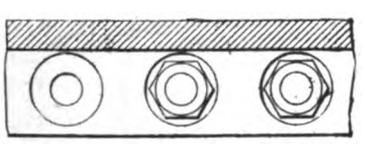

FIG. 76.

the sunk facings, as well as the holes, are a source of weakness, the flanges between the facings may be an eighth or so thicker. A radius or rounded angle where the flange joins the wall, as at *a a* (Fig. 74), is, of course, a further source of strength in such a case.

Combination Bed-plates.—Though we shall be able to illustrate and describe further examples of bed-plates for belt-driven machines, our attention must now be turned to the larger types of bed-plate, such as are used for carrying both engine and dynamo. We pointed out various combinations of engine and dynamo in our opening remarks.

Now, a primary question was at that time just touched upon, which in connection with these large bases possesses perhaps more relative importance than when dealing with single belt-driven machines. This question is to what extent the foundations are to be relied on for rigidity, in contradistinction to the opposite method of trusting for all necessary rigidity to the bed-plate itself. Every variation at and between these extremes appear to be in vogue in present practice. It may be said, indeed, to be quite obvious, that when bolted down directly to a solid mass of concrete scarcely any bed-plate is required at all. On the other hand, if in the circumstances of any given case it should be required to sling a combined plant of engine, dynamo, and bed-plate, all complete, in a crane, it is equally obvious that a light and flimsy bed-plate would stand a poor chance of passing such an ordeal without opening some cracks, an occurrence which, in fact, has happened in practice in at least one instance with which the writer has been made acquainted. Our attention may hence most appropriately be first given to bed-plates constructed for strength, so that they contain within themselves all necessary rigidity.

(To be continued.)

THE PRINCIPLES OF ALTERNATE-CURRENT WORKING.*

BY ALFRED HAY, B.Sc.(EDIN.), A.I.E.E.

(Continued from page 200.)

149. There are several methods by means of which polyphase currents may be produced. The method commonly used in practice consists in providing an alternator armature with as many independent windings as

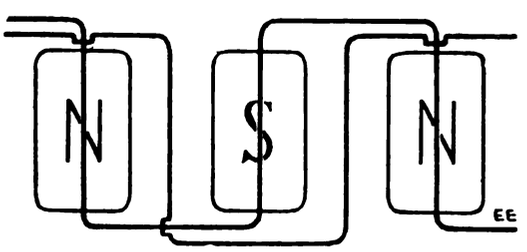

FIG. 102.

there are phases, and arranging these windings in such relative positions that the required phase difference is obtained. In the case of a two-phase generator, for instance, the two armature circuits would be so placed with regard to the poles that the E.M.F. in one circuit reaches its maximum value while that in the other is passing through its zero value. This will be understood by reference to Fig. 102, which shows three poles, with a number of conductors so placed that the E.M.F. in alternate conductors is at its maximum value, while that in the intermediate conductors is zero. By connecting alternate conductors, as shown in the sketch, to form one circuit, and the intermediate conductors another, we obtain two independent circuits, the E.M.F.'s in which are of the same periodicity, but in quadrature with each other. By adopting this method of winding, we can construct an alternator which will produce two-phase currents, or a *two-phaser*.

A similar procedure may be adopted in constructing *three-phasers*, or alternators capable of yielding three currents, the phase difference between which is $\frac{2\pi}{3}$ (or 120deg.). In order to fix the relative positions of the three circuits, we divide the distance A B (Fig. 103), which

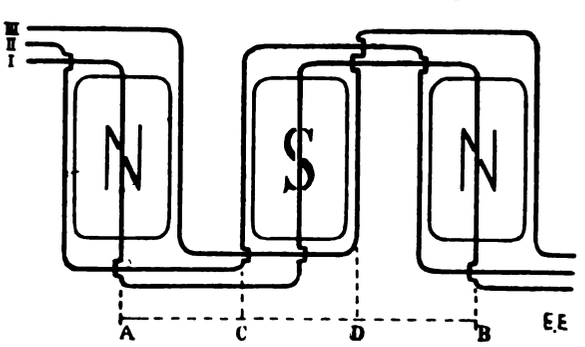

FIG. 103.

corresponds to a complete period, into three equal parts. If, now, conductors be placed in the positions A, C, and D, and maintained in these relative positions on the armature, it is evident that the phase difference between the E.M.F.'s corresponding to any two of these conductors is $\frac{2\pi}{3}$, since they are placed at distances apart which correspond to one-third of a period.

150. We have next to consider how two-phase and three-

* Based on a series of evening lectures delivered at the University College, Liverpool.

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phase currents may be transmitted from the generating station to the area of supply. It is obvious that this may be accomplished by keeping all the circuits independent, and using two conductors for each circuit. This plan is sometimes adopted with two-phase circuits, and in that case four conductors will be required for transmitting the power. For a three-phase system this method would involve the use of six conductors. In order to avoid needless complication, reduce the number of conductors, and effect considerable economy of copper, the circuits of a three-phase system are coupled together so that the number of conductors is reduced to *three*. The circuits of a two-phase system may also be connected together, so as to require only three wires for transmitting the power.

151. In Fig. 104, let A B and A C denote the two windings of a two-phaser, and A′ B′ and A′ C′ the two-windings of a

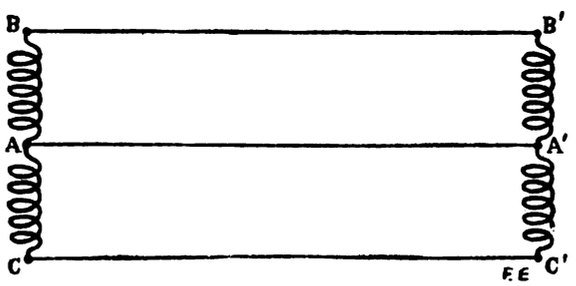

FIG. 104

two-phase motor. Instead of using four wires (two for connecting each pair of circuits), we may join the ends of the circuits to common points A and A′, and use only three wires as shown. If we assume the currents in A B and A C to follow the simple harmonic law, then the instantaneous values of these two currents may be represented by the projections on the vertical axis of two equal rotating vectors at right angles to each other, as shown in Fig. 105. Now the current which flows along A A′ is at every instant equal to the algebraical sum of the currents in B B′ and C C′ respectively; hence it may be represented by the projection on the vertical axis of the diagonal of the square shown in Fig. 105. It is thus evident that the wire A A′ connecting the junctions of the two circuits carries a larger current than either of the outside wires B B′ or C C′, the ratio of the currents being $\sqrt{2} : 1$, or 1·41 : 1 approximately.

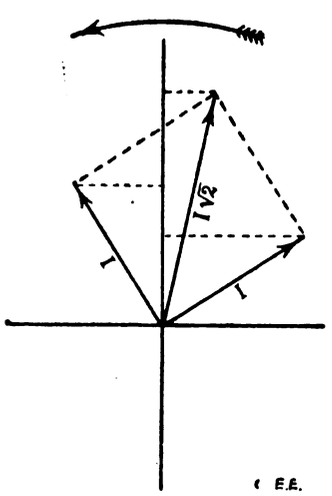

FIG. 105.

If we suppose that the current density is the same in all the wires, then it is easy to calculate the saving of copper effected by the use of three wires instead of four. For if a denote the sectional area of each wire in the latter case, the total amount of copper required will be proportional to $4a$. With three wires, on the other hand, the amount of copper will be proportional to $2a + 1{\cdot}41\,a = 3{\cdot}41\,a$. We therefore find that with three wires only about 85 per cent. of the copper will be required which would have to be provided if four wires were used.

The reduction in the amount of copper is, however, balanced by the better insulation of the line which must be provided with the three-wire arrangement. When four wires are used, the maximum P.D. between any two wires never exceeds the E.M.F. developed by one alternator winding. But when the windings are coupled as in Fig. 104, it is evident that the P.D. between B B′ and C C′ is much higher than the E.M.F. of one of the circuits, and for a simple sine wave is about 40 per cent. higher. The extra cost of the insulation with three wires might therefore in some cases more than balance the saving in copper, and it might be more economical to use four wires instead of three.

152. With a three-phase system the connections may be made as in Fig. 106. The three circuits are connected so as to form a closed mesh, A B C, round which there is no resultant E.M.F., the E.M.F.'s in any two circuits being at every instant balanced by the E.M.F. in the third circuit. The total current which enters the mesh must at every instant be equal to the total current which leaves it. Hence

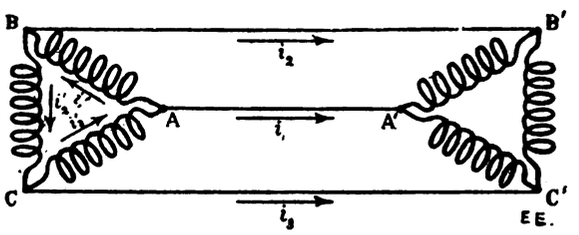

FIG. 106.

if i_1, i_2, and i_3 stand for the instantaneous currents in A A′, B B′, and C C′ respectively, reckoned positive when flowing from left to right, we must have

$$i_1 + i_2 + i_3 = 0\,;$$

i.e., the algebraical sum of the three currents must at every instant be equal to nothing. Similarly, if i_1', i_2', and i_3' denote the instantaneous currents in A B, B C, and C A respectively, reckoned positive when flowing in a counter clockwise direction round the mesh, we must have

$$i_1' + i_2' + i_3' = 0,$$

since there can be no local current round the mesh (the E.M.F.'s balancing each other at every instant).

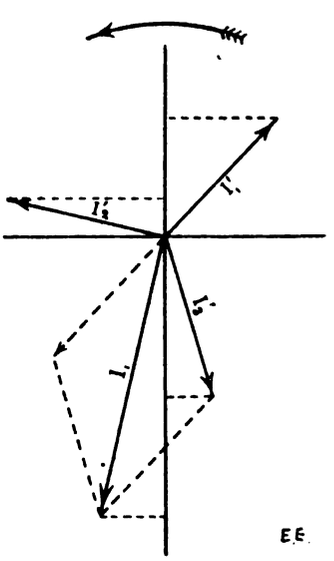

FIG. 107.

We also have the equations

$$i_1 = i_3' - i_1'\,; \qquad i_2 = i_1' - i_2'\,; \qquad i_3 = i_2' - i_3\,,$$

since the currents flowing towards any point must equal those flowing away from it.

If A′ B′ C′ represent the three sets of coils of an induction motor, then from the symmetry of the arrangement it follows that the currents in the three-line wires will all be equal to one another. In order to find their values, we make use of the last set of equations. The currents i_1', i_2', and i_3' differing 120deg. in phase, they may be represented by the projections on the vertical axis of three equal rotating vectors, I_1', I_2', and I_3' inclined 120deg. to each

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other, as shown in Fig. 107. Using the equation

$$i_1 = i_3' - i_1',$$

we see that the current i_1 may be represented by the projection on the vertical axis of a rotating vector I_1, which is the resultant of I_3' and of I_1' reversed (the latter is shown dotted in Fig. 107). From the geometry of the figure it will be evident that

$$I_1 = 2\ I_1' \cos 30\text{deg.} = I_1' \sqrt{3} = 1{\cdot}73\ I_1'.$$

In other words, the currents in the line wires are about 73 per cent. greater than those in the alternator and motor coils.

The above method of connecting the circuits of a three-phase system is known as the *mesh* or *triangle* method. It is easy to compare the relative amounts of copper required when this method is used and when the three circuits are independent of each other and connected by means of six wires. Let the sectional area of copper in each conductor corresponding to the latter case be a. The amount of copper will then be proportional to 6 a. In the former case, when three wires are used with a *mesh* arrangement, the amount of copper is proportional to $3 \times 1{\cdot}73\ a = 5{\cdot}19\ a$, so that a saving of copper amounting to over 13 per cent. is effected by using the mesh arrangement. This saving is not counter-balanced by any increased difficulties as regards insulation, for it will be seen that the P.D. between any two wires is never higher than that which would exist if the circuits were maintained independent and six wires were used.

153. Besides the *mesh* arrangement of the circuits of a three-phase system, there is another one, known as the *star* arrangement. This is shown in Fig. 108. The three

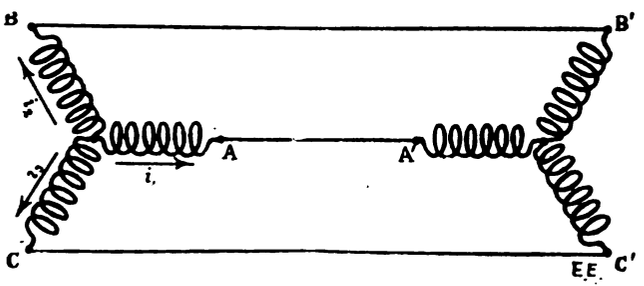

Fig. 108.

circuits have one point, O (called the neutral point), in common, and their other ends are connected to the three line wires. If i_1, i_2, and i_3 denote the instantaneous currents in O A, O B, and O C, reckoned positive when flowing away from O, then we have

$$i_1 + i_2 + i_3 = 0.$$

These three currents might, as in Fig. 107, be represented by the projections of three rotating vectors making angles of 120deg. with each other.

Let the instantaneous P.D.'s between O and A, O and B, and O and C respectively, reckoned positive when acting away from O, be denoted by v_1, v_2, and v_3. We may suppose that the projections of the rotating vectors of Fig. 107 represent to a suitable scale these P.D.'s. Then, since the P.D. between A and C is equal to $v_3 - v_1$, it follows that the vector marked I_1, in Fig. 107, will represent the maximum value of the P.D. between A and C; and this, as we have seen, is 1·73 times (Art. 152) the maximum value of the P.D.'s across O A, or O B, or O C. Hence with the star arrangement the P.D. between any pair of line wires is over 70 per cent. higher than the P.D. across each alternator circuit.

The currents in the line wires being the same as those in the three alternator circuits, it is obvious that the *star* arrangement results in a saving of copper amounting to fully 50 per cent. as compared with a six-wire line. Again, comparing the *mesh* with the *star* arrangement, we find the relative amounts of copper to be as 519 : 219, so that if we replace a *mesh* arrangement by a *star* one, we save over 42 per cent. of the copper. Against this, however, must be put the cost of the higher insulation required with the star grouping, so that in some cases the mesh arrangement might be preferable to the star.

(To be continued.)

THE LIGHTING OF PUBLIC BUILDINGS.

BY H. W. HANDCOCK AND A. H. DYKES.

One cannot help being struck by the fact that in large numbers of fine buildings the electric lighting work is often of a most unsatisfactory nature, and quite out of harmony with the rest of the work in the building. How often does one not see lengths of wood casing carried across walls in the most conspicuous places, jumping elaborate cornices and running down marble panels, switches and switch and fuse boards looking as though they had been "thrown on" to the walls, and fine rooms spoiled from the architectural point of view by numberless strings, called by the initiate flexible cords, ornamented at the bottom with opal shades of the severest lines, the appearance being further enhanced by several being pulled aside at various angles to suit the convenience of the users.

These are points which are patent to everyone, but when we come to examine the technical details the state of things there is often worse. The fault does not lie altogether, or even principally, with the electric light contractor, who has given good value for the money expended, but is due to the conditions under which the work is given out. In many cases no specification is drawn up, and each contractor, in addition to the expense of preparing his estimate, has to propose his own scheme of lighting. It is obvious that, even if the profits obtainable were sufficient to allow of a very considerable amount of time being expended in considering the arrangements most suitable to the building before preparing the estimate, the inevitable tendency of the keen competition now existing would be to cause the very cheapest arrangements to be proposed regardless of other considerations. In other cases the number and position of lights may be specified, but the building is laid out and completed without any provision being made for the electrical apparatus, and the wiring contractor has to make the best job he can under the circumstances.

In order to light a building in a thoroughly satisfactory and pleasing manner, three principal requirements have to be borne in mind: first, and foremost, the requirements as regards safety and durability of the work; secondly, the arrangement and disposition of the lamps themselves so as to get the light exactly where it is required with the least possible consumption of current; and, lastly, the requirement that the wiring shall be as unobtrusive as possible, that switches, fuseboards, etc., shall look as though they were part of the original scheme of the building, and not like something added as an afterthought, and that the fittings shall harmonise with the style of architecture and other decorations.

As regards the system of wiring to be employed, there is the choice of wood casing, conduits, brass tubes, iron tubes, either plain or insulated, and the various concentric systems. Which is best to use depends on the particular circumstances, and can only be decided after careful consideration of the building and its requirements. In some instances the wiring can be on the surface, but in the majority of cases it should be hidden. This becomes a *sine quâ non* in buildings where the walls are tiled or covered with marble slabs, or even with Parian cement, and the floors of concrete and wood block, and for such constructions there can be no doubt that a draw-through system of some kind is most suitable. What is wanted is that the electric light installation shall be of as permanent a nature as the building itself, and that if any wire has to be replaced at any time it can be done without disturbing walls or decorations. A solid substantial draw-through system, which cannot be injured either by workmen during erection or by nails being driven through it, may cost more at the outset, but it will last practically for ever, and in any case it is absurd to expect, as so many people apparently do, that the wiring of such a building should be at the same rate per light as that of the cheapest kind seen in some small city offices.

For buildings having their own supply of current the concentric system of wiring offers many advantages, and for surface work and running under boarded floors the systems now on the market answer most requirements. Where, however, it is necessary to bury the wires in concrete floors, and in cement behind tile-work, something

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more is wanted. The writers have recently drawn the specification for an installation which appears to them to combine the advantages of the concentric system with those of the "draw through." In this case, $^3/_{20}$ vulcanised rubber wires are run in solid-drawn Muntz metal tubes (which can be easily bent cold) $\frac{3}{8}$in. diameter, No. 20 gauge, with cast brass joint and draw-through boxes, the pipes and boxes being the return conductor. All joints between the tubes and between tubes and boxes are made by butting the ends, slipping a brass sleeve over the joint, and sweating it; and the pipes terminate at ordinary pattern concentric sockets and fittings. Owing to the small size of the pipes they are easily embedded in the plaster, but little cutting away being required, and for the same reason they are mechanically strong and will withstand a very considerable amount of hard usage. It will be readily seen that such a system possesses many advantages over the "double wire" tube system, as not only is half the wire and half the weight of tube saved, but the cutting away and cost of running is considerably reduced also, whilst the tubes are mechanically much stronger. The writers are of opinion that this system as now elaborated is likely to prove a useful one.

One great point to be borne in mind with all new buildings is that a substantial pipe system can be put in as the walls go up, with little or no cutting away, and after the plastering is completed and the building practically finished the wires can be drawn in without a single yard being damaged by workmen and without any making good of decorations. In all cases where good permanent work is wanted the joints in the cables should be vulcanised *in situ*, as it is no use going to the expense of good vulcanised rubber cables if the joints are to be insulated only with pure rubber.

In settling the amount and distribution of light, fixed rules depending simply on the square feet of floor area are of very little use, an alteration in the colour or nature of the surface of walls, floor, or ceiling making a difference sometimes of 50 per cent. or more in the amount of light necessary. Speaking generally, there are two kinds of illumination required—one in which a general diffused light is wanted, and the other where, in addition to a certain amount of diffusion, a stronger light free from shadows is required on tables, desks, etc., for writing. In most large halls or offices, to attempt to work by means of the general light, either reflected or direct from ceiling or wall fittings, is pure vexation of spirit unless current be used on a lavish scale, and it is far more convenient and economical to have a single 8 c.p. lamp at one's elbow and the rest of the room moderately well lit than to rely on, say, a six or eight light electrolier in the centre of the room. Private consumers would find it greatly to their advantage to be prodigal of plug points wherever a ready light is likely to be required, both on the score of convenience and also of economy in the consumption of current. Where each person has his separate standard light and there are more than one on a desk, 8-c.p. lamps are quite sufficient, provided that the light be arranged in the proper place, and that if 16-c.p. lamps are already in use the change be made gradually—preferably without the people who use the light being aware of the change.

This brings up the oft-repeated but still not properly appreciated fact, that the eye is no judge of the absolute value of illumination, and that what is wanted is a soft, diffused light on the desk or papers, its source being hidden. The usual device of a piece of writing-paper affixed to the edge of an opal shade is not beautiful, and the object can be better achieved by means of a fixed ground-glass disc. For lighting passages, small lavatories, strong-rooms, and telephone-rooms it is surprising that more use is not made of low candle-power lamps, so frequently does one see 16-c.p. where 3-c.p. would do. In banks, insurance offices, and other commercial buildings where white glazed bricks and tiles are freely used, the writers have substituted large numbers of small-bulb $2\frac{1}{2}$-c.p. and 3-c.p. 100-volt lamps with marked economy in the lighting bills, as it is just these lamps which are run the longest hours.

It will probably now be generally conceded that separate fuses are out of date, and that the only permissible method in good work is to group the cut-outs on distribution boards which are controlled by separate cables from a main circuit board in some convenient position. These distribution fuse-boards should, wherever possible, be sunk in flush with the wall line, and in any case the mouldings and woodwork should be in harmony with the surroundings, as nothing is more obtrusive than, say, a teak frame standing out in the midst of oak or mahogany panels, or a light mahogany against a dark. Unfortunately, in so many cases it seems to be impossible to get a convenient position for these boards, and even in buildings specially frequented by engineers, where better things would have been expected, one is confronted with boards fixed in inaccessible places over doorways, and even there out of centre with everything. The same want of symmetry and an eye for proportion is shown with regard to switches and wall sockets. If these be sunk in the walls and covered by a neat wood or metal plate, and care be taken that they come symmetrically in panels or rails, they are not at all obtrusive; but the spectacle of a couple of switches or wall sockets standing out some 3in. from the wall or a piece of "workshop" teak, and just managing to cut into the dado line or fixed all out of centre on a rail, makes any person of taste shudder.

Bronzed metal might with advantage be more used for electrical fittings and accessories rather than so much highly polished assertive brasswork. As regards fittings, there can be no doubt that, speaking generally, they are much too flimsily made, and great difficulty is experienced in getting any that are really satisfactory from an electrical, mechanical, and, at the same time, artistic point of view. Where is the sense in selecting light inexpensive fittings, all spinnings and stampings, and for ever afterwards being plagued by their getting out of order? In far too many cases, also, they are selected on their own merits, without considering the environment in which they are to be placed.

In public and commercial buildings, the fittings in general use, such as desk standards, must be made exceedingly strong, or they are sure soon to give trouble. Good sound castings should be insisted on instead of spinnings; all joints should be brazed, and the switches should be ordinary tumler or other strong pattern fixed in the base. Fittings simply screwed together with two turns of the thread are bound to be twisted round and fall to pieces, and the slight delicate switches on them are a continued source of annoyance. There are honourable exceptions, but, speaking generally, the taps and dies in use by fittings makers appear to be threadless, and lock-nuts unheard of. Examine any large electrolier carrying heavy cut-glass vases or globes: in nine cases out of ten the globes are held on by three screws, a very shaky fit in the gallery, about two threads engaging. There being no lock-nut, it is only a question of time before the screws slack back and the globe falls, lucky if it does not seriously injure somebody. Greater care, too, is required in fixing fittings. The fixing screws are generally too small and back plates often weak, with the result that the bracket or standard carries away if it gets the slightest blow or pressure. In the case of long brackets carrying a heavy shade the tension on the one, or at most two, screws along the centre line (which, of course, are the ones which take practically all the strain) is often far beyond the safe limit.

The wiring of fittings is the weakest part of the installation, and it is worthy of much more attention than it usually obtains. Artistic appearance and harmony with surroundings are of very great importance, but the fact that well-insulated wires have to be led to the lamps, and that some good mechanical method of fixing and insulating is essential, must not for a moment be lost sight of. Far too much flimsy flexible cord is used; and as regards fixing, the man on the spot is left to do the best he can, causing a great deal of unnecessary waste of time and money.

This article has been written, not with a view to bring out new points, but rather to emphasise conclusions at which many have already arrived. Doubtless many engineers have realised that if electric lighting is to justify the high expectations which have been formed of it, serious attention will have to be given to installing it in a more permanent way than is usually done. Electrical engineers must not rest satisfied until they put in installations in

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such a manner as to make the essential parts durable as the building itself. There is nothing impossible in this—it is done already in some cases; all that is wanted is honest work, method, common sense, and all pulling together. At the same time the consumer cannot expect to get more than he pays for, and as long as he persists in taking the lowest tender without enquiring any further, so long will the present state of affairs exist.

SIXTY YEARS OF SUBMARINE TELEGRAPHY.

Prof. W. E. Ayrton delivered a lecture on the above subject at the Imperial Institute on Monday last before a large and appreciative audience. The chair was taken at 8.30 by Sir Henry Mance, who was supported by Sir F. Abel and Sir A. Jephson. In introducing the lecturer, Sir Henry Mance regretted that Mr. W. H. Preece was unable to attend to take the chair owing to indisposition.

Prof. Ayrton commented on the short time at his disposal—*i.e.*, 60 minutes to cover the events of 60 years; but he was encouraged to exceed the allotted time later on by the acclamations of the audience. In February, 1837, the year the Queen ascended the throne, a contract was signed between Charles Wheastone and Mr. W. F. Cooke for the construction of the first telegraph line in this country. An interesting extract from one of Mr. Cooke's letters to his mother was read, showing the difficulty of obtaining reliable information about electric currents at that date. That year the same gentlemen were also considering how to insulate a wire so that it could be laid under water. Prof. Ayrton alluded to the reported fact that Baron Schilling was the first to lay electric wires under water. He was said to have exploded mines under the Neva by these means in 1812. About the year 1837 Colonel Pasley laid a wire under the Medway and transmitted electric signals by it. He also blew up the hull of the "Royal George" at Spithead, using insulated wire. The insulation in those days consisted of tarred rope covered over all with pitched yarn. Wheatstone himself had devised a scheme for laying a wire under the Channel insulated in the above manner. Prof. Ayrton gave Morse the credit of having first used a rubber-covered cable under water. This inventor covered about two miles of wire by hand, and laid it successfully. It did not give permanent results, but signals were sent for a few hours. It was not, however, until the introduction of guttapercha that submarine telegraphy entered its practical stage. Sir William Siemens was very keen in his appreciation of the new material, and with the co-operation of his brother in Germany produced a "Macaroni" machine for squirting the guttapercha round the conductor. A wire of this type was soon laid in Kiel harbour.

The first person to deal with the question from a commercial standpoint was Jacob Brett, who in 1845, with his brother, John Watkins Brett, registered an electric telegraph company, and made a formal application to the Government of Sir Robert Peel for the purpose of obtaining a monopoly. The application was written with an electric printing apparatus, and was treated with the circumlocution of a well-established Government department. As indicating the state of telegraphic facilities in those days, the lecturer quoted a paragraph from the *Weekly Register* describing the transmission of the Queen's Speech to Newcastle in 1847. The speech was first sent by special engine to Rugby, and was then telegraphed, the message having to be repeated three times—at Derby, Normanton, and York. The first part of the speech, which was about a column in length, was received at Newcastle at 20 minutes to 4 p.m., and the close about 9. The time occupied in its transmission was the incredibly short period of 6½ hours. Thus the message was not sent so quickly as the average express train now. Jacob Brett and his brother having failed to get a favourable answer to their first letter, applied again to the Government two years later, and then got the permission of both the English Government and the Emperor Napoleon to lay a telegraph wire between Dover and Calais. Numerous delays occurred, and it was not until 1850 that, on the strength of the concession they had received, a submarine telegraph company was formed; but all the money the public would subscribe for the project was £300. It was thus generally agreed that submarine telegraphy was an impossibility.

Prof. Ayrton proceeded to describe the many difficulties met with in laying this cable in the autumn of that year, and the short time which the cable worked when laid. The next step in advance was in armouring the insulated core, and a cable of this type was laid on September 25, 1851. When the ship had got to within a mile of the coast it was found that all the cable had been paid out, and the end had to be left there till a further length had been made. The lecturer proceeded to describe with many experiments the troubles which were found in these early cables, due to the retardation of the signals. Fourier's book, published in 1820, on the theory of the transmission of heat, gave the methods by which these troubles could be explained and corrected. Lord Kelvin, in a paper written in 1855, took the matter up, and did more than anyone else to remove these retardation troubles. After the French cable had been made a success, England and Ireland were next connected. As early as 1844 Morse had spoken of the possibility of an Atlantic cable, but it was not until 1855 that the idea of telegraphic connection between America and Europe was seriously considered. In the following year an agreement was signed between Cyrus Field and John Watkins Brett and others for the formation of an Atlantic telegraph company, with guarantees and subsidies from the English and American Governments, and in 1857 the first Atlantic cable expedition started. The capital was obtained mostly from England, an active part in the enterprise being taken by the brothers Charles and Edward Bright.

Prof. Ayrton then proceeded to detail the numerous unsuccessful attempts to connect the two continents, and the short life of the first cable completed. The workers pluckily continued their labours, until in 1866 a complete cable was laid, and the one previously broken was successfully repaired and finished. The lecture was profusely illustrated by experiments, and a most interesting collection of samples of old cables and cable instruments were shown. A number of portraits of eminent men taking part in the development of submarine telegraphy were hung about the room, and illuminated in turn by a small projector when reference was made to them. A hearty vote of thanks was given to Prof. Ayrton for his interesting lecture.

ELECTRICITY SUPPLY AT 230 VOLTS.*

BY ALFRED H GIBBINGS, MEMBER.

The past 12 months have seen a very marked development in the design, adoption, and popularity of the 200-230 volt incandescent electric lamp. The discussion on Mr. Barnard's paper at the meeting of the Municipal Electrical Association in June, 1896, and the few actual facts and experiences which Mr. Addenbrooke was able to put forward in his paper on high-voltage lamps, read before the Institution of Electrical Engineers in March, 1896, are in themselves quite sufficient to show how little had been accomplished in this direction so recently as 12 months ago. In 1893, while I was at Hull, I experimented somewhat considerably with 220-volt lamps. Although at that time there were not many reliable high-voltage lamps in the market, yet I found it convenient to choose the best that could be obtained, and to declare the supply pressure to some consumers on the outlying mains to be 220 volts. These lamps gave so much satisfaction that upon my removal to Bradford I was encouraged to make a wholesale change of pressure. The results of this, I believe, unprecedented step I shall endeavour to place before you in this paper.

At this point, however, and before proceeding to details, the following extracts from a speech made by Lord Kelvin so long ago as May 3, 1883, may be of more than passing interest. The occasion was a series of lectures delivered at the Institution of Civil Engineers, and, speaking of the regulation of pressure, Lord Kelvin said: "Supposing, for example (as in the case of my own house, temporarily, until I can get 200-volt lamps), that the proper potential is 84 volts." And later on in the same lecture he says: "The domestic incandescent lamp of the early future ought to be, and we hope it will be, a one-millimho

* Paper read before the Northern Society of Electrical Engineers, February 8, 1897.

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lamp, to give a 10 or 12 candle light with the Board of Trade regulated 200 volts of potential." Lord Kelvin also made other references in his lectures in support of the 200-volt lamp.

At the present time I believe that many municipal electrical engineers, and some consulting electrical engineers, are greatly in favour of high-voltage lamps, both for alternating and continuous-current systems of supply. As examples, I may mention the recommendation by Prof. A. B. W. Kennedy of a three-wire continuous-current system, at 460 volts on the outer mains, in connection with the city of York, and also his recommendation of high-voltage lamps for Edinburgh. The instances with reference to alternating-current systems are: (1) Cardiff, in which Mr. N. Applebee has recently been purchasing transformers with the intention of supplying at 200 volts; (2) Kingston-on-Thames, where the matter is having the consideration of Mr. J. E. Edgcome this year; (3) Blackpool, where Mr. R. C. Quin is at present installing 200-volt lamps in place of 100-volt lamps from the distributing system; (4) Bolton, where Mr. Arthur Ellis proposes to introduce the 200-volt lamp in the residential districts; (5) Southport, where Mr. Charles D. Tate has decided to supply outlying residential districts at 200 volts, leaving the business portion of the town to be supplied at 100 volts.

The subject of my paper, however, is "Supply at 230 Volts." I wish it, therefore, at the outset to be understood that I consider the question to be of equal importance and interest whatever may be the system of supply, either in vogue or in contemplation, which may be thought most appropriate to any particular district, county borough, or town. Hence I shall confine my remarks chiefly to our experiences with the consumer and the fittings on his premises, and I shall take it for granted that the advantage of supply at 230 volts from a distributing and central-station point of view, as far as plant, mains, network, regulation, transformers, public lighting, and economy are concerned, are sufficiently admitted to be beyond dispute. We have at present about 530 consumers on the mains of the Bradford Corporation electricity supply, all of whom are now users of the current at 230 volts. Of these 530 consumers, 500 have been "changed over" from 115 volts since November, 1895, when I first took the management of the department, and it is a significant fact that no solitary instance of supply at 115 volts now remains. Bradford is, therefore, the first town which has completely gone over to the higher pressure. The following figures give the number of lamps, etc., supplied at the higher voltage—viz., 230 volts—at December 31, 1896: 8 c.p., 2,492; 16 c.p., 11,795; 25 c.p., 169; 32 c.p., 1,298; 50 c.p., 167; 100 c.p., 120; 150 c.p., 3; 200 c.p., 32; 250 c.p., 5; and 300 c.p., 14.

Description.—The public arc lamps (15 in amperes) four in series, are eight in number; private arc lamps (10 amperes) four in series (single carbon), 359; private arc lamps (five amperes) two in series (Jandus and other enclosed type arcs), 18; private arc lamps (five amperes) two in series (double carbon), 48; and motors (total horse-power, 160), 71. The equivalent of the above in 8-c.p. lamps at 3·5 watts per candle, is 49,653. The amperes demanded are as follows: at 115 volts, 12,088; at 230 volts, 6,044; and at 460 volts, three-wire system, 3,022.

I have given the above statistics for two very cogent reasons. First, it shows for both continuous and alternating currents the immense saving effected in copper, on the three-wire system, over the old methods which were adopted of making the distributing network a simple two-wire system at 115 volts maximum pressure. Secondly, I think you will agree that the experience gained with the actual supply of so many incandescent lamps, arc lamps, and motors over a period of 12 months at once removes the question as to the practicability, efficiency, and general satisfactoriness of supply at 230 volts in general, and the 230-volt lamp in particular, from a laboratory experiment to that of an accomplished reality. I now proceed to consider the subject in detail from the house service terminal-boxes to the consumer's lamp, and I will take the opportunity to mention incidentally many little experiences which we have had in effecting the change.

I.—House Terminal Fuse-Boxes.

On the table before you lies a sample of the house terminal fuse-box, which was originally designed for 115 volts, and which is the universal type adopted in Bradford. For current up to 50 amperes at 230 volts—that is, of course, equal to 100 amperes at 115 volts—we have found the length of fuse amply sufficient, and the insulation equally satisfactory. The covers of these boxes are made entirely separate instead of being hinged, as in the latter case there is always the liability, through possible contact of one box case with that of another, of getting a spark to earth and thus damaging the cover. The few older types of fuse-boxes which were in use previous to the present design have been replaced, not only on account of the fuse being too short a break, but for other reasons irrespective of the alteration in voltage. The boxes are, of course, single-pole in order to meet the requirements of the Board of Trade.

II.—Meters.

The types of meters now in use are the Ferranti, the Hookham, and the Thomson-Houston. Previous to these were the Edison electrolytic meter, the Frager, the Aron, and the Oulton-Edmondson, none of which now remain in use. The few remaining pendulum meters which were in circuit at the commencement of 1896 were replaced by those of the motor type, at the time of changing the lamps of the consumers. The motor meters, which were then calibrated at 115 volts, of course, required readjustment. The Ferranti and the Hookham meters, being all direct-reading, and simply current meters, were, of course, still available by adopting a constant of 2 as a multiplier. I may here mention that it is now the practice to test every meter for starting current once in three months, and also to take a short test of accuracy of registration at the same time. The Thomson-Houston meters being wattmeters, it was necessary to replace those in use at 115 volts by new meters suitable to the higher pressure. The meters removed were, after re-calibration, used for subsequent consumers. The alterations to the Thomson-Houston meters in the readjustment from 115 to 230 volts were as follows: (1) The resistance of the shunt was increased in the ratio of about 20 to 6, and a portion of the additional windings (about 1,000 turns) was placed inside one of the main coils to act as a starting coil; (2) the number of controlling magnets was reduced from three to two; (3) the dial train was altered to read at twice its previous rate. With these alterations, the meters started at one-tenth of an ampere, and the consumption of current in the shunt was reduced from about 10 to 6 watts. The cost of the alterations was about 25s. per meter.

III.—Wiring and Fittings.

It is a peculiar coincidence that Bradford was the first town to own municipally an electricity supply, which, as you are all aware, was designed on the simple two-wire system at 115 volts pressure, and that it should also be the first to adopt the 230-volt lamp *in extenso*. Having been started in 1889, and taking over at the same time several installations which had even then been in existence two or three years, it will not be surprising to learn that some antiquated and crude forms of wiring and fittings have had to be dealt with. In fact, I think I may say with every assurance that in no other town will there be found such instances of defective and primitive wiring as we found in Bradford. Fortunately, however, the cases were not numerous. Many of the worst had to be rewired before my advent, but of those remaining the chief characteristic defect was that the wires were only cotton-covered, and therefore dangerous under any circumstances. Notwithstanding the use of cotton-covered wire we found the insulation tests exceptionally high, as, indeed, was the insulation of the entire system.

The opportunity afforded in making the change, however, enabled us to call upon these consumers to have their premises rewired, and when the danger of such inadequate insulation as cotton was pointed out to them no protest whatever was made. Now it is just at this point that I wish to state that no additional restrictions or conditions with regard to insulation of wires have been imposed in consequence of the change of voltage, the rules and regulations drawn up for 115-volt supply still being retained. I had ample opportunity of observing the effect of 220 volts on ordinary vulcanised rubber-covered wire and ordinary fittings at Hull and at Bradford in premises supplied from the outer mains of the three-wire system, and the insulation resistance was invariably maintained in a more perfect condition than was generally found with 115 volts only. This experience has now been verified in a remarkable way, for since all our consumers have been supplied at 230 volts, we have much less leakage in installations particularly and on the whole system generally. The higher pressure, instead of causing unpleasant troubles, has actually freed us from much "earth searching" so frequent in the past, and it appears to maintain the general satisfactoriness of high insulation. One other slight advantage has been gained. In very large buildings, such as our music halls, markets, free library and art gallery, hotels, etc., the loss of potential at the furthest lamp has been reduced by one half, and even this loss has less effect upon a 230-volt lamp than upon one of 115 volts. In such buildings and electric light installations the wiring is calculated, more frequently than not, upon current density rather than upon fall of potential. The average provincial wiring contractor thinks he sufficiently and conscientiously complies with the corporation rules and regulations when he arranges his wiring for a current density not too suspiciously above 1,000 amperes per square inch of section, but he would in many cases look aghast if told that he would only be allowed one-volt drop at full load at the farthest lamp. In fact, in Bradford, the wiring firms have already shown their appreciation of the lessened ampereage per lamp, which admits of cheapened wiring in most cases, but I have found it advisable and necessary to stipulate for fall of potential where the length of wire is considerable.

In respect of fittings—by which I mean switches, fuse fittings, wall plugs, ceiling roses, brackets, pendants, electroliers, and lampholders—I may say at once, as a general experience, that we

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have found the more modern type of ordinary 115-volt design equally satisfactory at 230 volts. I have one or two examples of switches, etc., on the table for your inspection, which are not of a modern type, and which I am sure you will agree are better removed than left in under any circumstances. Ceiling roses, switches, wall plugs, and fuse fittings have here and there required renewal, and have given trouble, but in each instance, fuse fittings excepted, only ordinary good modern types have been used in replacing; in no case has a special fitting been made. Fuse fittings constituted the principal failures under the new supply owing to the usually very short break gap. Smaller sizes were replaced by special types, but the larger sizes were altered *in situ* by the addition of a small bridge of ebonite placed in the gap, thus necessitating the fuse wire being bent around a corner. These alterations were, of course, carried out at the time of changing the lamps in each place, in order not to inconvenience the consumer, and his new lamps usually made ample amends for a little temporary trouble. As a matter of fact, after about 100 consumers were changed, others personally applied at the town hall to have the new lamps, and as no public notice had been given of the alterations to be carried out, an impression gained ground, for some reason or other, certain consumers were being highly favoured by the department. This, of course, made matters very smooth, and in no single instance was any opposition offered. With regard to Ediswan lamp-holders, including those of the switch pattern, not a single one of modern design has been renewed. It is now about four months since the department has had to attend to any defect in respect of fittings, and these four months have represented the heaviest load in the year.

IV.—Motors.

There are at present over 70 electric motors on the Bradford Corporation mains, and of these about 35 have had to be rewound for 230 volts. The last to be altered was completed on September 24, 1896, and as the rewinding was placed in the hands of a good firm, and each motor was on completion carefully tested for efficiency, speed, and temperature before being replaced, the results have been perfectly satisfactory. Needless to say that in some instances old types were improved and errors in design rectified, and much better machines replaced than were taken out. A spare machine was in each case temporarily loaned, and the entire work took about nine months to accomplish. The regulation of motors at 230 volts is better than at 115 volts.

V.—Arc Lamps.

Referring for a moment to the earlier portion of the paper, it will be seen that the number of arc lamps in Bradford, both public and private, is 433. Of these there are eight public lamps, leaving 425 private arc lamps, of which about 400 were coupled, two in series on 115 volts, 12 months ago. These 400 arc lamps must be further divided into two classes—viz.: (1) consumers using more than two arc lamps, 40=365 arcs; (2) consumers using two arc lamps only, 30=60 arcs. It will now be seen that in order to change over these arc lamps it was necessary, in regard to the first class just mentioned, to get as many lamps as possible reconnected, four in series instead of two in series. This has been the only serious and important task in connection with the entire change, as it primarily interfered very greatly with the convenience of the consumer, which was the chief thing we endeavoured to avoid. However, this did not prove to be entirely an evil or even an annoyance. As in the case of wiring, so with the arc lamps, we found that the more modern lamps were easily readjusted; and as each lamp was individually dealt with for its proper ampereage and voltage, and the correct resistance left in circuit, some improvements in the way of effective working were consequently obtained. These little details of careful adjustment had obviously been neglected altogether when the installation had been first carried out. Most lamps were exceedingly dirty, the working parts not having been cleaned for years. Other little difficulties occurred as we passed from consumer to consumer. One individual has six arcs, and we had to promise two special lamps for him; another had four arcs, but two were inside the shop and two were outside, and it was obvious that we could not ask him to be burning all at the same time. All difficulties have, however, been surmounted, and, I may add, to the mutual satisfaction of the consumers and ourselves. As a matter of fact, the consumers have had their lamps cleaned and put in good condition. The lamps of one consumer in particular we found taking 17½ amperes. He, of course, was in entire ignorance, but he wisely replaced them, and at once got a better light and reduced his account 50 per cent. Several similar interesting facts could be given illustrative of how much good has resulted from a little evil. I will, however, only mention further that our experiences suggested the idea of hiring out arc lamps, which has been so satisfactory and so well appreciated that 20 were left on hire during December last, and enquiries continue to be made.

(To be continued.)

WATT AND THE MEASUREMENT OF POWER.*

BY W. H. PREECE, C.B., F.R.S.

James Watt, who died 77 years ago, was a great inventor. He was "one of the most illustrious followers of science, and one of the greatest benefactors of the world." If he had never improved the "fire-engine" of his, the "steam-engine" of our, day, the copying-press alone would have maintained his name on the scroll of inventive fame. His greatest invention—that which has been the most prolific in exciting further improvements in the steam-engine, and which has supplied the engineer with a new sense—is perhaps the "indicator." The indicator enables an engine itself to record automatically on paper a diagram which, properly interpreted at leisure, conveys a clear history of the performance of the steam in the cylinder. It enables the engineer to measure the actual work that is being done by it, and it gives a report of the action of the valves and parts which control the ingress and egress of that steam, and which regulate the performance of the machine. It gives an insight into the internal actions of the machine, which, being out of the range of direct observation, are so liable to be misinterpreted. It is to the engineer what the stethoscope and the thermometer are to the physician. Accuracy in measurement is the foundation of engineering and the secret of practical success. It leads to the detection of error and to perfection in working.

No instrument has been more productive of improvement in this respect than Watt's indicator, and few instruments have been found to require less modification. The conception and development of this apparatus showed that Watt was a long way before his time in grasping the doctrine of energy and applying the practice of graphics. With such an extensive literature on the subject, and with its universal employment by engineers, it is unnecessary to describe the instrument. I content myself by showing you side by side Watt's original instrument, 112 years old (kindly lent by Mr. Tangye, of Birmingham), and the most recent form designed to meet the requirements of modern machinery. In his patent of 1782 describing his application of the principle of expansion to the economical working of the steam-engine, Watt drew a diagram, which I reproduce, showing how much he was before his time in the use of graphics and in the conception of the principle of energy. It is quite clear that this mode of looking at the work done in the cylinder led him to consider its automatic record. It was only necessary to know the length of stroke, and to indicate the pressure of the steam upon the piston exerted during each instant of its movement to obtain the factors of the work done during each stroke. A curve is thus formed by a pencil on a sheet of paper which by its shape gives the whole history of the performance of the engine. The area of the curve, although it contains nearly all we want, is not that which we require to know so much as its mean height. The horizontal length gives the time of one stroke. The mean height gives the average pressure exerted during the stroke. We thus learn the work done per stroke, and by multiplying this amount by the number of strokes per minute, and knowing the dimensions of the machine, we obtain the total work done per minute.

The principle of work lies at the very root of the profession of the engineer; Watt gave us not only the means to measure it, but a system to indicate it. Work done means resistance overcome. It means the application of force through space against this resistance. In Great Britain we employ as our practical unit the force or weight of 1lb. Our space is measured in feet. Thus if we raise 1lb. 1ft. high against the resistance of gravity, we do an amount of work which we moderns call a "foot-pound," though Watt did not. The "foot-pound" conveys to them who habitually use it the conception of a reality as distinct as 1lb. of butter. The engineer, like Shakespeare's poet, gives to airy nothing, not only a local habitation and a name, but a concrete existence. The French unit of work is larger. It is a kilogramme raised one metre against gravity, and is called the "kilogram-metre." The kilogram-metre contains 7·23 foot-pounds. I have had some difficulty in tracing the parentage of the term foot-pound. It came into existence in the forties, Joule, in his earlier papers, spoke of the work done by 1lb. acting through 1ft. Lord Kelvin writes me, "I believe we had 'foot-pound first from Lewis Gordon, the first professor of engineering in Glasgow University (1844), the first really of the United Kingdom. We used it thoroughly in Glasgow when I came from Cambridge to be his colleague in 1846. Joule was much pleased to use it, I believe—in fact almost remember—that he got it from me." The English engineer is forced to use the pound weight as his unit of force, not because he is wedded to it, but because the pound and yard are the legal units prescribed by the Legislature. When Parliament thinks fit to introduce a decimal and metrical system the change of units will be easily effected, and we shall experience the inestimable advantage of having one absolute system of measurement employed alike,

* Delivered at Greenock, February 5, 1897, being the Watt Anniversary Lecture.

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not only by science and practice at home, but universally by all European nations. It is not generally known that James Watt proposed in 1783 a new and decimal system of weights and measures. His unit length was based on the seconds-pendulum. His unit weight was to be the unit cube filled with water, and he proposed to weigh all liquids and gases in terms of this unit in order to express by the same figure specific and absolute weights. There is reason to believe that these ideas were instrumental in framing the splendid system finally made legal in France in 1801, for Watt himself visited Paris in 1786, and was in intercourse with La Place, Monge, and other members of the committee of the academy dealing with the question. Nothing can prevent this system, probably the child of Watt, from ultimately becoming universal all over the civilised globe.

Now, Watt in introducing the steam-engine found the chief competitor he had to meet was the horse. It worked the pumps in mines and "brewhouses." It drew the ores to the surface. It was employed for grinding and for milling. It was clear that his customers would compare the performance of his engines with that of their horses. He determined by experiment that a good horse, working continuously, could raise 22,000lb. 1ft. high in one minute. He thought he would go "one better"; so he said, "I will call 33,000lb. raised 1ft. high in one minute a horse's power." Thus he gave his customers the advantage of 50 per cent. more work; but he did more, instead of compelling them to keep relays of horses, each of which could not work continuously more than six or eight hours, he gave them a machine which worked continuously throughout the 24 hours. He showed, moreover, that in Whitbread's brewhouse his engine "does the work for which 30 strong horses were kept, and consumed 8-10 bushel of coal per hour." The above definition of a horse's power was singularly unfortunate. It means 15 tons moved at a snail's pace. Few people can grasp the conception. We know what a man can do, especially when rowing a race, or when raising bricks. Going up a mountain at the rate of 1,000ft. per hour—a fair performance—he does about one-twelfth of a horse's power (h.p.) if he weighs 12 stone. Working a treadmill absorbs $\frac{1}{8}$ h.p., which is distinctly hard labour. If he runs upstairs at the rate of 3½ft. per second he does 1 h.p., and this is not good for his heart. We also know what a horse can do in drawing a cart or moving a canal barge. "Five hundred and fifty pounds moved 1ft. per second"—the leisurely pace of a child walking—is more comprehensible than and the same thing as 33,000 foot-pounds per minute, and is now more frequently used, especially abroad. But Watt was not the first to use the term "horse's power." Savery did this in 1702. "An engine," said Savery, "which will raise as much water as two horses, working together at one time in such a work, can do, and for which there must be constantly kept 10 or 12 horses for doing the same, then I say such an engine will do the work or labour of 10 or 12 horses." Watt, however, gave the unit a scientific character and was virtually its founder. He thus introduced the conception of power as the rate of doing work. His unit of work was 1lb. raised 1ft. high, irrespective of the time in which it was done; but by conceiving this being done in a unit of time he conveyed the idea of power, a scientific definition of a much-abused term. Boulton said at Court to George III.: "I am engaged, your majesty, in the production of a commodity which is the desire of kings." "And what is that—what is that?" asked the King. "Power, your majesty." Again he was anticipated, for Smeaton, in the *Philosophical Transactions* for 1759, in describing his experimental enquiry concerning the natural powers of water and wind, said, "The raising of a weight relative to the height to which it can be raised in a given time is the most proper measure of power." Watt did, however, introduce the term "duty" to determine the comparative merits of steam-engines. It was introduced by him in Cornwall, and is often known as the "Cornish million," for he determined how many pounds could be raised 1ft. high by burning a bushel of coal in his boiler, and found that this could be expressed only in millions. Watt's bushel was subsequently changed in this country to 1cwt. (112lb.), and in the United States to 100lb. It has now become practically obsolete, for more effective and more uniform means are adopted to express the relative efficiency of engines.

The term "horse-power" has probably seen its best days. It is gradually being displaced, and with the advent of the metrical system it will disappear. As a scientific term it has been much abused, and as a commercial term it conveys no meaning. Sir Frederick Bramwell wrote, in 1883: "A barrister lately said to the same writer of this report, 'You surely do not mean to tell me that you do not know what a horse-power is—you that have been a mechanical engineer all your life?' The answer given was, 'Indeed I do not, there is a difficulty in the outset; what sort of horse-power do you mean?' 'Why I mean a horse-power.' 'I know you do, but there are five kinds of horse-power.' 'Five kinds! Impossible, it can't be!' 'But there are; I will give you the names and the nature of them: (1) the real horse-power, the power of a horse, estimated to lift 22,000lb. 1ft. high per minute. (2) That which in James Watt's time was called the nominal horse-power, a horse-power of 33,000lb. raised 1ft. high per minute, which power he gave all his early engines, so that the purchaser, having one and a half times the power of a good horse, should not be in a position to complain of the engine as inadequate. This term "nominal" is now commonly confounded with the commercial horse-power, and the name "theoretical horse-power" is substituted to represent that which was received as the scientific horse-power of 33,000 foot-pounds. (3) The gross indicated horse-power. This is the whole power developed on the piston of the engine without any deduction for friction, which power, divided by 33,000, gives the gross indicated horse-power. (4) The net indicated horse-power. This is the same as the foregoing, minus a certain allowance for friction. (5) The commercial, or, as it is now frequently called, the nominal horse-power. This is a horse-power about which no two persons can agree.'" Sir Frederick Bramwell might have added a sixth—viz., electrical horse-power, that which appears in the circuit, or electrical energy.

Is a horse-power really a horse's power? Tredgold made it 27,000 foot-pounds per minute for eight hours. Rennie assumed 22,000 as correct. Beardmore had a horse weighing a little over half a ton which did 39,000 foot-pounds per minute for eight hours a day. Morin made it 26,150 foot-pounds. Two horses will tow a canal-boat at 2½ miles an hour, while a steam-engine of 10 h.p is needed to do the same work by means of a screw. Tramcars are drawn by two horses at a speed which the so-called 25-h.p. motor can scarcely do. The horse is really a more efficient machine for a time than the engine, and its "pull" can be directly applied, but he tires and sickens and dies. He is better adapted to certain kinds of work. He can at times expend much more energy than the so-called horse-power. At other times he is helpless and hopeless. Thus it appears clear that a horse-power is not a horse's power.

The horse-power is based, as I have pointed out, on the British units—pounds, feet, and minutes. Scientific men are now universally using a system of units based on the "centimetre," "gramme," and "second"—hence called the "C.G.S." system, to distinguish it from the "F.P.S.," or British engineers' system. In this system the unit of work—viz., one gramme moved through one centimetre against unit force—is very small, but 10,000,000 of these small units are taken and are called, in honour of our great British experimenter, the "Joule," and become a practical unit of work. Thus Joule's own mechanical equivalent, the work absorbed in raising the temperature of 1lb. of water 1deg. F. at or about its maximum density, indicated in the "F.P.S." system as 778 foot-pounds, is in the "C.G.S." system the work absorbed in raising the temperature of 1 gramme of water 1deg. C., at or about the same maximum density, as 4·2 joules. Thus the joule is to the foot-pound as 1 to 1·356, and the horse-power, instead of being 550 foot-pounds per second, becomes 746 joules per second. The joule per second, or the unit of power, has now been universally called a "watt;" and thus in the new system the rate of doing work—that is, the power developed by the steam-engine, or any other machine, or by any other process, mechanical or physical—is most appropriately indicated in units bearing the name of our great Greenock inventor. The term "watt" was applied in 1883 by the late Sir William Siemens to the joule per second, but I had previously in 1881 at the Paris Congress proposed to apply it to 1,000 joules per second. Siemens's proposal has been preferred, and in consequence the practical unit of power comparable with the horse-power becomes the *kilowatt*. Had my proposal found favour the practical unit of power would have been the watt, and Siemens's unit would have been a milliwatt. I venture to think the acceptance of my unit would have hastened the departure of the term "horse-power." I was surprised and pleased the other day to find in Marseilles that the man directing the electric tramcars in that city corresponding to the driver of the old horse-car, sometimes called in America the motorneer, is called the *wattman*, and I have since learnt that this term is very general in France. I hope our friends in Glasgow who are about to introduce electric traction in their city will follow France's good example and honour one of their greatest mechanical heroes by inaugurating the same name in Great Britain.

Energy, though so protean in its character, retains its joule throughout all its changes. Every joule impressed on the surface of the ocean by the rays of the sun adds to the moisture of some cloud which, condensed into rain by contact with our cool highlands, feeds a river like that which forms the Falls of Foyers. The engineer directs this falling water through the blades of a turbine, and each joule that passes assists in rotating dynamos to excite strong electromagnetic fields and powerful currents of electricity, which in their turn produce light, the intensest heat known, and chemical decomposition. This lump of aluminium, the first produced at Foyers, has been extracted from crude bauxite by the expenditure of about 60 million joules. Thus in every stage of its transformations the joule remains

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the same mechanical unit, whilst the energy that it measures out-proteuses Proteus.

The grand principle of the conservation of energy teaches us that no energy is ever lost. The total energy present assumes a form either useful or useless to man. The skill of the engineer is devoted to render that which is useless useful, and no one has helped him to do this more thoroughly than James Watt. The rapid introduction of electrical energy for electric light, for traction, and for the transmission of the waste powers of nature to distant places is revolutionising our systems of units. The British Association in 1861 formed a committee to consider the question of general electrical measurement, and aided by Wheatstone, Varley, Balfour-Stuart, Siemens, Matthiessen, Clerk Maxwell, Joule, Fleeming Jenkin, who have departed, and Lord Kelvin, who remains as active as ever, they have so impressed the world by their work that, aided by the congresses in Paris in 1881 and 1883, in Chicago in 1893, and in London in 1894, the system proposed has been universally adopted, so that electricians in all parts of the world, whatever their nationality or their language, use the same terms, the same measures, and the same units. The ohm is the unit of the resistance, which has to be overcome in any case of the flow of electrical energy; the volt is the unit of pressure which maintains this energy through this resistance; the ampere, the result of one volt acting through one ohm, is the unit of current; and the coulomb is the unit of that electrical quantity which is being driven. These are electrical units pure and simple; but leading from and associated with them are the mechanical units—the joule and the watt. The watt is universal and exact; the horse-power is not. The latter equals in England 550·00 foot-pounds per second, France 542·47 foot-pounds per second, Germany 582·25 foot-pounds per second. How can one reconcile such discrepancies? Yet the horse-power is maintained in high places with all the fervour and enthusiasm of an old Scotch Covenanter, or the *non-possumus* of a good old English Tory. The foot-pound per second equals 1·356 watt. The horse-power therefore equals 746 watts. The watt equals 0·7373 foot-pound per second. The kilowatt, 1,000 watts, equals 1·34 h.p. If, in order to obtain the value of the power, we divide by 33,000 the ordinary formula, A P S n, where A is the effective area of the piston in square inches, P the mean pressure of the steam in pounds per square inch during one stroke, S the length of this stroke in feet, and n the number of strokes per minute, we get it in horse-power. If we divide it by 44,238 we get it in kilowatts. Horse-powers multiplied by 0·746 are expressed in kilowatts; and kilowatts multiplied by 1·34 are expressed in horse-power. The new system is universally used by electrical engineers. Names, when well selected, secure precision of language; a watt is a watt and nothing else. A pound, on the other hand, may be either a force or a mass or inertia. Names fix ideas. Every electrical workman has a definite and clear conception of an ohm or an ampere. He requires no definition to impress them on his mind. The name alone conveys to him all he wants to know. They become fundamental ideas. There is no ambiguity, hence there is no difficulty either in teaching or in practice. The same benefits would certainly arise if we applied the term kilowatt to the unit of power. No one would have to ask, "What sort of kilowatt do you mean?" The same principle which enabled Watt to examine the interior of his cylinder enables the electrician to examine and record the behaviour of his plant and his circuits.

Power-houses which generate electric currents for supplying electric light or for working trams are generally supplied with recording instruments that tell of the energy expended at each instant of the 24 hours. The engineer has thus before him every moment the history of the whole previous day's work. Here, for instance, is a record of a whole day's work in Rome, and here a record of another day at the General Post Office in London. We are able by means of meters to measure water consumed or gas burnt in our premises. The former is sold by the 1,000 gallons, and the latter by the 1,000 cubic feet. Similarly we measure the electrical energy that is utilised in our houses and factories by the kilowatt-hour—that is, we pay 6d. for every 3,600,000 joules we direct to meet our wants. The custom of paying for power applied is by no means a modern innovation, but it has recently been made legal by the Electric Light Act of 1882. That Act makes legal as a Board of Trade standard or unit a "kilowatt-hour." It is there defined as a thousand volt-amperes per hour—the watt had not then been adopted. Thus the Board of Trade unit becomes a unit of work done, and we are able to sell as a commercial commodity "the work done" by a kilowatt, or, in Watt's language, the work done by 1⅓ h.p. in one hour. Through the kindness of Lord Kelvin I am able to show you many forms of meter, the offshoot of his own genius and his industry. There is no one who has done so much to secure accurate, sensitive, and reliable instruments of precision and of measurement.

Electrical energy is supplied in Glasgow for 6d. per unit, for the kilowatt-hour has not yet received a name. It was proposed to call it the "Kelvin," and a more appropriate name could scarcely be found, for who is more entitled to share the glory of Watt's name than he who has again made the Glasgow University so famous. Lord Kelvin himself objected to its introduction, but in a case of this kind personal wishes scarcely can control the public will, and the necessity for a name is becoming so strong that I shall not be surprised to find electrical energy sold at so much per Kelvin, even though it is measured by a Kelvin meter.

I should have liked very much to have diagonised the causes which have led Scotch universities to dominate so strongly the advances of practical science. The pages of the history of the branch of engineering I have so lightly touched upon teem with the name of Watt, Rankin, Clerk Maxwell, Fleeming Jenkin, and Lord Kelvin—great towers of light that have brightened up and hastened our rapid progress. Why is it thus? Is it that it needs the strong common-sense influence of practice and the wholesome conception of utility so characteristic of the North to be impressed on the abstract views of pure science to secure concrete advantages in its practical applications? Our English universities are in this direction out of the running. They adhere to abstract science. But in Glasgow the doctrine of energy has been crystallised and applied; it is from Glasgow that so much of our engineering knowledge has emanated, it is to Glasgow that we shall continue to look for more light, and it is therefore to Scotland that we must accord all honour.

FORTHCOMING EVENTS.

The following are some of the announcements for forthcoming week:

To-day (Friday).—Royal Institution (Dr. G. Johnstone Stoney on "The Approaching Return of the Great Swarm of November Meteors"), 9 p.m.—Also at Manchester, dinner of the Northern Society of Electrical Engineers.—And at Paris, meeting of the French Civil Engineers.

To-morrow (Saturday).—Royal Institution (Mr. Lord's second lecture on "The Growth of the Mediterranean Route to the East")—Junior Engineers' visit to the Fire Brigade Head-quarters, 3 p.m.

Monday, February 22.—Society of Arts (Mr. Cross's third Cantor lecture on "Cellulose"), John-street, Adelphi, 8 p.m.

Tuesday, February 23—Royal Institution (Prof. A. D. Waller, on "Animal Electricity," sixth lecture), 3 p.m.—Also at Glasgow, meeting of the Scottish Engineers and Shipbuilders, 8 p.m.

Wednesday, February 24.—Society of Arts ("Reproduction of Colour by Photographic Methods," by Sir Henry Trueman Wood, Captain Abney will preside), John-street, Adelphi, 8 p.m.—Westminster Electric Supply Corporation's meeting, Eccleston-place, 11 a.m.—Charing Cross and Strand Company's meeting, Maiden-lane, 12 noon—City of London Company's meeting, Winchester House.—Crystal Palace Wednesday lectures recommence.—Institution of Civil Engineers ("The Main Drainage of London" and "The Purification of the Thames"), 8 p.m.

Thursday, February 25.—Institution of Electrical Engineers, at the Civil Engineers, 8 p.m. ("Electric Interlocking the Block and Mechanical Signals on Railways." Reply of Mr. F. T. Hollins to the discussion, and paper on the "Relative Size, Weight, and Price of Dynamo-Electric Machines, by E. Wilson).—London Chamber of Commerce (Mr. Dowson on the "Metric System"), Botolph House, Eastcheap, 2.30 p.m.—Kensington and Knightsbridge Company's meeting, 1, Great George-street.—Royal Institution (Dr. J. W. Gregory, on "The Problems of Arctic Geology. Lecture III.), 3 p.m.—Society of Arts (Prof. Ewing on "The Production of Cold," fifth lecture).

Friday, February 26.—Physical Society, Burlington House, 5 p.m. ("Photography of Ripples," by J. A. Vincent").—Henley's Telegraph Company's meeting.—Electro-Harmonic Society's concert (ladies' night).—Royal Institution (Lieut.-Col. C. R. Conder on "Palestine Exploration"), 9 p.m.

Saturday, February 27.—Royal Institution (Mr. Lord's third lecture).

The Chapsal Brake.—The Chemin de Fer de l'Ouest Company have been experimenting with the Chapsal electric air brake between Paris and Mantes. The brake, which has been already described in these notes, is designed to obviate the troubles which arise when it is attempted to apply without modification the ordinary air or vacuum continuous brake to goods trains, owing to the time the impulse takes to travel along the train. In the Chapsal brake an electrical apparatus starts the braking pistons simultaneously, and therefore there is in no case undue tension or compression between various sections of the train. One of its advantages is that it can be easily applied to the existing Westinghouse brakes.

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THE

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TO CORRESPONDENTS.

All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notice of Meetings, Issue of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

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Vol. XVIII. of new series of "THE ELECTRICAL ENGINEER" can be had bound in blue cloth, gilt lettered, price 8s. 6d. Subscribers can have their own copies bound for 2s. 6d., or covers for binding can be obtained, price 2s.

A STRAIGHT TALK.

No doubt many of our readers have received through the medium of the Post Office a copy of an excellent paper in its own way, entitled *Transport*. The particular copy of the paper to which we refer contains an article upon an arc lamp of, we fancy, French introduction. We have purposely not read the description given of the lamp, because whether it be good, bad, or indifferent, and whether the lamp itself be likewise, has no bearing upon our argument. In the *Financial News* of February 9 a list of joint-stock companies registered at Somerset House during January is given. This list occupies three columns of the paper, and the total capital asked for amounts to some few millions of pounds. It is not our place to preach to the investing community about company-mongering in general, but it is our duty to point out what we deem wrong methods of exploitation when the companies are of an electrical character. What would be the value of an article on Greek accents in a sporting paper, or upon strain in bull-pups in a religious paper? We opine that the direct value would be nothing, because every expert reader would ask, What on earth do these people know about this matter? The indirect value to a person who wanted to sell bull-pups of the particular breed recommended might, however, be appraised at a high figure. The breed at any rate would have respectability to commend it, and the seller would make much of his chance. All this is conceivable, and the whole may be done with innocent intentions all round. We ask somewhat similar questions with regard to descriptions of electrical apparatus in non-technical papers. Why are such descriptions given? Are they intended to bring buyers, or is it intended to form a company in the future and use extracts from such descriptions upon the prospectus? If the latter is the case, it is an attempt to influence the public in an unfair manner. If the former is the case, can anything different be said? A description by inexpert writers must necessarily be a description as told without expert sifting, and we never yet knew an inventor or promoter who did not describe his own baby as the best that had ever been put before the public. With regard to the specific case mentioned, we must be careful again to state that we have no knowledge as to the value of the lamp described. So far as we know or care for present purposes, it may be the best in existence; or, on the other hand, it may be the worst. Our text is, that if such things are to be brought before the notice of the public, and it is desired that a more or less critical opinion as to the merits of the thing should be given, the proper method to do this is by the aid of the technical Press, and not by other sources.

THE MUNICIPAL ELECTRICAL ASSOCIATION.

We have received the first volume of *Proceedings* issued by the above society, containing the papers read at the 1896 meeting. The volume, containing some one hundred and twenty-eight pages, is a creditable production for the first year of a young association. The subject-matter of the papers was

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fully treated in our columns in June last, when we were the first to publish a report of the discussions. Several of the papers are well worthy of the subjects they treat of, and add considerably to previous knowledge. Others, again, form bare pegs on which interesting discussions were hung. In this respect we are sure the association will not offend again, but that with better organisation it will be able to secure contributions up to the standard of those contributed by Mr. Arthur Wright, Mr. A. H. Gibbings, and Mr. A. B. Mountain to the last year's meeting. The discussions will lose nothing of their present value from the fact that they are preceded by more carefully prepared papers. We think, however, that in their future volumes the editing committee will do well to omit such punctuation as "cheers" and "applause" from the report of their discussions. From the list of members we see that even now a majority of the municipal electrical engineers have joined the association, and that the assistants are joining in fair numbers as associates. A goodly number of the electrical committees have also become members, as arranged by the articles of association, and send their chairmen to represent them at the meetings. Those who read the account of the recent discussion on the insurance question will remember that the non-technical members added largely to the value of the discussion on that subject. We wish the association every success, and trust that the meeting this year will show that it is already recognised as a power in advancing the standing of the profession.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

RADIATION.

SIR,—May I offer my hearty congratulations to Mr. C. M. Dorman on the able and well-thought-out presidential address he delivered to the Northern Society of Electrical Engineers? May I also say that I appreciate the address, both as showing the bent of the minds of thinking men, and also as showing the kind of engineers and manufacturers the modern educational mill is turning out? I do not refer, of course, to the primary educational system, or the intermediate, or the technical, but to the education which each engineer and manufacturer is giving himself by reading and thinking. Contrast the modern engineer with the practical man of 25 or 30 years since.

I am pleased also to find that Mr. Dorman endorses the views I ventured to express in your columns some few years since as to what electricity is. It may be remembered that after the first few articles on the subject that you were good enough to print, I was solemnly warned in various quarters that I was meddling in matters I had no business to. Now, it appears Prof. Bose has placed the electric wave in the very position I assigned to it, below the infra-red. I should like to point out, however, that what Prof. Hertz and Prof. Bose have measured are electromagnetic—that is to say, induced—waves, and that, unless we are agreed that, as I suppose, the two are really the same in form, though not in degree, just as the waves of red and yellow light are, the electric wave that traverses a conductor has still to be deal with. Further, I note that Mr. Dorman puts the X-rays beyond the ultra-violet. It appears to me that these also must be below the infra-red, inasmuch as they emanate from the same source and in much the same manner as the waves measured by Hertz and Bose, and are shortened on passing through particular substances, such as platino-cyanide of barium, till they come within the range of vision.—Yours, etc.,

SYDNEY F. WALKER.

Cardiff Electrical Works, Severn-road, Cardiff.

THE LUNDELL MOTOR.

As we have previously mentioned in our columns, Messrs. J. H. Holmes and Co. have purchased from Mr. Robert Lundell the patent rights of his motors in this country. As the firm have also removed their London offices from Coleman-street to 17, Soho-square, W., they commemorated the double event by a reception yesterday afternoon. The formal invitation announced the fact that Mr. Lundell would be present, and we, as representing those electrical men not able to be present, were asked to attend one hour before the general company. In this way we were able to cross-question the inventor on the general characteristics of his designs of motors, which we believe will find favour in this country. The inventor explained to us the reasons of certain features in his design, which we are reluctantly compelled to hold over till our next issue owing to the fact that illustrations are required. The performance of these motors may be gathered from the following few examples. Thus a motor giving ¼ b.h.p. has a guaranteed commercial efficiency of 65 per cent. These motors work at any voltage, even up to the high pressure of 220 volts. Again, in the 5-b.h.p. size an efficiency of 82 per cent. is guaranteed. We may also mention that the 1-h.p. motor only weighs 135lb. with all fittings. Messrs. J. H. Holmes and Co. are taking the manufacture of these motors up most energetically, and are building a new shop 150ft. long and 70ft. broad, adjoining their present large factory in Newcastle-on-Tyne, to be devoted entirely to this new branch. We understand that these small motors have created a trade in America such that some 6,000 have to be provided for the spring demand. Messrs. Holmes and Co. will be supplying English-made motors of this type in the course of the summer. A large number of prominent electrical engineers were present, and assisted to christen the new and convenient suite of offices.

A CONVECTION-SCOPE AND CALORIMETER.*

BY ALFRED R. BENNETT, M.I.E.E.

There is an especial propriety in bringing my paper on this subject before the Manchester Literary and Philosophical Society, for in 1863 your great townsman, Joule, made a communication (reported in volume III. of your *Proceedings*) on a thermoscope, which, so far as I am aware, is the only instrument which can in any sense be regarded as a forerunner of the one to be described to-night. Joule's apparatus consisted of a glass tube 2ft. long and 4in. in diameter, divided longitudinally into two compartments, but having openings about 1in. wide at top and bottom. When either face of the instrument was exposed to a greater heat than the other a convection current started, flowing from the warmer to the colder division at the top and from the colder to the warmer at the bottom, a magnetised needle suspended by a silk thread in the upper opening serving by its deflections over a scale to indicate the difference of pressure existing between the two columns of air. With this thermoscope Joule was able to detect convective effects due to the heat of moonlight.

Although in no way suggested by Joule's instrument, with which I was unacquainted until quite recently, my own depends on the phenomenon of current convection generated in a confined area by the action of unequally heated surfaces. Instead of a suspended needle, my index consists of a light fan or vane, accurately poised, which is caused to rotate by the convective currents in such a way as to afford a measure of the heat employed.

The principle of my instrument will be clearly understood from Fig. 1, in which A is a metal funnel or chimney surmounting a glass or mica tube, open at the bottom, within which is pivoted an aluminium fan, E. The whole is covered by a glass or mica shade, G.

* Paper read before the Manchester Literary and Philosophical Society, January 26, 1897.

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Another form of motor is shown in Fig. 2, where E is a vane with vertical blades, pivoted, like the other, in a transparent screen, which is surmounted by a metallic chimney, A. In this case the air enters by a vertical opening, O, in the side of the screen and impinges on the vane, afterwards assuming a rotary motion in ascending the funnel. G is a glass shade, as before, covering the whole.

When such an instrument—which I have named a "convection mill"—is placed in the open air or in a room near a window, the radiant heat of the sun if it is shining, or otherwise the diffused radiant heat of daylight, will pass through the shade as through the glass of a greenhouse, and warm the fan, its supports, and the walls of the chimney. On these surfaces the high-temperature solar rays are degraded into obscure radiations which are unable to escape through the glass shade, so that the motor can can only cool by conduction through its base and by

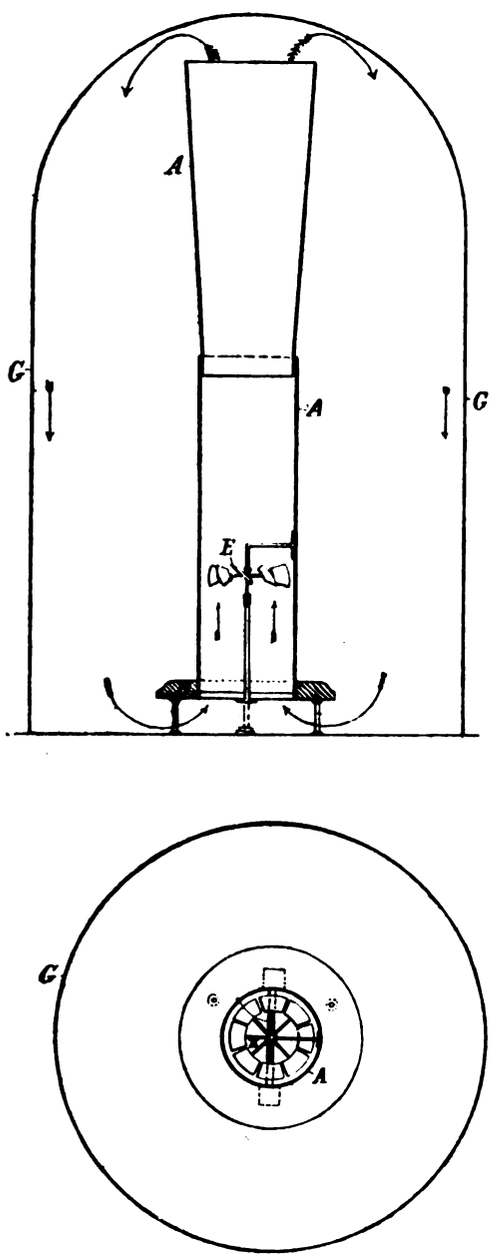

FIG. 1

the aid of convection currents, for direct molecular conduction through the gas may be neglected. On exposure to daylight, the air in contact with the motor surfaces becomes expanded, ascends, issues from the top of the chimney, and strikes against the glass, which absorbs and radiates outwards the excess of heat brought from the warmed surfaces by the air. Cooled and condensed, this sinks to the bottom of the shade, whence it is once more drawn into the tube and heated by contact with the fan and chimney surfaces, a cycle of operations which is indefinitely repeated. A column of warmed air is thus continually rising through the chimney and a cascade of cooled air falling down the walls of the shade, as indicated by the arrows in the diagrams.

The fan, when well made and well balanced, will usually rotate all day in the open air whatever the weather conditions may be. It is affected by variations in the barometrical pressure, and the speed of rotation depends on the difference of temperature existing between the motor surfaces and the glass shade, the height of the barometer, and the condition of the sky. A clear sky which permits of free radiation from the shade, together with a high barometer, induces the maximum speed of rotation, which, with a 3in. fan, may be put at 160 revolutions per minute. In gloomy weather, when the radiation from the shade is intercepted by clouds, the difference of temperature between the motor surfaces and the glass is much reduced, and the speed of rotation falls off; but since April last, when the instrument was devised, it has never, except on one occasion, to which I shall refer later, entirely stopped during the hours of daylight.

In wet weather, motion ordinarily ceases at sunset; in gloomy weather, if the barometer be high, it will sometimes continue for several hours thereafter; but with fine weather and a clear sky it frequently persists all night. If the instrument

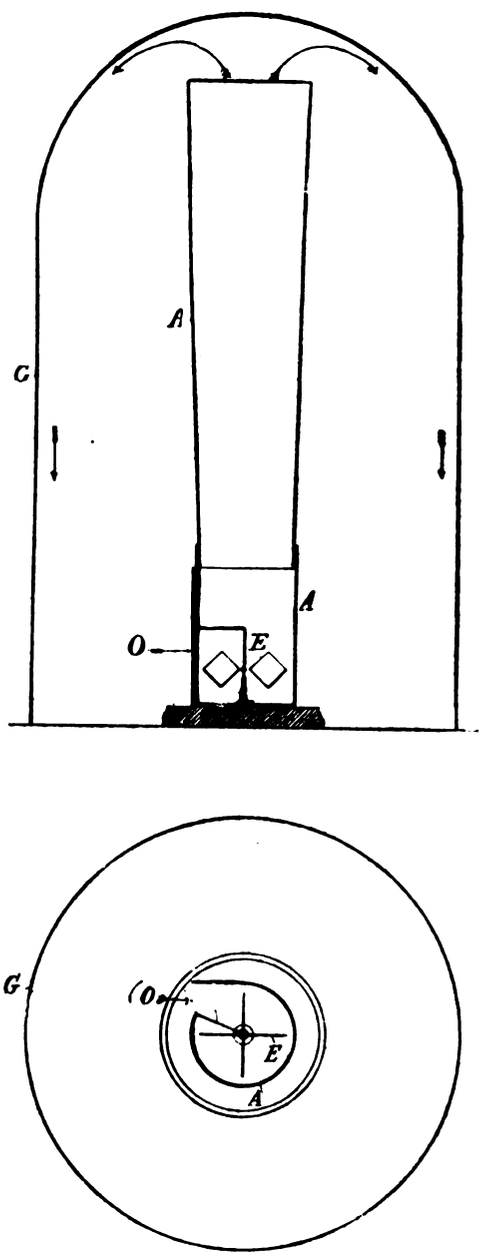

FIG. 2.

has stopped about sunset owing to unfavourable conditions, it will recommence rotation should the sky become clear at any time during the night. The cause of rotation after sunset, when there is no longer any radiant heat to warm the motor surfaces, is chiefly due simply to a continuous fall in the outside temperature. However low this may sink during the night, the motor surfaces will always remain a little warmer than the shade, for they can only lose heat by convection and must follow the shade in its descent at a distance without ever being quite able to catch it. In August last, on many occasions—but neither before nor since—the vanes stopped and then reversed the direction of rotation, showing that air was falling down the chimney and ascending by the shade walls. These reversals, which never lasted long and were always coincident with the passage of clouds over a previously clear sky, were perhaps due to a sudden check being imposed on a rapid cooling of the motor surfaces, which resulted in heat already

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abstracted from the surfaces by the moving air being retained by the glass owing to the interception of radiation skywards, with the consequence that the glass temporarily became warmer than the motor and returned to it by convection some of its abstracted heat. But more prolonged observation is necessary in order that all the phenomena noted in connection with the instrument may be fully understood. For instance, this reversing occurred more than once when the sky continued quite clear overhead, but banks of heavy clouds were just becoming visible on the horizon, miles away. Again, under a clear sky, rotation often continues in a forward direction when thermometers indicate a lower temperature inside the motor than outside the shade. Moonlight appears to assist rotation, as the speed has been noticed to decrease on a bright moon becoming obscured by trees or buildings, the sky meanwhile remaining clear; this is confirmatory of Joule's results. Occasionally, on a fine night, a sudden increase of speed has been observed to occur in several instruments working side by side, and the tops of the shades have simultaneously become wet with dew. The instrument is therefore capable of marking the dew point. The coolness of the shade had induced condensation of water vapour, but the radiating power of the glass, instead of being temporarily reduced by the consequent liberation of latent heat, had apparently been markedly increased.

Thus dewy nights, notwithstanding the liberation of latent heat by condensation of water vapour, are favourable to rotation.

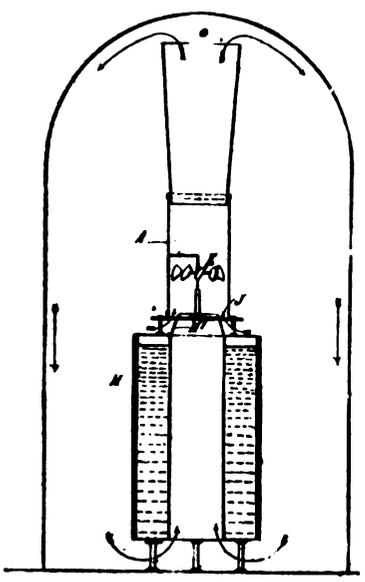

FIG. 3.

The instruments also usually work well when the shades are wet with rain, partially buried in snow, or coated with ice. Under such circumstances the glass disregards a cloudy sky, since it can radiate freely to its snowy or icy covering. A complete coating of ice does not interfere in the least with the activity of the vane—rather the reverse—since the radiant heat warms the motor surfaces through the ice and the latter constitutes a very efficient condenser for the glass. Nothing brings the exquisite sensitiveness of the instrument so forcibly to the mind as having to scrape a window in a thick coating of ice before a view can be obtained of the vane merrily rotating within. The instrument will even work at night during severe frost provided the sky be clear.

Two thick fogs have occurred in the district in which I live this winter. During the first the instruments continued in motion, making from 17 to 20 revolutions per minute; during the second they were all stopped, even at mid-day. Possibly the sky was partially clear on the first occasion and overcast on the second, although equally invisible on both.

Water, and even a saturated solution of alum, when used in a double glass shade having walls ½in. apart, so as to entirely cover the instrument, are incompetent to reduce the heating effect on the motor surfaces of sunlight or daylight. The speed continues as rapid as under a simple glass shade. But if the double shade be filled with solutions of aniline violet, blue, or green, the powerful influence of colour absorption is at once demonstrated by a reduction of speed to nearly one-half.

Seeing that the action of the convection mill in its simple form is so nearly continuous, I shall now briefly touch on two systems of automatic heat storage by which I have endeavoured to bridge over the intervals due to cloudy weather.

The most simple storage arrangement is shown in section in Fig. 3, and consists of a funnel with a double skin forming an annular watertight vessel, H, traversed by a tube. This funnel, the outside and ends of which are covered with non-conducting material, after having been filled with water, is placed either above or below the cylinder, A, containing the fan, in such a way that the air passing through the motor must pass, at least in part, through the tubular vessel also. During the day the liquid gradually attains a temperature a little above that of the shade, and as water possesses a high specific heat, and can only part with its heat by convection to the inner skin of the annular vessel, it cools but very slowly, and frequently retains a higher temperature than the outer air all night. It consequently gives off heat to the air in the tube, which, expanding, rises and keeps the fan moving briskly even during a cloudy night. An annular air-space, J, is shown between the storage vessel and the motor. This promotes rapid rotation during the early part of the day, when the water in the vessel, by reason of the heat it has lost during the night, is cooler than the outside atmosphere. Were the motor fixed directly on the storage vessel, it would have to pull all its air through the tube against the opposing influence of the cold water. The opening enables it to draw at least a portion of its air supply by a short or shunt circuit directly from the shade. This storage arrangement greatly extends the period of rotation.

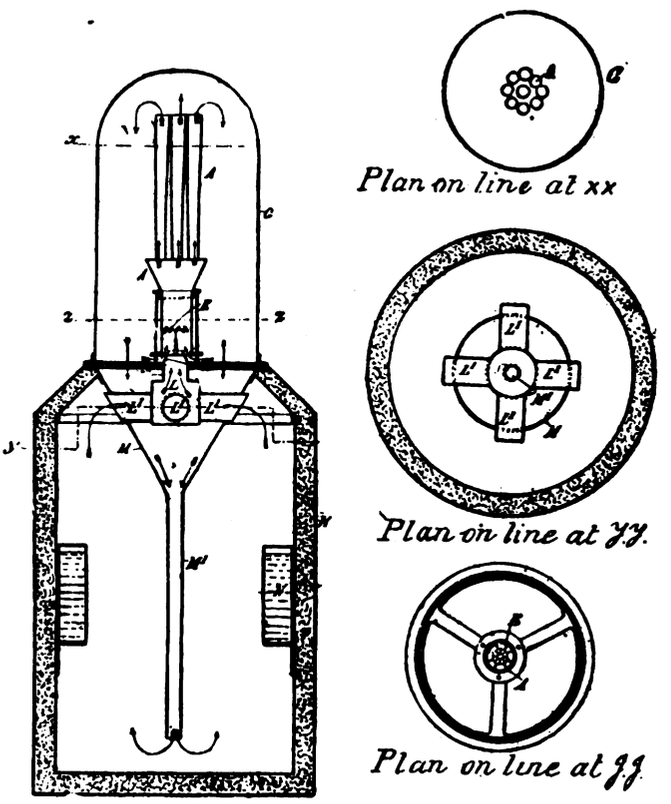

FIG. 4.

A more efficient, if more elaborate, storage system is shown in Fig. 4. It consists of a motor and shade mounted on a metal drum, or tank, K, which is covered with asbestos cloth, or packed in straw or sawdust, to prevent loss of heat by radiation. Air which has been cooled by contact with the glass shade is forced by the guiding cone, M, and pipe, M^1, to descend to nearly the bottom of the tank. It afterwards finds its way upwards by the channels, L^1 and L, to the base of the motor, when it is drawn in, heated, and caused to ascend through the chimney, A, which in this instance is divided into several small tubes for the purpose of affording greater heating surface, to the glass shade, G, where it is again cooled and sent to the bottom of the reservoir. This cycle of operations being constantly repeated during the day, the circulating air stores heat in the walls of the tank and in any vessels of liquid, N N, or other substances that may be placed therein. This heat it can only lose, as it gained it, through the glass shade, so that when on the approach of night the temperature of the motor surfaces falls below that of the reservoir the latter yields heat to its contained air, which expands and rises *vid* L^1 and L, through the motor and chimneys to the glass shade, turning the fan in its passage. Being cooled by the shade, the air drops once more through M and M^1 to the bottom of the tank, where it receives fresh heat from the walls, and ascends anew. Soon after sunrise the motor surfaces, becoming by radiation from outside hotter than the reservoir, resume the driving function, and heat is again stored. This transfer of the seat of motive power from the motor to the reservoir and *vice versâ* is accomplished without any intermission in the rotation of the fan.

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The first instrument constructed in accordance with Fig. 4 ran night and day during May, June, and July of the past exceptionally fine summer without stopping of its own accord. It paused twice or thrice for short periods during August and September, and has done so more frequently since, for the night temperatures under the influence of cloudy skies and changes of wind have often been as high as those of the day, and so afforded the storage cell no opportunity of parting with its heat. In a finer climate, as that of Egypt, where clear nights succeeding warm days are the rule and not the exception, such a storage instrument would undoubtedly continue in incessant motion for very long periods.

(To be continued.)

INSTITUTION OF ELECTRICAL ENGINEERS, Jan. 28.

Sir HENRY MANCE (president) in the chair.

ELECTRIC INTERLOCKING.

After Mr. Hollins's paper,

The **Chairman** (Sir Henry Mance), in opening the discussion, said it was important for the Institution to have such papers as the one Mr. Hollins had given them then, as it brought them thoroughly up to date. He (the Chairman), in the sixties, when the Clayton tunnel disaster occurred, brought before the London, Brighton, and South Coast Railway directors a system of interlocked signalling which included a rail contact. He had no idea, then, nor, indeed, up to seeing Mr. Hollins's paper, that even so far back as that the invention had been anticipated.

Mr. Wyles, in his speech, dealt mainly with the practice on the London and South Western Railway. He saw from the appendix to the paper, which would be useful for reference, that the South-Western stood first as regards the number of levers interlocked. On that line they did not use insulated rails At Waterloo they had a series of fouling bars and a double system of signalling in. In a climate like that of England the insulation resistance of the rail circuits must be exceedingly low. As to single lines, the interlocking of signals used with the Tyer tablets was of very recent date. About four years ago his company tried it at Farnham. It had proved thoroughly satisfactory, and all the tablet-worked stations were served so. It could be applied to any tablet system, but the details sometimes required some little thought. As to Sykes's system generally, the plans adopted by the Great Eastern Railway, the London and South-Western Railway, and the South-Eastern Railway were very much the same. The London, Chatham, and Dover had a slightly simpler system. The South-Western system was practically that of the Great Eastern, only they retained the old Preece signs. Applied to the Sykes's interlocking, these gave an extremely simple instrument which worked well. The paragraph about lightning was open to criticism. He did not know that the lightning discharge was always positive, and if it were so, it might strike a neighbouring wire and produce an induction current, which would be negative. But he did know that there had been no case in which the Sykes's instruments had been affected in this way. Fouling bars were useful and necessary in stations where trains were divided in order to ensure that the plunger should not be used until both portions of the train had gone from the station. With regard to signal reversers, it was now about six or seven years since Mr. Sykes's original pattern, which was technically known as the "mousetrap," was invented one Sunday in a box at Waterloo. It took a great many cells to work it. The next pattern was known as the "banjo," and the number of cells came down to about four. It now worked with two. Mr. Hollins claimed the back lock as peculiar to the Great Eastern, but it really was an integral part of the Sykes system.

Before the discussion was adjourned **Mr. Langdon** suggested that, as reference had been made to other systems, the gentlemen whose systems had been referred to should be at liberty to bring down models or diagrams to be placed before the meeting.

The **Chairman** considered it an excellent suggestion, and the discussion was adjourned to February 11.

FEB. 11.

Sir H. MANCE in the chair.

There was little other business besides the ballot list, which we gave last week, and the meeting proceeded at once to resume the discussion on Mr. Hollins's paper.

Major Marindin sent a letter, which was read by the **Secretary**. He (Major Marindin) had intended to be present, but, unfortunately, it was necessary for him to go Manchester for an enquiry. He hoped Lieutenant-Colonel Addison would be able to attend, as his views would be of more value than his (Major Marindin's) own. As to lock-and-block working it was a thing which the inspecting officers of the Board of Trade had long advocated. It would be difficult to exaggerate its advantages in obviating a signalman's mistake, such as he understood had led to a very serious collision at Stockport a few days ago. Without minimising what had been done, they would very much prefer to see the system introduced in its entirety, and the treadles applied to sidings and cross-over roads as well as to through working.

Mr. W. E. Langdon (Midland Railway) congratulated Mr. Hollins on his paper. It was not the first time the subject had been brought before the Institution. In the session of 1872-3, there were three important papers relating to it read by Mr. Preece, Major Mallett, of the India Service, and Mr. Alexander Siemens. Mr. Tyer took out his patent in 1869, which the speaker believed was not introduced into practice, and therefore he thought he might claim for Mr. Preece and himself the first practical system of interlocking, the date of which was 1870. It locked the home signal—as they had not starting signals in those days—and the first signal so fitted was at Southampton. The transfer of the telegraphs to the Government in 1870 took him away from that line of work. But in 1878, when he was again associated with railways, he applied his attention to the system which is now at work on the Midland Railway. He considered it a point of great importance that the system introduced should be one which could be applied to the already existing form of block instruments without causing any change in the manner of working them. It was, indeed, highly undesirable that the signalman should be asked to learn a new instrument. The matter could not be made too simple. All that was really necessary was that when a train had, by entering the section, placed the signal at danger, it should not be possible for the signalman to remove that signal until the train was clear of the section. [Mr. Langdon then described his instruments with the aid of large wall drawings and working specimens on the table. It would be hopeless, short of a column or so of detailed description, illustrated with drawings of the parts, to show the exact points in which it differed from those in use or proposed for use on other railways, and a similar remark may be understood in reference to the models shown and described by other speakers.] In reference to the hydrostatic contact-maker of Messrs. Siemens, the two claws were only about 20in. apart, and it seemed wonderful how they could get sufficient rail deflection within that limit to produce the required contact. As a matter of fact, with 85lb. rails they had not had the slightest difficulty. Now that they were going to 100lb. rails he almost anticipated that there would be some. He was inclined to think that it was a wave motion passing along the rail which was effective in always securing the contact. Besides the three principal systems in use—those of Mr. Sykes, Mr. Spagnoletti, and himself—Messrs. Saxby and Farmer gave attention to the matter in 1872. Their system was by no means a bad one, and he did not know why they had dropped out. From Mr. Hollins's list it appeared that there were about 800 miles of line protected by interlocking, but that, though a good start, was a small proportion of the total railway mileage of the United Kingdom. There was no doubt that what had been referred to by Major Marindin would draw considerable attention to the question. The present systems were not all that could be desired, in that it was the first vehicle instead of the last which gave the signal. Passenger trains were not likely to become divided, but goods trains might, and would be in that case quite as dangerous as a passenger train. There might be some difficulty in arranging that the last vehicle should give the signal, but if it was understood that it was a desirable thing to do, and inventors' attention was called to it, no doubt eventually a satisfactory result would be obtained. He could not conclude without referring to the admirable way in which railway signalmen did their really responsible work.

Lieutenant-Colonel Addison said interlocking systems had now passed beyond the merely experimental stage, and could no longer be regarded as fads of electricians or timid Board of Trade inspecting officers. They did not want automatic signals. The signalman should be left responsible for the signals, but the train should watch over him and put back the signal if he omitted to do it. Many objections raised in various quarters—for instance, that the system destroyed the intelligence of the signalman—really applied to all block working. Again, though it would be desirable to have the system applied to shunting work and cross-over roads, if they were always to wait for absolute perfection there would be no progress. He agreed that it was a serious matter to change a type of instrument to which men have been accustomed for many years, and the adoption of some of the interlocking systems would mean a considerable expense to those lines which used single-wire block working; but he believed that if any company attached importance to retaining the single-wire block, Mr. Sykes was almost ready to oblige then with a system adapted to it. Many people were afraid of the treadle, and thought it unreliable and difficult to maintain. He would not like to say that improvement was not desirable, but he thought that those who had used the Sykes treadle most would be inclined to condemn it least. One system which was used on the Lanarkshire and Dumbartonshire lines of the Caledonian had not been referred to. It was practically the Sykes treadle with a rubbing contact. As to arrangements for cancelling trains, some means of resetting the block instruments were necessary, but to enable one signalman only to release the instruments with a key was to do away with the real safety of the block. Mr. Hollins had a way of avoiding that without much additional expense, which certainly deserved trial. It was for the interests of the companies to adopt and extend the interlocking, and it was the highest praise of the signalmen that they had done their work so well on the whole that there had been no outcry to put pressure on the companies to do it.

Mr. C. E P. Spagnoletti regretted that he could not agree with everything in the paper of his friend Mr. Hollins. Such papers had a threefold value: for reference; for the guidance of the members; for the enlightenment of posterity. It was therefore necessary that they should be not only accurate, but contain full information. Mr. Hollins had described at length the system he had recommended his own company to adopt, and had named two or three other systems. The descriptions of these were meagre

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and occasionally not quite correct, and consequently they were placed in a position of disadvantage. He (Mr. Spagnoletti) would like to remark that his system provided without difficulty for sidings and cross-overs and shunting, and protected the train while it was on the wrong line. He had shown it to a Board of Trade inspector, who was kind enough to say that it went further in that respect than any other. Mr. Spagnoletti quoted the authority of the late Sir Daniel Gooch that it was inadvisable to take the work out of the hands of the signalman. Mr Spagnoletti claimed as his own the design of instrument in which colours were used to assimilate with the lamps, and said that the *crux* of the whole question lay in the treadle. He had had a great deal of trouble in getting treadles adopted. He had tried about 50, and had got one at last which worked without giving any trouble. With between 250 and 300 treadles at work on the Metropolitan Railway under the disadvantages of tunnel working, they got about 1·3 per cent. of treadle errors, or, if they counted by trains passing, about one in a million of actions failed. He would be glad to know some of Mr. Hollins's reasons for keeping the indicating instrument in the line circuit. On the grounds of simplicity and of possible battery failure or current leakage, he held the opposite view. The advantage of his (Mr. Spagnoletti's) form of instrument was that it could be placed anywhere. With a mechanical system the instrument must be just over the lever. His system was adaptable to single lines as well as double ones.

Mr. W. H. Wilson demonstrated with models on the table the interlocking system invented by his brother, which is largely used on both single and double lines in India, New Zealand, the Argentine Republic, and Australia. It was a single-wire system without any great complications.

Mr. Ireland (Great Northern Railway) referred to matters already dealt with by other speakers as to adapting interlocking to the single-needle block instruments. With regard to the electrical interlocking at King's Cross, which had been described by Mr. Hollins as "interesting," he (Mr. Ireland) was happy to say it was also useful. He believed that the interlocking at King's Cross was unique. It provided for shunting, and had enabled them to dispense with two blocks. Mr. Ireland also described the method of rail insulation adopted, and handed in a model. At the end of the insulated section the usual fishplate was dispensed with and vulcanised fibre used at the break between the rails, the ends of the rails being supported on separate chairs. The insulation resistance varied from 0·8 to 2·0 ohms, according to weather and circumstances.

Mr. Shoolbred referred to Anderson's system of interlocking, the author of which was now Sir William Anderson, the Director-General of the Ordnance Factory. Other inventors would do well to consult some of the original arrangements. He (Mr. Shoolbred) did not think they would get a solution until, as time went on, they got electrical transmission of power into their goods yards, and were able to use large currents and use large masses of iron in their apparatus.

Major-General Webber referred to the great accuracy with which signalling operations were done and the high degree of safety in train running attained in this country. When he was in an express train he did not usually meditate on the fact that his whole safety, as Mr. Hollins put it, depended upon either two treadles and one man, or two men and one treadle—he did not quite remember which combination it was. A man might be overworked, and as for a treadle, Mr. Spagnoletti had told them he had tried 50 treadles before he found a really satisfactory one. It was dreadful to imagine what those other 49 treadles might have been doing. Many ingenious systems of insulation had been devised for track circuits, under which signalling was possible to the moving train. That was in France, but he believed that track circuits were now little used there. He would like to know if anyone could tell him if they were still in use in America. In reference to what Mr. Shoolbred had said as to strong currents, they had already available Mr. Siemens's strong magneto pull signaller, if anything of the kind was really wanted. It had, however, not come into use.

Mr. Goodenough (Great Western Railway) sent a communication, which was read by **Mr. Gray**. He regretted that, owing to illness, he could not be present. He did not think finality could be regarded as being reached until it was brought about that the starting signal remained locked until the section was clear. This meant using the line as a conductor and the abandonment of the treadle. He approved of mercury contacts as at present those least likely to fail, but it was possible that they might be made too sensitive. He was interested in the tablet and train staff systems, as his company had so much single line. What was wanted was to protect the train, if, as occasionally had occurred, it left the station without the driver having any staff or tablet.

The **Secretary** announced that some further communications had been received, but time would not allow of their being read that evening. (The names of the authors were not mentioned.)

Mr. P. W. MacMahon said that at the City and South London terminus at Stockwell, out of thousands of movements per day they had very few failures. In their case, the last vehicle did the work. The essential part of the apparatus was a strip of brass at the side of the tunnel worked by a brush attached to the bogie of the coach.

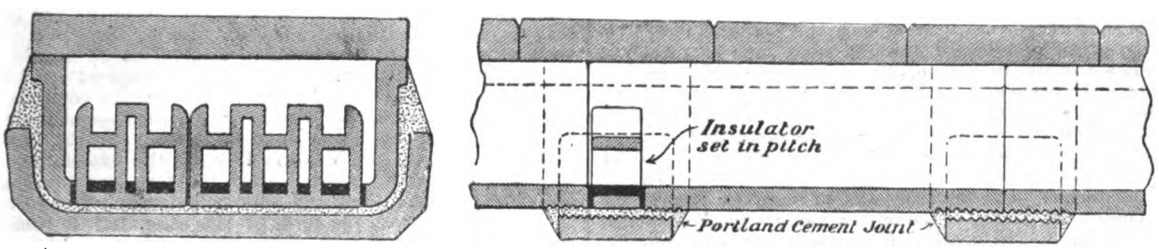
Mr. R. W. Weekes remarked that all the apparatus they had heard spoken of that evening were to help the signalman to do his part of the work correctly, but there was nothing at all to prevent the engine-driver over-running signals set against him. In the future, when their trains were electrically driven, it would be one of the incidental advantages that a means of doing this most effectually would be provided by sectionising the conductor, so that if a train ran past signals at danger the current was cut off.

The **President** said that, as it was past the usual hour for finishing the meeting, Mr. Hollins's reply must be adjourned until February 25. The paper announced for that date, which will presumably follow immediately, is by Mr. E. Wilson on the subject of the relative size, weight, and price of dynamo-electric machines.

The discussion was adjourned accordingly.

STONEWARE CULVERTS.

The accompanying drawing illustrates a new type of culvert for bare copper mains designed by Mr. T. H. Tonge, the engineer to the National Electric Supply Company, of Preston, in conjunction with Doulton and Co., of Lambeth, which has recently been adopted for an extension of mains at Preston. Hitherto such mains have been in nearly all cases laid in culverts constructed *in situ* of concrete or brickwork, or in iron culverts. Iron culverts can be rapidly laid, but they are costly, and their use is attended with risk of short-circuits, while the construction of concrete or brick culverts is a slow process, and one which is objectionable, owing to the length of time during which the ground must be kept open. The culvert used at Preston is constructed of sections of strong glazed stoneware 2ft. long, which are bedded in Portland cement on stoneware cradles at the joints. Every third section of culvert is made with a recess for the reception of an insulator, which is secured with pitch. The insulators are of glazed vitrified stoneware of the pattern used by Prof. Kennedy, and supplied by Doulton and Co. for the electric lighting schemes at Aberdeen, Oldham, Belfast, Edinburgh, and Sunderland. Prof. Kennedy's system of laying the copper strips on the flat in slots in the insulators has been adopted at Preston. This system permits of the section of copper in each slot being increased to one square inch by drawing in extra strips after the culvert has been laid. The culvert is covered with flags set in cement. Beneath the culvert a 3in. stoneware pipe has been laid to receive pilot wires, etc. The cost of laying the culvert was carefully noted, and it was found to compare favourably with that of concrete, and further, the ground was kept open not more than about half the time that would have been necessary had concrete been used.



PHYSICAL SOCIETY.—Feb. 12.

The chair was taken by **Captain Abney**, who, as retiring president, referred to some of the changes which had occurred in the society during the past year. The annual subscription had been raised, but a satisfactory number of new Fellows had been enrolled. The society had lost two by death. A good deal of work had been done in the direction suggested by the discoveries of Dr. Röntgen.

The **Treasurer** (Dr. Atkinson) then presented his report and balance-sheet for the year 1896. There was evidence of improvement in the financial position, but there was still a deficiency to be met. Profits from sales of publications had been small; it was desirable to reduce the price of the volumes of collected papers of Joule and Wheatstone, and to call the attention of the physicists to these valuable records of classical work.

Mr. Walker suggested that physical laboratories, especially those in London, should be visited by Fellows of the society with a view to comparing notes as to the construction of apparatus. Professors of colleges and other institutions should be invited to appoint visiting days for this purpose.

Votes of thanks were passed to the retiring president, council, and officers, and also to the council of the Chemical Society for the use of their rooms at Burlington House.

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In replying, **Captain Abney** said that the coming year would probably bring about further improvements in the system of abstracting and indexing by co operation with other societies at home and abroad. He then read the list of council and officers for the year 1897 8: President—Mr Shelford Bidwell, M.A., LL.B., F.R.S; vice-presidents who have filled the office of president—Dr. Gladstone, Prof. G. C Foster. Prof. Adams, Lord Kelvin, Prof. Clifton, Prof. Reinold, Prof. Ayrton, Prof. FitzGerald, Prof. Rücker, Captain Abney; vice-presidents—Major-General E. R. Festing, L. Fletcher, Prof. Perry G. Johnstone Stoney; secretaries—T. H. Blakesley, H. M. Elder; foreign secretary (new office)—Prof. S. P. Thompson; treasurer, Dr. Atkinson; librarian, C. Vernon Boys; other members of council—Walter Baily, L. Clark A. H. Fison, Prof. Fleming, R. T. Glazebrook Prof. A. Gray, G. Griffith, Prof Minchin, Prof. Ramsay, J. Walker. The newly-elected president, Mr. Shelford Bidwell, then took the chair, and an ordinary meeting was held.

Mr. Blakesley read a paper by **Mr. H. H. Hoffert, "On the Use of Very Small Mirrors with Paraffin Lamp and Scale."** For the mirrors of reflecting instruments the author prefers small rectangular strips of microscope cover-glass chosen thin and plane. These are first silvered, and then cut to shape by a splinter of diamond embedded in wax. They are about 8mm. long by 1·5mm. broad, and are suspended so that their longer sides are vertical. Rectangular mirrors suspended in this way are lighter and have less inertia than round mirrors of equal aperture. A paraffin-lamp flame placed edgewise to the mirror gives sufficient illumination. The image of the flame is focussed on the mirror by a lens midway between them—it is a right, vertical, line, and thus conforms to the shape of the mirror. A scale is fixed upon a screen between the lens and lamp, and the screen has a circular aperture just below the centre of the scale provided with a vertical cross-wire. The relative position of screen and lens is adjusted so that an image of the wire is formed upon the scale after reflection at the mirror.

Mr. Boys said he had frequently used small mirrors constructed as described by the author, and he could not see what was new in the method except that a paraffin lamp had been found sufficiently bright for the purpose It was desirable to diminish inertia by choosing extremely thin glass. Microscope cover glasses were generally supplied in squares or discs very fairly equal in size; if they were dealt out on a table like a pack of cards their relative thicknesses could be judged by the note produced as they fall. Flatness could be estimated nearly enough by balancing them one by one upon the knuckle nearly level with the eye, and observing the reflection of an illuminated straight edge, such as a window bar. Bad glasses should be broken. The good ones could be further examined by a telescope and artificial star. A common "writing" diamond is best for cutting the thin plates. Special care must be taken not to distort the mirror in fixing to the suspended system. If liquid shellac was used in the attachment, distortion would certainly occur, at any rate if it is applied throughout the whole length of the mirror. The best way was to make the attachment at a mere point near the top of the mirror, using a speck of shellac as viscous as possible, and heating, if necessary, by radiation, not by conduction. Mr. Boys thought that a reflecting prism near the mirror might be used in certain cases where a paraffin lamp with its inevitable vertical flame was required for horizontal projections.

Dr. Thompson pointed out that Mr. Hoffert had obtained his results, using only *one* lens, by properly choosing the position of the cross-wire.

A vote of thanks was given to the author, and the meeting adjourned until February 26.

HULL TRAMWAY TENDERS.

On the minutes of the Works Committee of the Hull Town Council appears an epitome of the tenders received in connection with the tramways, drawn up by the chairman, deputy-chairman, the town clerk, and the borough engineer. It is as follows:

1. W. Nettleton and Co.—This firm ask for a lease for 15 years; the Corporation to lay the lines and maintain the same in good order and to provide stabling for 300 horses and shed room for 60 cars. If electricity be used, to provide the necessary power, at a rate that may be agreed upon; the Corporation to pay all rates except water. Rent, £3,000 per year. Fares as at present. Service six minutes, and if increased traffic five minutes' service.

2. The Gas Traction Company, Limited.—This firm require a lease for 21 years. Rent, £300 per single mile run of line. Mode of traction, gas motors. Service, 5 to 10 minutes, according to requirements. Fares, 1d. per mile. Hours of labour, 10 per day. Company will make the necessary alterations to depôts in accordance with particulars and conditions of tender of December 8, 1896. (N.B.—The company do not make any remark as to the construction and maintenance of the lines, and it is therefore assumed that they will require the Corporation to undertake this.)

3. New General Traction Company.—This firm require the Corporation to construct and maintain the permanent way and all necessary depôts, and to provide (subject to arrangements) the necessary station for supplying the electric current with the appurtenances thereto, the lease to be for 21 years from date of Board of Trade's certificate. Rent, £500 per annum per single mile. Company to pay rates except landlords' taxes. Company will, if required (and subject to terms being arranged), contract with Corporation for the supply of the necessary current at a price to be agreed upon. Five minutes' service, such service to be increased as traffic justifies. Mode of traction, electricity by overhead installation. One penny fare for any single journey. Hours of labour, 70 per week. In case electric current is not supplied by the Corporation, the company to erect electric station, but the station to remain their property at the termination of lease.

4. The British Thomson-Houston Company, Limited.—This company only send in tender for approximate cost of supplying necessary electric appliances.

5. Alfred Dickinson and Co.—This firm, on behalf of clients, require a lease for 21 years, the rent to be at the minimum rate of £100 per annum per single mile of track, with a further sum of £25 per annum per single mile of track for every 1 per cent. above 5 per cent. paid in dividends to the shareholders of the new company, so that if 6 per cent. is paid the Corporation would receive £125, if 7 per cent. £150, and if 8 per cent. £175 per annum per single mile of track. Service, electric traction overhead system with side collection. Minimum service, 10 minutes, to be augmented on principal routes as traffic requires. Fares, maximum, not to exceed 1d. per mile. Hours of labour not to exceed 10 per day. To construct lines, enumerated to specification of the borough engineer. If lease not renewed, Corporation to take rolling-stock, feeders, and overhead construction at a valuation.

6. British Electric Traction Company, Limited.—The company to construct the track and charge 10 per cent. to cover engineering fees and company's profit. The cost as above to be paid by the Corporation. The Corporation to maintain track. Company to maintain depôts. Company will be prepared to take electric current from Corporation as per agreement submitted to them. If necessary, company will provide generating station and plant, which upon expiration of lease Corporation are to take over with electric equipment of line and the rolling-stock. Lease to be for 14 years. Company to pay to Corporation the following sums: (*a*) a sum of £5 2s. per cent. per annum on the capital expended by the Corporation on the purchase of the tramways, and on the construction of the track to provide for interest on, and sinking fund for redemption within 30 years of such capital, to commence from date of completion of equipment of the tramways; (*b*) the rent of £2,375 per annum, being £250 per mile of road, to commence from date of completion of equipment of the tramways; (*c*) a sum equal to 25 per cent. of all interests or dividends paid by the company in any one year on the capital employed by the company in the Hull tramways undertaking in excess of a cumulative return of 10 per cent. per annum. Electric traction overhead system. Service: the company to run cars at five minutes' interval on all routes for the greater part of the day, with such more frequent service as the traffic from time to time demands. Fares: the company during the first year to charge a fare of 1d. per passanger for any distance a car runs in one direction, except in the instance of cars running from the Victoria Pier to the extremities of any of the other routes, in which case the fare per passenger will be 1d. per mile. Company will make every effort to continue this rate throughout the term of the lease, but it reserves the right to increase the rate to not exceeding 1d. per mile or part of a mile. Company will pay all its employés on the basis of 10 hours per day. All the metal parts of the existing tramways to become the property of the company, and to be removed by them as taken up, with the exception that any parts thereof which the Corporation may deem suitable to be reused in the construction of the tramways.

The sub-committee having considered the tenders, it was moved by the Chairman, and seconded by the Mayor, that inasmuch as this committee is unable to recommend the acceptance by the Council of any of the tenders a special sub-committee be appointed to consider the report as to the most suitable tramway system for the borough, and for the purpose of obtaining information to visit such towns or places as may be reasonably necessary. Motion carried unanimously.

LEGAL INTELLIGENCE.

AN ELECTRIC LIGHTING DISPUTE.

Last Friday, in the Queen's Bench Division, before the Lord Chief Justice and a special jury, the case of the Electrical Installation Company, Limited, *v.* Armfield came on for hearing.

The case arose out of the supply by the plaintiffs of the electric light to the house of Lord Stratheden and Campbell, known as Hartrigge House, at Jedburgh, in Roxburghshire. The plaintiffs, who contract for the installation of the electric light in private houses and country mansions, obtained a contract from Lord Stratheden and Campbell to supply his house with that light. The question of the power to drive the dynamo arose, and they consulted the defendant, Mr. Joseph J. Armfield, of Ringwood, Hampshire, and of Mark-lane, an hydraulic engineer, as to what should be done for the purpose of utilising the water in a burn or brook near the house, called the Tower Burn. The lighting arrangements did not prove a success, but the plaintiff company sued Lord Stratheden and Campbell for a large sum of money which they said they had earned. Lord Stratheden and Campbell was successful before the official referee, but on appeal before a Divisional Court the action was settled by his agreeing to pay the plaintiffs £750. Plaintiffs now alleged against the defendant (Armfield) that in making his report as to the capabilities of the burn he had been negligent, and that it was due to his negligence that the electric lighting arrangements had broken down.

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Mr. M'Call and Mr. Crawford appeared for the plaintiff; and Sir R. T. Reid and Mr. R. M. Bray for the defendant.

After evidence had been called for the plaintiffs, the **Lord Chief Justice** suggested that it was a case for settlement, and after a consultation with him in his private room, it was announced that the parties had come to terms, which were not stated, all imputations upon the defendant being withdrawn.

TRADE CREDITORS AND DEBENTURES.

In the Court of Appeal on Saturday last, before Lords Justices Lindley, A. L. Smith, and Rigby, the case of the London Health Electrical Institute, Limited, came up. This was an appeal from a decision of Mr. Justice Vaughan Williams dismissing a creditor's petition for the winding up of the company. The company was registered in September, 1892, and was formed for the purpose of acquiring from Messrs. G. I. and M. C. Spalding the business theretofore carried on under the style of the Magneto-Electric Battery Company and the London Health Electric Institute. The company was what is known as a private company, and upon its formation £3,000 debentures were issued to Messrs. Spalding as consideration for the sale of the business. The company was heavily indebted to the petitioners for printing and advertising. The company very soon got into difficulties, in consequence, as was tated by counsel at the Bar, of the exposure of the Harness belt business, which was alleged to be similar to the business which the company proposed to carry on, and it was admittedly insolvent at the date of the petition. When the petition was presented, the appeal to the House of Lords in the one-man-company case—Broderip *v.* Salomon—had not been decided, and an attempt was made to make the Messrs. Spalding liable to indemnify the company on the principle of the decision of the Court of Appeal, but that became impossible after the reversal of that decision by the House of Lords *sub nom.* Salomon *v.* Salomon and Co. The opposition to the petition was based on the fact that the Messrs. Spalding held debentures in the company for £3,000 and that the assets were not nearly sufficient to satisfy those debentures, and consequently the outside creditors would gain nothing by winding up the company. Mr. Justice Vaughan Williams reluctantly came to that conclusion and dismissed the petition. The petitioners appealed.

Mr. Waghorn and **Mr. Nepean**, for the petitioners, now contended that there was no real consideration for the debentures, and that they ought to be set aside under 13 Eliz., c. 5, Sections 1 and 2, as a fraud upon the outside creditors. The appeal was dismissed, **Lord Justice Lindley** saying the Court was bound to accept the decision of the House of Lords in Salomon *v.* Salomon and Co. The only businesslike thing to do was for tradesmen to refuse to give credit to these small companies.

Lord Justice A. L. Smith agreed. If he could, he would wind up the company and sweep it off the face of the earth, because he was quite certain its continued existence could not benefit a single human being, and

Lord Justice Rigby agreed with the learned judge below both in his expression of regret and in his judgment that nothing could be done.

ALLEGED DEFECTIVE WORK.

In the Westminster County Court, on Tuesday, the case of Fox *v.* Salter was before his Honour Judge Lumley Smith, Q.C., on a judgment summons in which the plaintiff, an electrician of Tottenham Court-road, sued the defendant to enforce payment of a judgment debt for work done and goods supplied.

The **Debtor** said the work was badly done, and was quite useless, but his **Honour** said that story was too late, and made an order for payment of the amount claimed and costs.

CLAIM FOR ELECTRICAL FITTINGS.

In the Westminster County Court, on Tuesday, the case of Gould *v.* Talbot was before his Honour Judge Lumley Smith, Q.C.

The plaintiff, an electrician of Westminster Bridge-road, sued the defendant to recover £5 for electrical fittings supplied and work done to his order.

The **Defendant** said his wife was the person who was liable, but his **Honour** said that was all nonsense, and made an order for payment of the full amount.

COMPANIES' MEETINGS AND REPORTS.

SHEFFIELD TRAMWAYS COMPANY.

The half-yearly ordinary general meeting of the Sheffield Tramways Company was held on Tuesday at the offices, Queen Victoria-street, E.C., Mr. Edmund Etlinger presiding.

The **Chairman**, in moving the adoption of the report, said an agreement had been effected between the Corporation and the Company, by which the Corporation paid the Company £27,500 in settlement of all claims. Undoubtedly the Corporation had acquired a profitable going concern for a very moderate sum, but the shareholders must remember that valuers were bound by the Section 43 of the Tramways Act of 1870, as interpreted by the House of Lords, to mean "construction cost less depreciation," which made it in the majority of cases impossible for tramway shareholders to get back the capital they had sunk in their undertakings. The statement submitted in the report showed that in winding up the Company the liquidators would be able to hand over to the shareholders about £5. 15s. 6d. per share. From this sum would have to be deducted the expenses of liquidation, and it was also subject to the fluctuating value of the investments.

Mr. Illingworth seconded the motion, which was unanimously adopted. A complimentary fee of 150 guineas was voted to Mr. Selby, the secretary of the Company, and at an extraordinary general meeting it was unanimously resolved that the Company be wound up voluntarily.

BRISTOL TRAMWAYS AND CARRIAGE COMPANY, LIMITED.

The half-yearly general meeting of this Company was held on Wednesday at Bristol, Mr. W. Butler presiding.

The **Chairman**, in moving the adoption of the report, said the total receipts for the half-year were £59,045, the largest on record. The increase in the tramways department was £7,150, and in the carriage department £272. So far as the tramways increase was concerned, it arose largely from the additional mileage run, as compared with the corresponding period of 1895. The disposable balance was £12,378 as against £11,454, and the directors had been enabled to pay the usual dividend of 6 per cent. per annum, and to set aside £2,838 to the various reserves, bringing the total of the reserve funds up to £56,000. He hoped that in the near future they would still further increase their funds, because as the life of the Company was limited it was wise that proper provision should be made, so that when they were called upon to sell the undertaking the shareholders might get a return of the full value of their interest in the Company. During the half-year electric traction had been introduced on a second section of the undertaking, and it was to be regretted that the Corporation of Bristol had imposed unreasonable conditions which had compelled the Company to abandon further extensions and the general introduction of electric traction over the whole of the system. The Corporation required the Company to take the electric energy from the city lighting works, but, as business men, the directors were not prepared to run the risk of expending hundreds of thousands of pounds and then to place themselves in the power of a Corporation department for the means of working the tramways. The directors would have been unfitted for the position they occupied if they had permitted the Company to be placed in such a position. Referring to the appointment of a Corporation committee to consider the question of acquiring the tramways, the Chairman said the Company had no desire to sell the undertaking, and did not intend to do so, by arrangement or otherwise. He did not believe there was any desire on the part of the citizens to take away from them the legitimate reward of their enterprise and sacrifices.

Alderman C. H. Low seconded the resolution, and it was adopted.

BELFAST STREET TRAMWAYS COMPANY.

The forty-ninth half-yearly meeting of this Company was held on Friday last at 7, Poultry, E.C., Mr. George Richardson presiding.

The **Chairman**, in moving the adoption of the report, said that during the six months under review they had run 30,867 more miles and carried 337,309 additional passengers than in the corresponding period of 1895. The gross profit showed an increase of £2,389, the traffic receipts having been more by £1,331 and the expenses less by £1,349. Notwithstanding the fact that their stud had numbered 959, against 920 in the previous year, the cost of forage had been reduced to £9,860, representing a saving of £1,200. After paying debenture interest, the half-year's rent to the Belfast Corporation, at the rate of £4,000 per annum, and putting aside the usual £1,500 to the sinking fund and £1,000 to the horse-renewal account, the Board were able to pay the usual dividend of 6½ per cent., leaving to be carried forward to the new half-year a sum of £1,248. It had been thought necessary, in the interest of the public, to give notice of an order in Council which they expected to get for the extension of the existing lines. When the borough boundaries were extended it became necessary for the directors to consider the advisability of carrying their lines to the city's new limits. While not at all anxious to incur this new outlay, the Board had come to the conclusion that, on the whole, it would be well to carry the lines to that point, and had arranged accordingly. Another extension much called for was to Knock. When these extensions are carried out the public would be greatly advantaged, and he hoped also that the Company would benefit. In their last report the directors informed the shareholders that Parliament had granted power to the Company to use electric traction, subject to the sanction of the Corporation being first obtained. The directors were fully alive to the advantages of electric traction, and had done their best to make terms with the Corporation so that the people of Belfast might have the benefit of the more rapid transit. The Corporation had, however, declined to sanction the use of electric traction, except upon terms which were absolutely prohibitive, and which it was quite impossible for the directors to accept. The question of electric traction was therefore, owing to the action of the Corporation, completely at a standstill. Unless the Corporation could see their way to grant the Company an extension of their lease, the Board would not be justified in going to the expense—about £250,000—of working the line by electricity. Their lease had only 10 years to run from

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August next, and, assuming that some arrangement with the Corporation could be come to in a month or six weeks, it would be as long as July, 1898, before the line could be converted into an electric system, which would give them not more than about nine years' use of the streets on that basis. Owing to the action of the Corporation the question of electric traction was, therefore, at a standstill.

Mr. G. F. Fry seconded the motion, and the report and dividend were agreed to.

At the motion of the **Chairman**, a dividend at the rate of 6½ per per annum was unanimously adopted.

Mr. Fry, the retiring director, was re-elected, for which he returned thanks.

On the motion of **Mr. Smith**, seconded by **Mr. Tozer**, Mr. Bishop, the retiring auditor, was re-elected.

DOUGLAS SOUTHERN ELECTRIC TRAMWAYS.

The annual general meeting of this Company was held on Tuesday in Manchester, Mr. G. W. Lowcock presiding in the absence of Sir John Goldie Taubman, the chairman.

The statement of accounts covered the period from the incorporation of the Company in October, 1895, to October 31, 1896, showing that during that period there had been on profit and loss account an expenditure of £904 and an income of £1,078, the difference being a balance of profit on the seven weeks' working of the Company's tramways during last season.

The **Chairman**, in moving the adoption of the accounts, said it was unsatisfactory that the contractors failed to complete their work in time to give the Company the advantage of the whole of the season last year, but they had met greater difficulties than had been anticipated, more especially in connection with the bridges, some of which had had to be re-erected before the lines could be laid on them. Instead of starting in June, they began business on August 7. The last three weeks of delay was owing to their having to wait for the Government inspector to perform his duty. It was intended, in the first place, to lay only 2½ miles of tramways to Little Ness, but the directors afterwards thought it best to lay the whole length to Port Soderick at once. From August 7 to September 5 they carried no fewer than 53,536 passengers. They were compelled to carry them only a short distance, and they charged 3d. each way as fare. They were under agreement to pay 1d. toll per passenger to the Marine Drive, Limited, but that company had acted considerately under the special circumstances of the short season, and had only taken ½d. per head. From September 5 to 24 they carried 16,594 passengers at their increased rate of 1s. for the return journey. If they could depend on the figures, the Company ought to be able next year to produce a balance-sheet which would give the shareholders every satisfaction.

Mr. W. Davenport seconded the motion, and it was adopted.

Mr. W. S. G. Baker ceased to be a director, the meeting re-electing all other members of the retiring Board, and adding Mr. Hutchinson as a representative of the Marine Drive Company.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY, LIMITED.

An extraordinary general meeting of this Company was held at Winchester House, E.C., on Tuesday, to consider resolutions having for their object the reorganisation of the debenture debt of the Company.

Lord Richard Browne who presided, in the absence, through indisposition, of Mr. Andrews, the chairman of the Company, explained that, as regarded the debenture-holders, he was glad to say that they had practically the assent of the whole body of them—*i.e*, they had received acceptances to the amount of £280,600 out of a total of £338 800, so that they had practically rather more than five-sixths of the whole. In explaining the scheme, the Chairman said the holders of the present debentures were invited to exchange them for debenture stock at the rate of £118 debenture stock for each "A" debenture and £115 debenture stock for each "B" debenture. The "A" and "B" debentures so exchanged would be vested in trustees representing the Company for the purpose of the annual drawings. The debentures not exchanged and those vested in the trustees would continue to be drawn for redemption precisely as at present, so as to safeguard the rights of debenture-holders not exchanging. All drawn debentures would be cancelled. The net revenue of the Company for the last three years available for the debenture-holders and shareholders had averaged £90,316. Deducting £16,000 for interest at 4 per cent. on £400,000 debenture stock required for the conversion of the whole of the "A" and "B" debentures, including premium and expenses of issue, and further deducting an annual sinking fund of £2,159 required for the amortisation of the above amount of debenture stock, a balance of over £70,000 per annum would remain upon the complete carrying out of the present scheme, while a diminution of over £20,000 in the present annual charge would be effected. This large margin of net revenue, and the permanent and marketable character of the debenture stock, offered important advantages to the present holder, whilst in the event of Government purchase he would have realised a substantial premium. There would only be one charge on the Company, and the new debentures could only come into existence as the old ones were paid off and cancelled, and consequently there would not be two debentures of the same kind existing. The interest of the debenture-holders was equally protected, with the exception that the position of the new debenture-holder was materially improved by the fact that he would possess a permanent security, and one which was not liable to be drawn off at par, as it was under the old scheme, and thus the market value of the debentures would be materially enhanced. The Chairman concluded by moving *en bloc* a series of resolutions, seven in number, authorising the conversion of the debenture debt upon the lines he had indicated.

The motion was seconded by **Mr. J. Copper.**

Replying to a **Shareholder**, the **Chairman** stated that the proposed conversion made no difference whatever to the Brazilian Government; in fact, it might be rather an advantage to them than otherwise. His remarks on the subject of the conversion applied only to £400,000. The total amount they were asking the shareholders to create was £500,000, of which £100,000 would be held in reserve. They might want it at some future date, and therefore they thought it prudent to create it If it was not created now it would have to come in as a second charge.

The resolutions were unanimously approved.

CUBA SUBMARINE TELEGRAPH COMPANY.

The ordinary general meeting of this Company was held on Wednesday at the offices, 58, Old Broad-street, Mr. Charles W. Parish presiding.

The **Chairman** said it gave the Board great pleasure to lay before the shareholders a satisfactory record of the working of the Company during the past six months. The receipts amounted to the highest figure ever touched in one year during the existence of the Company. The receipts for 1895 amounted to £54,116, and for 1896 to £58 635. Shareholders would remember that in 1896 the Company had the advantage of the Cienfuegos-Mazanillo cables, which accounted for the difference to some extent. The actual expenses which the Company had been put to during the period under review in order to earn gross receipts of £28,681 showed an advance of £1,641, which was almost wholly due to expenses at stations, especially those stations connected with the new cable. The new cable had now been at work for 12 months, and consequently when they next met they would be able to draw comparisons between the working of the Company for two years under similar conditions. The ordinary expenditure amounted to £7,180, but they had to add to that three special items which had occurred during the six months covered by the accounts. There was £84 in connection with the International Telegraphic Congress, and there was a special sum of £987 which the shareholders voted to the staff at the last meeting, and £100 which the Board had subscribed to the Spanish Humanitarian Relief Fund. The sum of £11,000 had been added to the reserve fund, which now stood at £109,000. The dividend on the preference shares would absorb £3,000, and leave £9,499, out of which the directors recommended the payment of a dividend on the ordinary shares at the rate of 8 per cent. per annum free of income tax, the balance, £3,099, being carried forward to the current half-year. The cables had continued in good order throughout the half-year, with the exception of the Cienfuegos-Santiago 1881 cable, which broke down in December, and arrangements were now being made for its repair. The directors regretted to report that a cable had been laid between New York and Hayti in connection with the French company's system, and which had taken that company's traffic from the Cuba Company's lines. He could not say as yet what difference that new cable would make in the receipts of the Company, but he was afraid it would be considerable.

The report was adopted.

CHARING CROSS AND STRAND ELECTRICITY SUPPLY CORPORATION, LIMITED.

Directors: G. H. Brougham Glasier, Esq., 7, St. James's-street, S W. (chairman); Stefano Gatti, Esq., 436, Strand, W.C. (vice-chairman and managing director); John M. Gatti, Esq., 436, Strand, W C.; Richard Chadwick, Esq., 34, St. Martin's-lane, W.C.; I. P. Mendoza, Esq., 4A, King-street, St. James's, S.W. General manager and secretary: E. Wilmot Seale, Esq. Chief engineer: W. H. Patchell, A.M.I C.E., M.I E.E., M.I.M.E.

Report of the directors to be presented to the ordinary general meeting of the shareholders, to be held at the offices of the Company, 15, Maiden-lane, Covent Garden, on Wednesday, February 24, 1897, at 12 noon:

In submitting the accounts for the year ended December 31, 1896, the directors are pleased to state that the business of the Company continues to show a most satisfactory increase. The directors have to announce with the deepest regret the death of Mr. Agostino Gatti, one of the managing directors. Mr. John M. Gatti, his eldest son, has been elected a director in his place. The Bill confirming the provisional order enabling the Corporation to supply electricity in the district of the Strand Board of Works received the Royal assent. Judging by the results already obtained, the directors have reason to congratulate the shareholders on obtaining the increase of their powers. The new central building covers a space of about 10,000 superficial feet, and is erected and equipped in the most modern and approved manner. An extensive electrical plant capable of supplying energy to 80,000 8-c p. lamps has been designed and erected under the superintendence of the chief engineer, and further plant, for which there is ample space, will be erected as required. Trunk mains have been laid connecting the two stations, and a large supply of energy is now being taken from the new station. Five miles have been added to the mains already laid in St. Martin's parish, and 41 miles of mains of sufficient capacity for 85,000 8-c p. lamps have been laid in the Strand

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district. The entire network of mains in that district is now nearly completed. The efficiency of the station has been well maintained, the plant, machinery, and mains working in a most satisfactory mannar. The demand for current, both in the St. Martin's parish and the area of the Strand District Board of Works, has considerably exceeded expectation, and the number of lamps to which the Company was supplying energy on December 31, 1896, was 73,464, or an increase of 22,164 8-c.p. lamps over those supplied in the year 1895; these totals include 12,641 8-c.p. lamps connected in the Strand district, although the Corporation only commenced to supply electrical energy there in August last. The directors are proposing to take immediate steps for issuing the remaining £50,000 of preference share capital. The net earnings, as shown in the revenue account, have amounted to £15,288. 15s. 1d.; £622. 12s., balance of law costs suspense account, has been written off; £3,579. 11s. 6d. has been paid in respect of interest on debentures and temporary loans up to December 31, 1896; and £3,625 was distributed in payment of an interim dividend at the rate of 5 per cent. for the half-year ended June 30, 1896 A sum of £7,461. 11s. 7d. remains, which, added to the undivided profit of £1,397. 6s. from last year's account, makes £8,858. 17s. 7d., and which the directors propose to deal with as follows: to provide for dividend on 4½ preference shares apportioned to December 31, 1896 (less tax), £797. 9s. 9d.; to pay a dividend (less tax) at the rate of £7 per cent. for the half-year ended December 31, 1896, on the ordinary shares, making with the interim dividend paid in August, 1896, £6 per cent. per annum for the whole year, £5,075; and to carry forward £2,986. 7s. 10d. Mr. I. P. Mendoza and Mr. J. M. Gatti are the directors who retire by rotation, and, being eligible, offer themselves for re-election. The auditors, Messrs. O. R. Johnson and Son, also retire and offer themselves for re-election.

REVENUE ACCOUNT FOR YEAR ENDING DEC. 31, 1896.

Dr.				£	s.	d.
To Generation of Electricity.						
Coal and other fuel, including carriage, etc.	£6,979	9	4			
Oil, waste, water, and engine-room stores	631	5	4			
Proportion of salaries of engineers, superintendents, and officers	472	18	5			
Wages and gratuities at generating stations	2,109	14	11			
				10,193	8	0
Repars and maintenance as follows:						
Buildings	54	5	11			
Engines, boilers, dynamos, motors, and other machinery, instruments, and tools	1,287	13	10			
Accumulator and accessories	102	0	0			
				1,443	19	9
Clearing away ashes				110	16	3
				11,748	4	0
To Distribution of Electricity.						
Proportion of salaries of superintendents and officers	680	19	6			
Wages and gratuities to linesmen, fitters, labourers	499	5	0			
Repairs, maintenance, and renewals of mains of all classes, including materials and laying the same	606	18	5			
Repairs, maintenance, and renewals of transformers, meters, switches, fuses, and other apparatus on consumers' premises	34	12	0			
Wayleaves and licenses	131	6	7			
				1,953	1	6
Royalties, etc., payable for use of patents or patent processes				91	3	11
Rents, rates and taxes, and insurance				1,933	9	0
To Management Expenses.						
Directors' remuneration	700	0	0			
Salaries of general manager and secretary, accountants, clerks, and messengers	1,373	2	3			
Stationery and printing	231	4	7			
General establishment charges	355	6	9			
Auditors of Company	52	10	0			
Auditor appointed under the provisions of the order, year 1895	51	17	3			
				2,764	0	10
Law and parliamentary charges				55	8	11
Depreciation in respect of leasehold premises, buildings, plant, machinery, etc.				4,854	0	3
To Special Charges.						
Insurance—employers' liability	24	14	3			
Stamp duties	3	2	6			
				27	16	9
				23,427	5	2
Rents, repairs, rates and taxes in respect of premises owned but not occupied by the Corporation				402	5	7
Total expenditure				23,829	10	9
Balance carried to net revenue				15,288	15	1
				£39,118	5	10

Cr.	£	s.	d.
Sales of current, less rebates and allowances for bad debts	38,104	19	6
Rentals of meters and other apparatus on consumers' premises	464	16	4
Profits on sales of sundries	133	18	7
Transfer fees	49	10	0
Discounts, etc.	51	8	11
	£38,804	13	4
Rents receivable in respect of the Company's house property not in its own occupation	313	12	6
	£39,118	5	10

GENERAL BALANCE-SHEET, DEC. 31, 1896.

Dr. Liabilities.	£	s.	d.
Capital account—amount received	280,000	0	0
Sundry tradesmen and others, due on construction of plant and machinery, fuel, stores, etc., to Dec. 31, 1896	27,912	2	2
Sundry creditors for debenture interest to Dec. 31, 1896	1,694	1	8
Net revenue account—balance at credit thereof, £12,483. 17s. 7d.; less interim dividend paid thereout in August, 1896, £3,625	8,858	17	7
Depreciation fund account	8,000	0	0
	£326,465	1	5

Cr. Assets.	£	s.	d.
Capital account—amount expended for works	309,603	12	10
Estimated minimum value of fully-paid shares taken in satisfaction of bad debt	32	0	0
Purchase of premises not used by the Company, including law charges in connection therewith	647	0	3
Stores on hand, Dec. 31, 1896—coal, £304. 6s.; oils, waste, etc., £33. 13s. 1d.; general stores, cables, etc., £1,424. 6s. 11d.	1,762	6	0
Sundry debtors for current supplied to Dec. 31, 1896	12,011	6	4
Other debtors	122	6	6
Cash at bankers and in hand	2,286	9	6
	£326,465	1	5

CITY OF LONDON ELECTRIC LIGHTING COMPANY, LIMITED.

Directors: Sir David L. Salomons, Bart. (chairman), the Earl of Suffolk and Berkshire, Edward Lucas, Colonel B. H. Martindale, C.B., Frederick W. Reynolds. Frank Bailey, engineer to the Company. J. Cecil Bull, manager and secretary.

Abstract of report of the directors to be presented to the shareholders at the ordinary general meeting of the Company, to be held at Winchester House, Old Broad-street, E.C., on Wednesday, February 24, 1897, at 2·30 p.m.:

The expenditure on capital account during the year ended December 31, 1896, amounted to £73,724. 17s. 1d. Details of this outlay are given in the capital account. In view of the rapid extension of the Company's business, your directors recommend that the Company's capital should be increased, and the following resolution will be submitted at the forthcoming meeting: "That the capital of the Company be increased to £1,200,000, by the creation of 40,000 new ordinary shares of £10 each." Your directors propose, should the resolution be passed, to issue only 10,000 of the new shares at present, and the remainder as the business of the Company may require. They propose to allot, as nearly as may be, the first 10,000 shares at par to the present ordinary shareholders, in the proportion of one new share to four old shares.

				£	s.	d.
The total revenue for the year was				£156,021	19	11
From which must be deducted the following items:						
Expenses of generation and distribution	£38,162	2	6			
Rents, rates, taxes, general charges, and allowances to consumers	30,820	8	6			
Transfer to depreciation fund No. 1	14,960	0	0			
Transfer to reserve fund	2,612	11	8			
Amount written off suspense account	1,338	0	8			
				87,893	3	4
Leaving a net revenue of				68,128	16	7
To which must be added the balance brought forward from 1895				3,776	3	10
Making a total available revenue of				£71,905	0	5
Of this sum the following amounts have been distributed:						
Interest on debenture stock for year ended December 31, 1896	18,489	17	4			
Interim dividend on £400,000 6 per cent. preference shares, half-year to June 30 last	12,000	0	0			
				30,489	17	4
Leaving for further distribution				£41,415	3	1

The directors now recommend the followiug dividends—viz., 6s. per share on the preference shares for the second half-year, making, with the interim dividend already paid, a total distribution of 12s.

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per share, or 6 per cent. for the year, and 14s. per share on the ordinary shares for the year, being at the rate of 7 per cent. per annum. This will absorb £40,000, leaving a balance of £1,415. 3s. 1d., which the directors propose to carry forward. They propose that the respective dividends shall be paid on February 25, 1897. The necessary provision for depreciation and reserve fund, in accordance with the City of London Electric Lighting Act, 1893, has been made, of which £17,572. 11s. 8d. has been set aside out of revenue. The generation and distribution expenses for the year, including repairs and renewals, were 34 per cent. of the earnings, as compared with 36 87 for 1895, 46 for 1894, and 54·2 for 1893. The Company continues to make satisfactory progress, the number of customers and lamps connected being at December 31, 1896, 5,303 and 247,785 respectively. On February 10, 1897, there were 267,502 8-c.p. lamps (equivalent) applied for, out of which 254,610 were connected. The income, as shown in the audited statement of accounts issued by the Company, for the year ended December 31, 1896, was as follows: gross revenue, £146,946. 14s. 7d.; net revenue available for depreciation, reserve fund, interest on debenture stock, and dividends, £85,701. 8s. 3d. In accordance with the articles of association, two of the directors, Sir David L. Salomons, Bart., and Colonel B. H. Martindale, C B., now retire, and, being eligible, offer themselves for re-election. Messrs. W. H. Pannell and Co. retire, and, being eligible, offer themselves for re-election.

REVENUE ACCOUNT FOR YEAR ENDED DEC. 31, 1896.

Dr.	Public lighting. £ s. d.	Private lighting. £ s. d.
Generation of electricity—		
Coal and other fuel, including dues, carriage, unloading, storing, and all expenses of placing the same on works	2,637 11 9	16,046 14 10
Oil, waste, and engine-room stores	339 10 9	1,604 1 9
Water	286 11 1	1,180 17 4
Salaries of station engineers and assistants	450 17 7	1,352 12 11
Wages and gratuities at generating station	1,691 19 2	5,129 5 0
Sundry expenditure	34 8 5	192 13 10
Total generation expenses	£5,440 18 9	£25,506 5 8
Distribution of electricity -		
Proportion of salaries of engineers' assistants	292 7 1	877 1 2
Attending mains and street boxes	852 13 3	784 2 4
Wages and gratuities to linesmen, fitters, and trimmers of lamps	1,252 2 0	261 8 3
Wages and gratuities to transformer men and sundry stores	—	1,598 19 7
Carbons and other materials for street and other lamps	653 0 9	138 14 11
Sundry expenditure	3 16 3	18 0 0
Proportion of salaries of engineer and assistants, as adopted by Board and approved by auditors	120 13 2	361 19 4
Total for generation and distribution	8,615 11 3	29,546 11 3
Rents, rates, and taxes—		
Rents payable	1,041 8 6	4,165 14 0
Rates, taxes, and lighting	1,441 14 9	5,766 18 11
Proportion of management expenses—		
Directors' remuneration, salaries of manager and secretary, accountant, clerks, collectors, etc.	1,086 10 10	4,346 3 5
Printing and stationery	96 19 1	387 16 6
General establishment charges, including meter reading	148 5 4	593 1 6
Auditors' fees	22 12 0	90 8 0
Trustees' fees	21 0 0	84 0 0
Legal charges	43 13 8	174 14 9
Special charges—		
Allowances, deductions to consumers and fines	362 11 3	8,712 14 1
Bad debts	—	175 6 10
Official testing of meters	—	11 0 0
Insurances	201 9 3	1,805 17 0
Claims	—	40 8 10
Total expenditure	13,081 15 11	55,900 15 1
Balance, being revenue for period carried to net revenue account	48 16 10	79,479 1 8
	£13,130 12 9	£135,379 16 9

Cr.	Public lighting. £ s. d.	Private lighting. £ s. d.
Sale of current	—	129,984 5 10
Revenue under contracts	12,945 14 6	—
Meter rentals	—	3,546 8 6
Rents receivable	144 17 2	1,448 11 10
Transfer fees	10 12 6	106 4 6
Testing fees and sundry receipts	29 8 7	294 6 1
Total income	£13,130 12 9	£135,379 16 9

The cost of repairs and renewals to buildings, machinery, mains, etc., amounting to £10,845. 10s. 6d., together with the statutory depreciation have been provided for out of the depreciation reserve funds in accordance with the City of London Act, 1893.

GENERAL BALANCE-SHEET, DEC. 31, 1896.

Dr. Liabilities, etc.	£ s. d.	£ s. d.
Capital account—amount received		1,200,000 0 0
Sundry tradesmen and others, due on construction of plant, machinery, fuel, stores, etc.		13 370 18 0
Sundry creditors on open accounts		16,646 7 5
Sundry deposits from consumers		328 7 10
Depreciation reserve funds—No. 1	£31,014 7 7	
Do. do. No. 2	21,513 10 4	
Reserve fund	7,396 6 11	
		59,924 4 10
Balance of premiums on issue of £400,000 debenture stock and dividends thereon	65,279 18 1	
Less transfer to depreciation reserve fund No. 1, £5,000; and No. 2, £10,279. 18s. 1d.	15,279 18 1	
		50,000 0 0
Net revenue account—Balance at credit thereof	53,415 3 1	
Less interim dividend on £400,000 preference shares to June 30, 1896	12,000 0 0	
Balance available for distribution as proposed in report		41 415 3 1
		£1,381,685 1 2

Note —Under existing contracts relating to the equipment of the stations and other works, there are further liabilities which become payable as the work progresses, subject to acceptance by and certificates from the engineer.

Cr. CAPITAL EXPENDITURE AND ASSETS.	£ s. d.
Capital expenditure	1,201,634 19 5
Stores at stations and elsewhere	21,155 2 5
Sundry debtors for current supplied to September, 1896, £602. 6s. 7d.; December, 1896, £58,871. 4s. 1d	59,473 10 8
Other debtors	5,735 19 11
Suspense account, £8,521. 8s. 3d.; less written off out of revenue, £1,338. 0s. 8d.	7,183 7 7
Cash on deposit account, £11,000; on current account, £12,852. 9s.; on hand, £15 2s. 9d.	23,867 11 9
Sundry deposits and interest accrued thereon	2,016 0 9
Investments against depreciation and reserve funds—(*a*) 2¾ per cent. consols and 2½ per cent. Metropolitan Stock, £16,366. 2s. 1d.; (*b*) British railway stocks, £34,617. 6s. 7d.; (*c*) freehold and leasehold property, £9,635	60,618 8 8
	£1,381,685 1 2

KENSINGTON AND KNIGHTSBRIDGE ELECTRIC LIGHTING COMPANY, LIMITED.

Directors: Alfred Sohier Bolton, Esq.; Sir Frederick J. Bramwell, Bart., F.R.S.; G. H Hopkinson, Esq.; Granville R. Ryder, Esq.; R. W. Wallace, Esq, Q.C.

Report by the directors to be presented at the tenth ordinary general meeting to be held at 1, Great George-street, Westminster, on Thursday, February 25, 1897, at 5 p.m.:

The directors submit to the shareholders a statement of the accounts of the Company, together with a report of the position of the undertaking at the end of the year 1896. The mains, which extended to a length of 20 miles on December 31. 1895, have been increased during the year 1896 to 21¼ miles. During the year the number of houses and shops connected with the system has increased from 1,109 on December 31, 1895, to 1,325 on December 31, 1896, while the number of lamps calculated on the usual basis of 8 c.p. has increased from 94,780 to 119,955. The balance of the £15,755 4 per cent. debenture stock issued at £105 per cent. in December, 1895, amounting to £3,974. 5s., was paid in January. Additional capital required by the Company during the year has been raised by the issue of £1,000 4 per cent. debenture stock at £107 per cent., and 1,000 second preference shares offered to the shareholders at a minimum price of £6 per £5 share were subscribed for, producing £6,059. 5s. The directors have thought it advisable to appropriate the premiums thus obtained to the reduction of the cost of conversion of debenture bonds. The directors have written £2,000 off the capital expenditure in addition to replacement of plant, and strengthened the renewal account by transferring to it £2,345. 19s. 6d., making the total amount placed to that account £12 336. 13s. 2d. After providing for the above amounts, and paying the dividends on the 6 per cent. first preference shares to June 30, 1896, on the 5 per cent. second preference shares to September 30, 1896, and an interim dividend at the rate of 6 per cent. per annum on the ordinary shares for the first half of the year, the balance standing to the credit of the net revenue account for the year 1896 is £6,425. 3s. 9d. Of the above sum £1,450 has been appropriated to the payment of the first preference dividend to the end of the year, and £200 has to be set aside to meet the portion of the dividend on the second preference shares accrued to the same date, leaving £4,775. 3s. 9d., out of which it is proposed to pay a further dividend on the ordinary shares, at the rate of 8 per cent. per annum for the past half-year, making, with the interim dividend paid to June 30, 7 per cent. for the year. This will leave a balance of £1,875. 3s. 9d. No provision has been made in the accounts for directors' remuneration.

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The directors propose in accordance with a wish which was expressed by shareholders at the last meeting, to submit a resolution to the meeting fixing the directors' fees for the year 1896 and subsequent years at £1,000. In accordance with the articles of association Sir Frederick J. Bramwell, Bart., F.R.S., and Mr. R W. Wallace, Q.C., retire from the directorship, and, being eligible, offer themselves for re-election. The auditors, Messrs. Lovelock, H. W. S. Whiffin, and Dickinson, offer themselves for re-election.

Dr. BALANCE-SHEET, DEC. 31, 1896.	£	s.	d.
Capital, 15,000 ordinary shares of £5 each	75,000	0	0
,, 10,000 6 per cent. first preference shares of £5 each	50,000	0	0
,, 3,500 5 per cent. second preference shares of £5 each	17,500	0	0
,, 4 per cent. debenture stock	76,055	0	0
Sundry creditors and open accounts	10,165	11	5
Renewal account, balance at credit thereof	12,336	13	2
Net revenue account	6,425	3	9
	£247,482	8	4
Cr.	£	s.	d.
Capital expenditure	206 798	16	1
Less amount written off	2 000	0	0
	204,798	16	1
Freehold and leasehold property, £25,365. 19s. 9d.; less sinking fund, £1,101. 15s. 2d.	24,264	4	0
Sundry debtors	13,071	10	8
Stock in trade and stores	707	2	3
Consols	549	3	10
Cash at bankers, £3,493. 19s. 3d.; and in hand, £39. 11s. 9d.	3,533	11	0
Balance of conversion of debenture bonds from last account, £1,923. 15s. 6d.; less premiums received, £1,365. 15s.	558	0	6
	£247,482	8	4

REVENUE ACCOUNT, YEAR ENDING DEC. 31, 1896.

Dr.	£	s.	d.
Manufacturing electricity, coal, oil, water, waste, sundries	6,916	9	10
Salaries	2,400	7	0
Miscellaneous expenses, including law charges	772	11	7
Rents, rates, and taxes	2,436	3	11
Insurance	389	10	1
Sinking fund, leasehold	260	0	0
Maintenance of buildings, mains, plant, meters, instruments, etc.	2,570	0	6
Repairs to leasehold property	239	11	4
Company's auditor	52	10	0
Board of Trade auditor	48	0	0
Repairs to freehold property	181	14	10
	16 266	19	1
Renewal account in respect of buildings, mains, plant, batteries, meters, and furniture	2,345	19	6
Amount written off capital expenditure	2,000	0	0
Net loss on sales of old plant	2,782	0	0
Balance	12,937	15	10
	£36,332	14	5
Cr.	£	s.	d.
Sale of electricity (1,514,729 units)	37,563	1	4
Less rebates and bad debts	3,191	2	1
	34,371	19	3
Rent of meters	1,122	8	6
Sale and maintenance of lamps	12	8	8
Rent receivable	803	6	10
Transfer fees	6	0	0
Apparatus sale and maintenance	16	11	2
	£36,332	14	9

BLACKBURN TRAMWAYS COMPANY, LIMITED.

Mr. R. A. Jackson presided last week at an extraordinary general meeting of this Company, held at the Golden Lion Hotel, Blackburn.

The directors' report and balance-sheet for the half-year ending December 31 showed a net balance of £2,026. 10s. 6d., which was sufficient to pay a dividend at the rate of 6 per cent. per annum to preference and 4 per cent. per annum to ordinary shareholders, and to carry forward a credit balance of £193. According to the decision of the shareholders in September last, the directors had made an arrangement with the Corporation for electric traction on Preston-road and Witton sections, all the terms of which, with the exception of one or two matters of detail, had been settled, and they expected the agreement would be ready for completion at an early date.

In the course of his comments on the various items the **Chairman** remarked that the Company had got two experts to visit their tramway, and they had confirmed Mr. Lacey's figures as to what it would take per unit per mile. The Corporation had applied for borrowing powers, but were not yet in a position to sign any agreement.

The report and balance-sheet were passed.

A question having been put by a shareholder with reference to third party insurance, the **Chairman** said it was a very difficult thing to deal with, as it had previously been passed by resolution that the Company should not insure against accident. However, if the shareholders desired it, the directors would get in tenders and full information and present it at the next meeting.

Mr. Lonsdale considered the business of the Company should not be carried on without insurance, and he moved a resolution that the directors take steps to arrange for the reinsurance of the Company against third party risks.

Mr. Smalley seconded the proposition, and **Mr. Ormerod** said he would oppose it unless the directors said it would be a saving. After further discussion, **Mr. Ormerod** moved that the directors obtain tenders and full particulars concerning third party insurance, and this was seconded and carried.

In answer to shareholders, the **Chairman** replied that the Corporation had said that, after they got their borrowing powers confirmed, it would take about 10 months before the electric cars would be running. The company wished to have cars to hold 50 passengers—24 inside and 26 outside—and was also desirous of adopting an overlapping system, whereby Preston New-road passengers would be able to travel to the railway station and Witton passengers could proceed to Preston New-road. When they got the electric cars the Company intended to keep the old Preston-road cars, so that they could use them as trailer cars in wet weather.

INDIA RUBBER, GUTTA PERCHA, AND TELEGRAPH WORKS COMPANY, LIMITED.

Directors: Matthew Gray, Esq. (managing director), S. Wm. Silver, Esq., Abraham Scott, Esq., the Hon. Henry Marsham, Esq., A Weston Jarvis, Esq., and Major Leonard Darwin.

Report of the directors for the year ending December 31, 1896, to be presented at the thirty-third ordinary general meeting of the shareholders, to be held at the Cannon-street Hotel, E.C., on Thursday, February 25, 1897, at 12 noon:

The annexed accounts show, after provision for doubtful debts, a net profit for the past year of £51,888. 17s. Adding £20,239. 9s. 4d. brought forward, and deducting £12,500 interim dividend paid in July, there remains a disposable balance of £59,628. 6s. 4d. The directors recommend the distribution of a dividend of 15s. a share, free of income tax, amounting to £37,500, making, with the interim dividend paid in July, a total payment of 10 per cent. for the year, and leaving £22,128. 6s. 4d. to be carried forward. The year's general business has steadily increased, but the cable department and steamships have again been only moderately employed. The factories at Silvertown and Persan are in a high state of efficiency. The Company's debenture issue was carried out last year, and now stands at £300,000, bearing 4 per cent. interest. The death of Mr. W. J. Tyler in November last, after 25 years' service, was deeply regretted by the directors, and will be felt by all the shareholders. Major Leonard Darwin (late R.E.) joined the Board in July last. Mr. Marsham and Mr. Jarvis, who retire by rotation, offer themselves for re-election as directors.

BALANCE-SHEET, DEC. 31, 1896.

Dr. Capital and Liabilities.	£	s.	d.
Authorised share capital	812,000	0	0
Share capital—Amount paid on issue of 50,000 shares of £10 each	500,000	0	0
Mortgage debentures	300,000	0	0
Reserve fund	450,000	0	0
Debts and loans owing by the Company	35,987	8	9
Unclaimed dividends	9	0	0
Profit and loss account—balance, £72,128. 6s. 4d.; less interim dividend paid in July, £12,500	59,628	6	4
	£1,345,624	15	1
Cr. Assets and Expenditure.	£	s.	d
Freehold and leasehold premises (Silvertown, Persan, London, and Liverpool), machinery, and steamships	492,545	2	10
Debts owing to the Company	168,800	17	1
Cash with bankers in current account, and in hand	20,239	13	5
Bills receivable	1,826	14	3
Stock-in-trade, including 150 miles of cable laid	281,916	7	9
Debentures and shares in other companies	208,358	4	2
Cash, stock, debts, etc, at Persan and agencies after deducting liabilities	170,937	15	7
Debenture stamps (balance)	1,000	0	0
	£1,345,624	15	1

PROFIT AND LOSS ACCOUNT, YEAR ENDING DEC. 31, 1896.

Dr.	£	s.	d.
Salaries, interest, rent, rates and taxes, repairs, and general expenses	66,422	19	10
Bad debts	579	3	6
Income tax	2,449	17	4
Debenture stamps (one-third of cost of new debenture issue)	500	0	0
Depreciation written off buildings and machinery	16,131	0	6
Directors' remuneration	2,209	17	6
Balance—profit for the year, carried down	51,888	17	0
	£140,181	15	

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Cr.	£	s.	d.
Gross profit for the year after making provision for doubtful debts	140,181	15	8
	£140.181	15	8
Balance brought down	£51,888	17	0
Amount brought forward from 1895	20,239	9	4
Carried to balance-sheet	£72,128	6	4

W. T. HENLEY'S TELEGRAPH WORKS COMPANY, LIMITED.

The annual report of the directors has just been issued, and shows that a net profit has been made of £26,077. 8s. 7d. After payment of debenture interest and income tax, and making ample allowance for depreciation of plant, machinery, etc., there remains £20,527. 0s. 5d., to which must be added £13 367. 6s. 2d. brought forward from last year, making a total of £33,894. 6s. 7d. From this must be deducted £1,050, the interim dividend on the preference shares, and £3,000, the interim dividend of 3 per cent. on the ordinary shares, both paid on September 1 last, and there remains a balance of £29.844. 6s. 7d. Of this sum the directors have transferred £7 500 to reserve fund, and they propose the payment of a further dividend on the preference shares of 3½ per cent., making 7 per cent. for the year, and recommend the declaration of a further dividend of 7 per cent., free of income tax, on the ordinary shares, making a total distribution of 10 per cent. for the year, free of income tax. These payments together absorb £15,550, leaving £14,294. 6s. 7d. to be carried forward.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Lyons.—Tenders are wanted by March 10 for installing the electric light at the lunatic asylum at Bron. Application should be made at the Prefecture of the Rhône, Lyon.

Tarragona.—The Local Authorities of Tarragona will receive proposals on February 23 for the establishment of electric lighting for the city, on the basis of an annual payment (estimate) of 28,000 pesetas (£1,120).

Madrid.—The Spanish Government telegraphic authorities (Direccion general de correos y telegrafos) are open to receive tenders for 42,000 telegraphic insulators, and about 20,000 telegraph posts of various lengths.

Aylesbury.—The Urban District Council require tenders for lighting the public lamps, the clock tower, and fire brigade station for six months from March 1. Tenders to be sent to Mr. George Fell, clerk, Aylesbury, by 22nd inst., at 10 a.m.

Morecambe.—The Electric Lighting Committee of the Urban District Council are prepared to receive tenders for the supply and erection of electrical plant for a lighting station. Full particulars are given in our advertisement columns.

Breslau.—Tenders will be received on February 22 by the Prussian State Railway Authorities for the supply of arc lamp carbons and dynamo lubricating oil. Particulars for 50pfg. from the Königl. Eisenbahn-Direktion, Breslau, Gartenstrasse 206

Paris.—The French Telegraphic Authorities are offering for contract the supply of about 235 tons of high-conductivity copper in nine lots. The date for tenders is March 4, but the preliminary application must be made at Paris, rue de Grenelle 103, by the 21st inst.

Braila (Roumania).—The Local Authorities are prepared to receive up to March 15 offers for a concession for the construction and working of a system of electric tramways. The aggregate length of line would be about 13 miles, and applications and enquiries should be addressed to the Mairie, at Braila.

Torquay.—The Electric Lighting Committee of the Town Council are prepared to consider proposals containing terms and conditions upon which companies and others will undertake the free wiring of houses and premises in the borough. Further particulars are given in an advertisement in another part of this issue.

St. Pancras, N.W.—The Vestry require tenders for supplying and fixing at the King's-road electricity works two Lancashire boilers, feed-pumps, steam-pipes, and accessories. Copies of specifications, conditions of contract, and form of tender in duplicate to be obtained upon application to the Electricity Department Offices, 57, Pratt-street, N.W., on payment of a deposit of 10s., which will be returnable on receipt of a bona fide tender and specification. Tenders to be sent to Mr. C. H. F. Barrett, vestry clerk, Vestry Hall, Pancras-road, London, N.W, endorsed "Tender for Lancashire Boilers, etc.," by 12 noon on 23rd inst.

West Ham.—The Council are prepared to consider proposals from persons or companies willing to undertake the free wiring of premises in the streets in the borough about to be provided with mains for the supply of electric light by the Council under their provisional order. Full particulars as to the streets to be lighted in the first instance and all other information may be obtained on application to Mr. J. J. Steinitz, the Council's electrical engineer, at the Town Hall, West Ham, E. Proposals, with a description of the scheme, setting out fully the terms on which the work will be undertaken, must be endorsed "Free Wiring," and must reach Mr. Fred. E. Hilleary, town clerk, not later than February 24.

Ashton-under-Lyne.—The Corporation are prepared to receive tenders for the supply and erection complete of the following apparatus and plant: Refuse destructors; multitubular and Lancashire boilers; economiser, tanks, pumps, steam-pipes, etc.; continuous current steam dynamos, motor-generator, balancing transformer, switchboard, cables, street-boxes, etc.; arc lamps and columns, accumulators, overhead crane, station wiring, meters. Tenders may be sent in for any section or for the whole of the sections, but not for part of a section only. Plans of the district can be seen and copy of the general conditions, specification, and form of tender can be obtained on deposit of £5. 5s., which will be returned on receipt of a bona fide tender, at the Borough Comptroller's Office, Town Hall, Ashton-under-Lyne, or at the offices of the consulting engineers, Messrs Fawcus and Clirehugh, Temple chambers, Brazennose-street, Manchester. Sealed tenders, which must be on the prescribed form, endorsed "Tender for Electric Lighting," to be delivered to Mr. John Neal, borough comptroller, Town Hall, Ashton-under-Lyne, not later than 12 o'clock noon on March 15.

Islington, N.—Tenders are required by the Vestry of St. Mary for the supply of electrical stores for one year from March 25. Persons tendering must give the names and addresses of two substantial householders as their sureties prepared to join them in the execution of the contract, and must attend the meeting of the Vestry at 8 p.m. on 26th inst. They must annex to their tenders a schedule of wages relating to their respective trades, and will be required to make a declaration that they do and will during the continuance of any contract they may enter into with the Vestry continue to pay the trades union rate of wages as in practice obtain, and observe the conditions and hours of labour prevalent among the several classes of labour they may employ; and they must also agree not to sublet or assign over their contracts or any part thereof without the consent of the Vestry. Forms of tender and further particulars may be obtained and the draft contract inspected by application between 10 a.m. and 12 noon, at the Vestry Hall, Upper-street, N. No tender will be received after 12 noon on 25th inst. Parties tendering must be prepared with a £10 note, to be deposited (not enclosed with the tender) as a guarantee of good faith until the execution of the contracts.

RESULTS OF TENDERS.

Taunton.—The Corporation have accepted the tender of Messrs. C. Goodland and Sons to supply 1,200 tons of coal, at 14s. 7½d. per ton.

Poplar.—The Board of Guardians have accepted the tender of the Consolidated Telephone Company, at £15. 15s., for electric bell work at the workhouse.

Blackwall.—The London County Council have accepted the following tender for wiring, etc., in connection with the installation of the electric light at Blackwall Tunnel: Laing, Wharton, and Down, Limited, £4 700.

German Railway Contracts.—The tenders for the supply of telegraphic stores to the Prussian State Railway Authorities at Berlin and Cologne have been published. The competition was naturally entirely between German firms, and the results would require too much space to be reproduced here.

Ealing.—The District Council have received the following tenders for alterations and additions to the electric lighting works: W Foord and Sons, Brentford and Ealing, £3,829 (accepted); H Morecroft, Acton Green, £4.189; G. Wimpey and Co., Hammersmith, £3,967; T. Adams, Wood Green, £5 719.

BUSINESS NOTES.

Personal.—The Harrogate Corporation have appointed Mr. Geo. Wilkinson electrical engineer and manager.

Boilers, etc., Bill.—The Engines and Boilers (Persons in Charge) Bill has passed its second reading.

Dudley.—The Town Council have generally approved of the Birmingham, Wolverhampton, and District Tramways Bill.

Hull.—The Markets Committee have decided to adopt the Brighton system of charging for current used at the market hall.

Stonehouse.—The District Council have decided to provide accumulators to the electric light in the hall at an expenditure of £100.

Bradford.—A scheme is on foot to buy up the Clayton and Allerton Gas Company by the Bradford Gas and Electricity Supply Committee.

Newmarket.—The Urban District Council have approved of the replies to the objections against the electric light scheme as prepared by the Electric Lighting Committee.

The Norwegian Cable.—Communication with Norway having been restored, the cable steamer "Orsted," which has been working in Peterhead Bay, has returned to Copenhagen.

Crewe.—Under the auspices of the Crewe Scientific Society Prof. Roberts-Austen, C.B., F.R.S., chemist of the Mint, delivered an interesting lecture last week on "The Electrical Furnace."

Perth.—The members of the Water Commission met at the works at the close of the recent monthly meeting to inspect a new electric water-level indicator and recorder which has just been fitted up.

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The Crewe Tramways.—The Railway Commissioners have granted the order asked for by the British Electric Traction Company to construct and work electric tramways in Crewe and the district.

Horncastle.—At the meeting of the Rural District Council a letter from Mr. R. A. Caine, of Woodhall Spa, suggesting that the public lamps there should be lighted by electricity was allowed to lie upon the table.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended February 14 amounted to £1,219, as compared with £1,134 in the corresponding week of the previous year, being an increase of £85

Shoreditch.—The Building Committee of the Guardians have reported that they have made arrangements for fitting the new infirmary block for the electric light should the Guardians decide to adopt that form of illuminant.

Bristol Tramways and Carriage Company, Limited.—The traffic returns for the week ended February 12 were £2,120. 15s. 5d., compared with £1,839. 16s. 7d. for the corresponding period of last year. being an increase of £280. 18s. 10d.

Warmley.—At the meeting of the District Council a recommendation that the Council should approve of the Tramways Bill for the Staple Hill extension, provided £30 was allowed by the company for street-lighting, was considered and approved of.

Harrogate.—The Corporation have joined the Municipal Electrical Association. The building of the generating station is being pushed on as fast as possible, and the borough surveyor has been instructed to take some of the work in hand to expedite matters.

Nantwich.—At the Rural District Council meeting a letter was read stating that a date had been fixed for three commissioners appointed by the Board of Trade to hold an enquiry at Crewe with respect to the proposed scheme of the British Electric Traction Company.

Brighton.—On condition of nominal rentals being paid to the Corporation, the Works Committee have approved plans for the construction of a jetty station for the Rottingdean electric railway on the east side of Paston-place groyne, and for a landing-stage on the west side of the groyne.

City and South London Railway.—The returns for the week ended February 14 were £1,062, compared with £949 for the corresponding period of last year, being an increase of £113. The total receipts for the half-year 1897 were £7,674, compared with £6,947 last year, being an increase of £727.

Leeds.—The members of the Tramways Sub-Committee of the Highways Committee made their usual monthly inspection this week of the work being done in connection with the electric tramway from Kirkstall to Roundhay. It was found that satisfactory progress has recently been made.

Fulham.—The Vestry have appointed the chairman, vice-chairman, Messrs. W. Stuart Bourkes, Grieg, Adams, and W. Thomas, the medical officer of health, and the surveyor as a deputation to visit the dust destructors in operation at Warrington, Oldham. and Cambridge, at a cost not exceeding £75.

Change of Title.—The Glasgow branch of the firm of Messrs. Paterson and Cooper has recently been purchased by Mr. Wilfrid Marshall. who has been with the firm for many years, and will henceforward be carried on by him at 137, West Regent-street, Glasgow, under the style of Paterson, Cooper, and Co.

Radcliffe.—The two reports made by the Electric Light Committee upon visits to the electric light works at Windermere and Lancaster have had a very favourable effect on the District Council, and it is felt that if it can be made to pay in a place like Windermere, it ought to pay in a populous town like Radcliffe.

Wolverhampton.—The promoters of the Birmingham, Wolverhampton, and District Tramways Bill, 1897, having failed to concede the terms required from them by the Tramways Committee, the Town Council have refused consent to the promotion of the Bill and the construction of the tramways therein referred to.

Glasgow.—At the meeting of the Tramways Committee of the Corporation, it was agreed that all members who have not witnessed the trolley or overhead system of electric traction should visit Dublin and see the installation at work there. A special meeting of the committee will afterwards be called to discuss the whole question of mechanical traction.

Birkenhead.—It is stated that the Gas and Watch Committees of the Corporation have under consideration a scheme for lighting Grange-road with electricity. In the meantime it is only proposed to erect one or two lamps in the vicinity of Charing Cross, but should these prove satisfactory it is probable that the whole of Grange-road and other business thoroughfares will be similarly illuminated.

Declaration of Dividend.—The directors of the County of London and Brush Provincial Electric Lighting Company, Limited, have decided to recommend payment of a dividend on the preference shares of the company for the six months ended December 31, 1896, at the rate of 6 per cent. per annum on the amounts paid up thereon less income tax, subject to confirmation at general meeting to be held on March 8, 1897.

Colwyn.—At the monthly meeting of the Urban District Council the surveyor reported that he had written to Prof. Kennedy and Dr. J. Hopkinson asking for their terms to report upon the schemes sent in for lighting the district with electricity. Prof. Kennedy had replied that he could not undertake the work for some weeks. Dr. Hopkinson would undertake to report for a fee of 50 guineas. Dr. Hopkinson's offer was accepted by the Council.

Birmingham.—The subject of traction to be adopted by the City of Birmingham Tramway Company has again been before the Public Works Committee. Nothing, however, was done beyond instructing the clerk to send a request to the directors of the company that they should lay their new traction proposals before the committee in writing.

Warminster.—A letter was read at the Urban District Council meeting from Messrs. Cruttwell, of Frome, pointing out that Mr. Mark Hill claimed £120 for work done in connection with the electric light and for electricity, but to avoid litigation he was prepared to accept £40. On the recommendation of the Electric Light Committee the Council decided to repudiate all liability, and declined to make any further compensation than the £25 previously offered.

Altrincham.—The Cheshire County Council have consented to the Altrincham Electric Supply Company breaking up, filling in and reinstating, or making good the main roads in the Ashton-upon-Mersey district, along which they propose to lay electric mains, upon their undertaking that the footpaths interfered with should be restored to the satisfaction of the county surveyor, and that the structure of the county bridge over which the mains would be laid should not be interfered with.

Morecambe.—The Lighting Committee reported at the District Council meeting that they had resolved that the sub-committee should advertise for an engineer in connection with the electric light undertaking, and that the applications be reduced to three and afterwards submitted to the Council. It was also resolved that the sub-committee, or some of them, be authorised to visit and inspect such electrical works as they may think advisable, and that their out-of-pocket expenses be paid by the Council.

Ashton.—At the Town Council meeting, the minutes of the Electric Lighting Committee stated that the town clerk submitted the draft agreement between the Corporation and the British Electric Traction Company, Limited, as altered by the company's solicitor. The various alterations were considered in detail, and the town clerk was instructed to make certain re-alterations and amendments therein, and to again submit the draft for re-perusal by the company's solicitor. These minutes were carried.

Ealing.—At a meeting of the District Council the Electric Lighting Committee reported that the surveyor had been in communication with the Local Government Board with reference to the question of a "penny-in-the-slot" supply of electric light. In the opinion of the committee the Council should retain control of this department of the electric lighting business, and it was recommended that the clerk and surveyor should enquire and report further on the matter. The report of the committee was adopted.

Whitehaven.—The engineer having reported to the Water and Lighting Committee on January 13 that Messrs Siemens were prepared to commence the preliminary testing of the private lighting conductors, he was authorised to make the necessary arrangements for that purpose. Councillor Musgrave, in moving the adoption of the minutes at the Town Council meeting, said the preliminary tests of the private mains had been exceedingly satisfactory. Councillor Barr seconded the motion, which was adopted.

Withington.—At the meeting of the Urban District Council the minutes of the Parliamentary Committee were read and approved. The committee recommended that the tramway along Wilmslow-road should be carried no further than Barlow Moor-road, providing the threatened opposition is withdrawn. The matters arising out of the scheme were referred to the committee, but the Council resolved to enter into an agreement with the Manchester Carriage and Tramways Company to construct the tramline in Upper Chorlton road.

Fareham.—A letter was read at the Urban District Council meeting from the Local Government Board sanctioning the borrowing of £1,700 for purposes of electric lighting. The application was for £1,900, but permission to purchase a second-hand alternator at a cost of £200 was refused. The Clerk stated that the Capital and Counties Bank was prepared to advance the money at 3½ per cent., the payment to extend over 20 years. Mr. Appleby considered that these terms were too high, and the clerk was instructed to interview the bank manager on the subject.

Southport.—Councillor Hesford, in moving the adoption of the Electricity Committee at the Town Council meeting, called attention to a paragraph which stated that it was resolved that the charge for current as measured by the maximum demand meter be as follows: first hour's consumption 7d. per unit; second hour, 4d. per unit; third and following hours' consumption, 2d. per unit. He explained that the change was to take place from January 1. The only reduction was on the hours following the second, from 4d. to 3d. Councillor T. Jones seconded, and, after a long discussion, the minutes were adopted.

Sheffield.—The detailed estimates which have been deposited for the information of Parliament with reference to the Sheffield Corporation Street Widenings and Tramway Bill covers upwards of 34 pages of printed matter. They give the estimated cost of constructing the proposed tramways at £239,195, and the cost of the street widenings at £353,935, making the total cost of the works proposed under this Bill £593,130. With these estimates is a declaration by the town clerk that the probable annual amount of the rates and revenue upon which the money required to be borrowed will be secured is estimated "at the clear sum of £225,000 and upwards."

Yarmouth.—At the meeting of the Town Council a report was read stating that in the electric light department the income for the past month was £413. 16s. 8d., and the expenditure £192. 9s. 3d., leaving £221. 7s. 5d. to meet capital and sundry charges

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of £150 per month. Four more customers had been obtained, making the total now 204 customers, using 9,976 lamps. Mr. Preece recommended the following optional systems of payment for customers: a fixed charge of 1s. 3d. per lamp of 8 c.p. used at one time per quarter, and a charge of 3d. per unit for all units consumed, or a charge of 6d. per unit as at present. Churches and chapels, it was resolved, should be charged 4d. per unit.

Dover.—A letter was read at the Town Council meeting from the electric light company acknowledging the decision of the Council as to the sites of the electric lights in Biggin street. They also suggested that as they had had to lay an arc cable specially to Priory-place that an arc lamp should be placed at the bottom of Military-hill The Town Clerk said that the Council had already entered into a contract with the gas company to light Worthington street. Councillor Edwin suggested that the matter should be referred to the Town Ward Lighting Committee, but found no seconder, and on the proposition of Councillor Ayres a motion was carried to the effect that the electric light company should be informed that arrangements were already made.

Grantown.—A meeting of the enlarged committee appointed to enquire into the practicability of introducing the electric light into the village was held last week. There was a large and representative attendance of householders and merchants, about 30 being present. Dr. Barclay was called to the chair, and Mr. Aff. M Pherson was appointed clerk of committee. The clerk read the correspondence he had had with Mr. Smith, factor for Lady Seafield, regarding the proposed scheme, and also with the Fishery Board. He also tabled a large number of letters giving information regarding the electric lighting of Fort William. The matter was discussed in its various phases, and it was unanimously agreed, on the motion of Mr. Andrew M'Pherson Grant, to introduce the electric light into Grantown by means of the water power of the River Spey. It was also agreed to get the opinion of Prof. Kennedy as to which side of the river would be most suitable for the proposed works.

Huddersfield.—The Corporation have replied to the objections lodged before the Board of Trade by the Huddersfield Property Owners' and Ratepayers' Association against the granting of a provisional order to enable the authority to extend the tramway system. It is denied that a pledge was given by the Corporation that they would not seek powers to extend the tramways. No such pledge was asked for or given. No reference was made to a provisional order at the meeting of ratepayers. The application for an order was properly made under the authority of the Town Council. Mr. W. Ramsden, the solicitor to the association, points out that the mayor offered to a deputation of property owners and ratepayers to listen to any objections. He assured them that there was no intention on the part of the Corporation to seek for powers to extend the tramway or to increase the borrowing powers, but the objectors say they can prove that a distinct pledge was given. The objectors do not oppose the proposal in the application fo general power to enable the Corporation to work the tramways.

Devonport.—At a meeting of the Borough Council, Mr. Burt asked when the provisional order for electric lighting expired. Mr. Graves said the application was only made last November for three years. Mr. Penberthy enquired if there was any intention on the part of the Council to adopt that system of lighting, or had the provisional order simply been obtained to prevent private enterprise from stepping in? Mr. Tozer referred to the need of lighting the business thoroughfares of the town more satisfactorily. Mr. Whitfeld was opposed to the Council taking up a matter which they never intended to prosecute, and piling up bills of cost which the ratepayers had to pay. The total law charges for obtaining the electric lighting provisional order was £230. A sum like that should not be flung away merely to keep away an outside company from supplying the electric light. Mr. Fredman referred to the improved lighting of Pipe-lane, and called the committee's attention to the bad state of Edinburgh-road. The Council instructed the Electric Lighting Sub-Committee to bring up a report.

London Motor Van and Wagon Company.—Subscriptions are invited for the capital of the London Motor Van and Wagon Company, Limited, which is £300,000, in £5 shares. The prospectus states that the Company is formed to produce and sell or let out on hire, or sell on the hire-purchase system, motor-vans, etc., whether propelled by steam, electricity or oil. The motors, it is stated, will be fitted by the Company to the bodies of vans, and arrangements for this purpose have been made with E. H. Bayley and Co., Limited, van builders, until such arrangements can be made by the directors as may seem desirable to them. The Company intend to offer for sale or hire parcel delivery and light motor-vans of all kinds, and wagons and drays, trolleys for dock purposes, post-office mail vans, etc. It is intended to build any kind of motor-van, and to supply experienced drivers. The business, it is said, will be confined as much as possible to London, and various depôts are to be opened. The prospectus points out that this Company under its license obtains the right to manufacture motor vans and wagons under all the patents at present owned by the British Motor Syndicate, including the Daimler, Kane-Pennington, Bollée, etc.

Leadgate.—A considerable discussion took place at the District Council meeting as to the advisability of taking steps towards having the district lighted by electricity. The Clerk said that Medomsley had decided not to join in any advances which might be taken in the direction of a scheme for the electric lighting of the district. Councillor Keenleyside remarked that he had noticed a remark recently made by one of the gentlemen who held shares in the gas company. This gentleman had said that the gas company did not exist so much for the sake of the shareholders as for the benefit of the general public. Councillor Whitfield said that if the three Councils would join together it would be quite feasible to run a scheme of electric lighting for the whole district. Councillor Costello said that if it was proposed to have a conference the Board would want some information on the subject, so that they might take an intelligent part in any interchange of opinions that might take place. Councillor Greener moved that the matter lie over for next month, and that in the meantime they should endeavour to get some information on the subject. Councillor Robson seconded. Councillor Costello remarked that it would be better to have a meeting of the Lighting Committee and report upon the matter. After some further discussion Councillor Greener's motion was carried, the Clerk undertaking to collate some information for the assistance of the Council.

Newport.—A new electrical sub-station, which has been provided in the basement of the town hall for the more economical working of the high-tension system—to provide for the incandescent lighting of the business premises and private houses—was opened last Monday. The fittings at the new sub-station consist of three transformers, reducing the current from 2,000 volts to one-tenth of that number; a high-tension switchboard, mounted with the necessary high-tension fuses and switches, by which either of the transformers can be cut off if necessary; and a low-tension distributing switchboard, by which the current for the whole district served can be supplied from either one, two, or the whole three transformers. The sub station is provided solely for the purpose of private lighting, and it will not be necessary now to cut off so much of a district when connecting a new consumer. Mr. G. H. Llewellyn, vice-chairman of the Electrical Committee, speaking at an Oddfellows' dinner on Monday evening, said he recently formed one of a small committee from the Corporation to visit other parts of the kingdom to get information as to how increased electrical plant could best be obtained, and on returning home he was greatly pleased to notice how favourably the Corporation electrical plant compared with that of other towns. He hoped that before the third year of the installation of electricity at Newport had expired the return would be such that a handsome profit would be handed over to the rates.

Bingley —At a meeting of the District Council, minutes of the Gas Committee were read to the effect that the Council, after taking the advice of an expert, could not accept the offer of the Leeds and Liverpool Canal Company to supply electricity to the Council at the rate of 4d. per unit. Mr. Gatecliff, in moving the adoption of the minutes, said that although some years ago the Council obtained borrowing powers for the provision of a supply of electricity, the proposal which the committee had had under consideration was first broached by the canal company, and it had been the subject of very careful inquiry. The committee learned that the price of 4d. per unit asked by the canal company was exorbitant, and decided to call in an expert for advice. His report had been considered, and the three points he dealt with were—the buying of electricity in bulk from the canal company; the generation of electricity by the Council at Dowley Gap by power gained from the River Aire; and, lastly, the generation of current by coal at the gasworks. It was shown that for the Council to generate current itself would be by far the cheapest way, and that it would be absolutely necessary to have a consumption of from 50,000 to 60,000 units per annum to make it pay at a charge of 6d. per unit to the public. That would represent the sum of £1,500 a year, and the total sales of gas last year were just over £10,000 in value, so that the public would require to use electricity equal to one-sixth or one-seventh of the amount spent on gas. Under these circumstances the committee were unanimous not to take further steps unless encouragement was given them by the ratepayers. The motion was adopted after a short discussion.

Taunton.—A memorial was read at the Town Council meeting from a number of ratepayers asking the Council to consider the advisability of reducing the charge for the electric light to 4d. per unit. The matter was referred to the Electric Lighting Committee. The following report of the electrical engineer (Mr. Harold W. Couzens) was read: "I have the honour to report that your consulting electrical engineer (Prof. J. A. Fleming, D.Sc., F.R.S.) has visited the works during the past quarter and inspected the machinery and plant generally. As ordered at the last meeting, we have extended the main on the Trull-road for the supply at Claremont. During the past quarter an accident, due to shortness of water, happened to one of the boilers at the generating station, causing the tubes to spring at the back end Repairs were at once effected, and the claim has now been settled by the Boiler Insurance Company. Acting under the committee's instructions the chairman and myself attended a meeting of the Municipal Electrical Association in London, regarding fire insurance of electricity works, on the 28th ult. The chairman ably put before them the vagaries that the insurance offices have been through with regard to our sub-stations The meeting was very representative and thoroughly in earnest, and I have no doubt that the insurance companies will be favourably influenced by it. We have had some trouble during the past quarter with some of the cables. This has been due to momentary effects which take place in switching the cables from one machine, which latter is done for economy in working expenses. The act of switching over is liable to cause an instantaneous discharge which may pierce the insulation of the cable. This has entailed much work and anxiety, and we are taking active measures which, when completed, will obviate entirely any recurrence of these destructive phenomena. The cables in themselves, I may add, are perfectly sound and as good as when laid."

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Cardiff.—At the meeting of the Electrical and Lighting Committee of the Corporation on Tuesday last a report was presented by the electrical engineer (Mr. N. Applebee) giving some interesting statistics. At the end of 1895, Mr. Applebee stated, there was an equivalent of 9,330 8-c.p. lamps connected to the system, and at the end of 1896 there were 14,136, showing an increase of 4,806. The returns of the amount of current supplied were also satisfactory. The units sold in the two years were 175,078 in 1895, and 306,450 in 1896, an increase of about 75 per cent. The current had been generated by the original plant, which had a capacity of 440 kilowatts, and a comparison showed that the plant at Cardiff had been made more use of during the last 12 months than the plant at any other municipal electricity works with the exception of four places—Brighton, Dublin, Edinburgh, and St. Pancras. When the additional plant which Messrs. Ferranti and others were supplying was completed, it would remedy the somewhat overloaded state of affairs, but he considered it necessary to point out to the committee that if the applications for the supply of current continued to come in at the rate they had been doing in the past the supply would be more than exhausted by the demand, and that, too, without allowing for any very large consumers, such as the new post office, or for electric traction purposes. The existing generating plant comprised four sets—two to supply 5,630 8-c.p. lamps each, and two to supply 1,250 8 c.p. lamps each—so that, estimating one large set to be held in reserve (as it should be), 8,130 lamps could be alight at once. By the addition of the new plant 13,860 lamps could be alight at the same time, and, reckoning the proportion at about 80 per cent., this would really mean a total of 17,000. Eventually, a small committee was appointed to go into the matter, and to visit some works near Manchester to inspect certain plant in working order. The sub-committee will accompany a deputation from the Tramways Committee which has been appointed to inspect the model of a tramway worked by electricity with a view to introducing electrical cars for Cardiff.

Chester.—At the annual meeting of the gas company the Chairman made some allusions to the electric light. He said those of the proprietors of the company who were in any way connected with the city felt proud that Chester had taken foremost rank for its public improvements, and the many advantages that it gave to the citizens. They would regret that Chester should not possess whatever advantages the scientific knowledge and engineering skill of the present day would give it as a residential place such as it was in competition with other towns. They must confess that the electric light had advantages for certain places and for certain purposes over lighting by gas, but having made these concessions with regard to the electric light, they could do so with very great heartiness when they considered that gas, too, had for certain purposes and in certain places advantage over the electric light, and above all it had the advantage of being considerably cheaper and a more economical illuminant. They had heard 10 years assigned as the period within which the gas company would be snuffed out. He thought it would last his time at any rate, whether it was 10 or 30 years, and he believed that in generations to come gas would continue in favour for purposes for which the electric light was not adapted or in any way so economical. There was no instance in England where the electric light had been introduced where the gas supply had been materially affected for any length of time, and he ventured to say there was no instance where the dividends had been cut down in consequence of the electric light. At this particular time it might be gratifying to the proprietors to know that in December and January last the ordinary gas stock of that company reached the highest price on the open market that it had ever touched. Besides that, it was also gratifying to know that they had a constant demand for services of supply. The electric light was introduced on December 17; it was not then in full force; but now there was a large amount of it in the town, yet up to the very day on which he was addressing them the gas company had a very large increase week by week over last year's supply.

Newcastle Exhibition.—The exhibition has been opened by the Mayor. In the display of electrical machinery local firms have the principal place, and their exhibits are sufficient testimony to the enterprise of Tyneside firms. Messrs. Ernest Scott and Mountain, Limited, of the Close Works, Newcastle, exhibit two vertical electric light engines which drive the dynamos supplying the current to the exhibition; the dynamos are of the compound-wound type, with drum-bar armatures. The firm exhibits also a set of three-throw pumps and an electric motor, high-speed launch engines, a ventilating fan and engine, an electric coal-cutting machine of the disc pattern, and other apparatus. Messrs. J. H. Holmes and Co, of Portland-road, Newcastle, are also exhibitors, and their electric lighting plant includes a "Holmes-Williams" steam dynamo and a "Lundell" patent slow-speed electric motor, driving printing machines direct without gearing, and fitted with a controller for starting and stopping and varying the speed; and a "Lundell" standard electric motor, driving a printing machine by belting. The machinery at the stands of Messrs. Clarke, Chapman, and Co, of the Victoria Works, Gateshead, includes a one-ton electric winch, two direct-coupled compound engines and "A V" type dynamos, direct-coupled single-cylinder engines and dynamos, belt-driven dynamos, alternate-current electric motors, and an electric drill arranged to drill holes up to 1¼in. in diameter at one cut, or to knife out holes up to 2in. diameter, with cutter and bar. Messrs. Easton, Anderson, and Goolden, Limited, of Erith (Kent) and London, illustrate the application of electricity to coal-cutting and rock-drilling and pumping, and they show besides an electric lift. Their electrical bar coal-cutter is intended for use in fiery mines, the armature, commutator, and brushes being enclosed in gastight covers. The machine cuts its own floor, and may be arranged to cut at any desired height above the floor. The rotary rock drill is suitable for ironstone mines, and, in Cleveland ironstone, the drill enters at the rate of 4ft. per minute in hard and 5ft. per minute in soft stone. Messrs. Thwaites Bros., Limited, Bradford, exhibit a Crichton's patent high-speed engine coupled to a "Castle" dynamo. A display of electric lighting is made by Messrs. Rowland Barnett and Co, Limited, of Dean-street, Newcastle. Among the machinery driven by electricity are the fine printing machines at the stand of Messrs. Andrew Reid and Co. Messrs. Hunting and Co., Newcastle, contribute wood-working machinery driven by electric motors, and machines for similar purposes are to be seen on the stands of Mr. John Anderson, and of Messrs. Robson and Jackson, and by Messrs. Kirchner and Co., of London. An electrically-driven lift, to raise 15cwt. at the rate of 100ft. per minute, is sent by Messrs. Pickerings, Limited, Stockton-on-Tees. The steam power for the exhibition is supplied by Messrs. Clarke, Chapman, and Co., of Gateshead, from two Petersen water-tube boilers. Messrs. Clarke, Chapman and Co. have also on view a Forster's patent single-acting engine. Among other firms exhibiting personally or through local agents are the British Aluminium Company, London; the Barrovian Portable Primary Electric Lamp; the Roller Bearings Company, Limited, of London; Messrs. John Mills and Sons, Limited, of Newcastle, lightning conductors, electric bells and fittings, electrical signalling apparatus for mines, telephones, ventilating fans, steam-pumps, and electrical clocks; the United Asbestos Company, Limited, Quayside, Newcastle; the Sunderland Forge and Engineering Company, Limited; and so forth.

Norwich.—A report was received at the Town Council meeting from the Law and Parliamentary Committee expressing the opinion that formal consent should not be given to the Norwich Electric Tramways Bill until all matters of detail arising thereout have been definitely agreed upon with the New General Traction Company, Limited, the promoters of the Bill, and embodied in an agreement under the seal of the company. Mr. Tillett said the committee had not been able to come to an unanimous decision, and, at the request of the chairman, who voted with the minority, he had undertaken to move the resolution arrived at by the majority. There were two schemes before the city—one the light railway, and the other the tramway scheme. At an early stage of the committee meetings a resolution was passed, stating that they should not proceed to the further consideration of the light railway scheme until it was seen whether it was possible to make arrangements and terms with the company. The question before the Council was whether or not consent should be given to the Bill of the tramway company. Perhaps "consent" was an unfortunate term. Innumerable details had to be dealt with to which objection might be taken, and the present question was whether the Bill was worthy further consideration. It was necessary that "consent" should be given that morning. It would be well that conditional consent should be given. Mr. Kennedy, the agent, had given an undertaking to withdraw the Bill at any time at the request of the Corporation, and this undertaking was backed up by the company and the directors. The committee had at its first meeting unanimously resolved that tramways are desirable in Norwich under proper conditions. The company proposed to spend a sum of £150,000 in Norwich. It was proposed to propel the cars by overhead wires, which was not objected to, though they might expect to hear sentimental objections to that. Cars would pass a given point every five minutes. The company would pay £1,000 per annum in rates, and the Corporation would have the option of purchase at a fair valuation by arbitration at the end of 21 years. The motion which was now submitted he moved in committee, but the facts, he said, had since changed, and he now moved it as a matter of form in order to admit of an amendment being made by Mr. Hackblock. If the consent was given the personal undertaking of Mr. Kennedy, the agent, the company, and the directors to withdraw the Bill at any time at the request of the Corporation, in his opinion would be a perfectly satisfactory state of things, justifying the giving of consent. It was to be regretted that the Corporation had not seriously considered whether they should not do the work themselves. This he regarded as much more within the range of practical politics than the taking over of the Norwich Waterworks Company. But if this were not possible, they might adopt the intermediate course of laying the lines themselves and leasing them to the company. Coming to the question of improvements, which might possibly be £60,000 or £100,000, he said that every member of the Corporation would agree that this was a matter into which they should not rush blindly, but one on which they should exercise too much rather than too little caution. Assuming that the improvements would amount to £100,000, it was proposed that the outlay should be divided between the Corporation and the company. The annual charge in respect of the capital would be £4,250, from which £1,000 would be deducted in respect of the rates which would be contributed by the company, leaving £3,200 to be divided between the Corporation and the company, the latter of whom would make an annual contribution of £1,600. As security for this moiety, the company would give a charge on the Norwich undertaking, which would be a good security or not according as the undertaking proved a success. Mr. Haynes seconded *pro forma*. Mr. Hackblock urged that the Council should take advantage of the offer of a company of responsibility to contribute to the improvement of the city. It was not advisable to kill the two earnest bidders for the adoption of their rival schemes until the Corporation had got the best terms possible. By all means let the consideration of the details proceed, and he accordingly moved that consent be given

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to the Bill. Mr. G. White seconded the amendment, and it was carried unanimously.

PROVISIONAL PATENTS, 1897.

FEBRUARY 8.

3248. A combined switch and brake lever for electric motor vehicles. Douglas Neale, 21, Rutland-square, Edinburgh.

3249. An improved method of gearing for electric motor vehicles. Douglas Neale, 21, Rutland-square, Edinburgh.

3254. Improvements in phonographs. Theodore van Heemstede Obelt, 1, Broad-street-buildings, Liverpool-street, London.

3279. An improved means of supporting the cells in electrically-propelled vehicles. Carl Tunstill John Oppermann, 2, Wynyatt-street, Clerkenwell, London.

3281. Electric automatic weighing apparatus attachable to any ordinary counter scales or weighing machine. Johannes Schuil and William Booth, 20, Gladsmuir-road, Whitehall-park, London.

3288. Improvements in electric furnaces. Ramon Chavarria Conrardo, Norfolk House, Victoria-embankment, London.

3330. Improvements in electric arc lamps. William James Davy, 40, Chancery-lane, London.

3334. Improvements in contact-boxes for depressible conductor rails of electrical railways. Zalmon Goodsell, 40, Chancery-lane, London.

3346. Improvements in secondary batteries Clement Payen, 45, Southampton-buildings, Chancery-lane, London.

FEBRUARY 9.

3363. Improvements in electric cables. Sebastian Ziana de Ferranti, Hollinwood, near Oldham.

3381. Improvements in appliances for electrically igniting the explosive charge in gas or oil engines. John William Hunter, 10, Dermody-gardens, Lewisham, London.

3459. Improvements in connectors for galvanic batteries. George Jesse Brown, Alfred William Southey, and the Electric Motive Power Company, Limited, 55, Chancery-lane, London.

3462. Improved carbon for electric arc lamps. Daniel Asa Shesler, 55, Chancery-lane, London.

3470. Improvements in clamp connections for electrical conductors. Siemens Bros. and Co., Limited, 28, Southampton-buildings, Chancery-lane, London. (Siemens and Halske, Germany.) (Complete specification.)

3471. Safety cut-outs for electric circuits. Siemens Bros. and Co., Limited, 28, Chancery-lane, London. (Siemens and Halske, Germany.) (Complete specification.)

FEBRUARY 10.

3488. Improvements in secondary batteries. Ernest Schattner, 146, Hithergreen-lane, Lewisham, London.

3526. Improvements in apparatus for the electro-deposition of metals. (Partly communicated by Frederick William Zingsem, United States). John Eborall Hartley, 12, Cherry-street, Birmingham.

3594. An improved switch device for common or party telephone lines. Julius H. West, 6, Lord-street, Liverpool.

FEBRUARY 11.

3648. Improvements in or relating to electric incandescent lamps. Frederic Ridyard and Walter Wardle, 55, Market-street, Manchester.

3669. Advertising on incandescent electric lamps and the like. Francis Harrison and Horace Stanley Deacon, Marie Villa, New Southgate, London.

3674. Telephonograph. John Clark and John Henry Calcott, 5, Brown's-court, Edgware-road, London.

3676. Improvements in phonographs. Theodore Van Heemstede Obelt, 1, Broad-street-buildings, Liverpool-street, London.

3716. Improvements in or relating to electric cables for telegraphy and telephony. William Arthur Price, 55, Chancery-lane, London.

FEBRUARY 12.

3754. Apparatus for transmitting electric current to a moving body. David Keil Tullis, 154, St. Vincent-street, Glasgow.

3768. Improvements in electric traction motors. Rankin Kennedy, 33, Gladstone-street, Bradford.

3772. Improvements in portable electric lamps for use in mines and other places. Sydney Ferris Walker, Severn-road, Cardiff.

3812. An improved current collector for use in connection with electrically-propelled vehicles and for like purposes. Anton Heusch and Paul Brandt, 11, Southampton-buildings, Chancery-lane, London. (Complete specification.)

3831. Improvements in or relating to electric batteries. Arthur Reginald Adams, 111, Hatton-garden, London.

FEBRUARY 13.

3848. Improvements in and applicable to electric arc lamps. Henry Mostyn Darrah, 70, Market-street, Manchester.

3906. Improved electrically-operated switch tongue. Emil Andre and Albert Silbermann, 111, Hatton-garden, London. (Complete specification.)

3914. Improved means for signalling or advertising by electricity. Alexandre Ginisty, 9, Warwick-court, Gray's-inn, London.

3973. Improvements in arc lamps. Ignace Hippolyte Hegner, 46, Lincoln's-inn-field, London. (Complete specification.)

3983. Improvements in or connected with prepayment meters for gas or other fluid or for electricity. Wesley Webber, 4, South-street, Finsbury, London.

SPECIFICATIONS PUBLISHED.

1896.

1396. Machinery or apparatus for transmitting motion from electric motors to other machinery. Hulse.

1843. Means or apparatus used for connecting electrically-propelled vehicles on tramways and railways to fixed conductors. Urquhart and Wynne.

1958. Electric gas lighters and extinguishers and the like. Armstrong and Braunerhjelm.

3809. Sockets and holders for incandescent electric lamps. Snell, Francis, and Spilsbury.

4937. Plates, grids, or supports for the elements of secondary batteries. Clark, Clark, and King.

5041. Conductors for telegraphs, telephones, and electrical distribution. Swinburne.

6510. Electric arc lamps. Brockie.

7259. Construction of soluble-metal electrodes for accumulators. Thompson. (Julien.)

12149. Electrolytic apparatus. Holland.

12244. Electrical lighting apparatus. Oldenbourg.

21116. Ticket-issuing apparatus for the electrical staff instruments on single lines of railways. O'Donnell. (Hopkins.)

24548. Automatic safety device for electric circuits. Rowand.

26846. Electric bell-pushes or knobs. Sanders.

29040. Means for automatically holding taut the communicating or conducting cord or chain of electrically-driven vehicles. Entwisle. (Beffa.)

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	£5	9-9½
Brush Company, Ordinary	£3	⅞ 1⅛
—— Non. Cum., 6 per cent. Pref.	£2	1½-1⅝
—— 4½ per cent. Debenture Stock	100	109-112
—— 4½ per cent. 2nd Debenture Stock	100	94-98
Callender's Cable Company, Debentures	100	104-109
Central London Railway, Ordinary	10	9½-10
——	6	5½-6
Charing Cross and Strand	£5	9½-10
Chelsea Electricity Company	£5	8½-9
—— 4½ per cent. Debentures	100	112-115
City of London, Ordinary	10	17-18
—— 6 per cent. Cumulative Pref.	10	16½-17½
—— 5 per cent. Debenture Stock	100	129-133
City and South London Railway, Consolidated Ordinary	100	59 61
—— 4 per cent. Debenture Stock	100	139-141
—— 5 per cent. Pref. Shares	10	15½-16
County of London and Brush Provincial Co., Ordinary	10	9½-10½
—— 6 per cent. Cum. Pref.	10	14-14½
—— 4½ per cent. 2nd Debenture Stock	£5	10½-10⅝
Crompton and Co., 7 per cent. Cum. Pref. Shares	£5	1⅞-2½
—— 5 per cent. Debentures	—	93 98
Edison and Swan United Ordinary	£3	1⅞-2½ x d
—— 5 per cent. Debentures	£5	3-4 x d
—— 4½ per cent. Debentures	100	105-110
Electric Construction, Limited	£2	1½-1⅞
—— 7 per cent. Cumulative Pref.	£2	2½-3
Elmore's Copper Depositing	£1	¾-1⅛
Elmore's Wire Company	£2	⅜ ⅝
W. T. Henley's Telegraph Works, Ordinary	10	19 20
—— 7 per cent. Preference	10	18½-19½
—— 4½ per cent. Debentures	100	109-114
House-to-House Company, Ordinary	£5	5-5½
—— 7 per cent. Preference	£5	8⅞-9⅛
India Rubber and Gutta Percha Works	10	21-22
—— 4½ per cent. Debentures	100	106-109
Kensington and Knightsbridge Ordinary	£5	10-10½
—— 6 per cent. Pref.	£5	8-8½
London Electric Supply	£5	1½-1⅝
Metropolitan Electric Supply	10	13½-14½
—— 4½ per cent. First Mortgage Debenture Stock	100	119-122
National Telephone, Ordinary	£5	7½-7⅝
—— 6 per cent. Cum. First Pref.	10	17-19
—— 6 per cent. Cum. Second Pref.	10	17-19
—— 5 per cent. Non. Cum. Third Pref.	£5	6½-6⅞
—— 3½ per cent. Deb. Stock	100	104-107
Notting Hill Company	10	11-12
Oriental, Limited, £1 shares	£1	1½-2
—— £5 Shares	£5	8½-9
—— £4½ shares	£4½	7½-8
Oriental Telephone and Electric Company	£1	11/16-13/16
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	103-105
St. James's and Pall Mall, Ordinary	£5	12½-13½ x d
—— 7 per cent. Pref.	£5	9½-10½ x d
Telegraph Construction and Maintenance	£12	39-42
—— 5 per cent. Bonds	100	102-105
Waterloo and City Railway, Ordinary	£8	10-10½
Westminster Electric Supply, Ordinary	£5	11½-12½
Yorkshire House-to-House	£5	8½-8¾

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NOTES.

Personal.—Mr. S. P. W. V. Luke, C.I.E., Deputy Director-General of Indian Telegraphs, retires from the service next month.

Electro-Harmonic Society.—The Electro-Harmonic Society have a "ladies' night" concert this (Friday) evening at the St. James's Hall Restaurant, Regent-street.

The Civil Engineers.—The papers last Tuesday at the Institution of Civil Engineers were on the "Main Drainage of London" and on the "Purification of the Thames."

Royal Institution.—Lord Rayleigh's course of lectures on electrical vibrations begins on Saturday, March 4. Dr. Percy Gardner starts a new set of afternoon lectures on Greek monuments. The fixtures for the week will be found in their usual place.

Institution of Electrical Engineers.—The next students' meeting will be held at 28, Victoria-street, Westminster, on Wednesday, March 3, at 7.30 p.m., when a paper on "The Lighting of Country Houses" will be read by Mr. A. H. Graham.

The Junior Engineers.—The annual conversazione of the Institution of Junior Engineers has been fixed for Saturday, March 6, at the Westminster Palace Hotel. There will be a reception at 7.30 p.m. by the president (Mr. A. R. Binnie, M.I.C.E.) and Mrs. Binnie.

Society of Arts.—There was a great crowd to hear Sir H. Trueman Wood's paper on photography in colours on Wednesday. It may be mentioned that examples of the pictures are on view to members and friends to-day and to-morrow, and they are certainly worth going to see.

Obituary.—Mr. John Faulkner, who recently died in his seventy-fourth year, at Manchester, had been connected with electrical science for many years. One of his applications of electricity was in connection with signals and bells for coal mines. In 1855 he invented improved electromagnetic telegraph sounders and bells.

Prof. Hughes.—The professors and students of the Polytechnic School of Engineering, Regent-street, have presented their president for this year (Prof. D. Hughes, F.R.S.) with an illuminated address congratulating him upon the honour conferred upon him when he received from the hands of H.R.H. the Prince of Wales the medal of the Society of Arts.

Royal Society.—Among the papers down for Thursday at the Royal Society were one by Prof. Dewar, F.R.S., and Prof. Fleming, F.R.S., on "The Dielectric Constant of Ice and Alcohol at very Low Temperatures," and another by Dr. E. T. Jones "On the Relation between Magnetic Stress and Magnetic Deformation in Nickel." For the rest, the proceedings related to the biological side of science.

Himalayan Telegraphs.—The Indian papers record another of those accidents which have added to the difficulties of keeping open the Gilgit telegraph lines. An avalanche on the Burzil Pass has swept away a party of five natives sent to repair the lines. Readers of these notes will have already realised that these are emphatically among the lines that have not fallen in pleasant places.

The Heilmann Locomotive.—According to the *Revue de Physique et de Chemie*, a Heilmann locomotive for trial on the Chemins de Fer de l'Ouest has left the workshop, so we may expect something definite in the way of performance at last. This particular locomotive has Willans and Robinson engines, but it is understood that the inventor, who appears to have his own ideas of economical working, has now (on paper) got beyond that to steam turbines.

A Problem in Toads.—An American contemporary, whose information is usually remarkably correct, under the title of the "Advantage of being a Toad," says that in a 7,000-volt alternating-current plant in France a short-circuit arose, and on examination it was found that there was a toad between the terminals of one of the transformers, the curious fact being that the animal was not dead when found and was resuscitated. As one-tenth of a volt properly applied is more than sufficient to tetanise the nerve or muscle of a frog, a little more detail is desirable.

Carbide of Calcium.—Mr. Kearley, the member for Devonport, has been asking the President of the Board of Trade whether he was aware that large quantities of carbide of calcium were being imported to this country, and whether, having regard to its dangerous nature when exposed to air, Clause 14 of the Petroleum Act could be made to extend to its inclusion. At first sight it would look as though even to an official there were difficulties in the way of classing C_2Ca among the compounds of carbon and hydrogen; but Sir M. W. Ridley, who replied, said the dangers attending the storage and conveyance of carbide of calcium had been occupying the attention of the inspectors of explosives for some months, and steps were being taken to apply to that substance by an Order in Council the provisions of the Petroleum Acts. A memorandum will eventually be issued to local authorities suggesting the precautions to be adopted for preventing risk.

High Tension.—Mr. H. Scholey has contributed to the February number of *Cassier's Magazine* a biography of Mr. Ferranti as the man responsible for most of what has been done in England in the way of high-tension transmission. It is noteworthy that, in spite of his Italian name, Mr. Sebastian Ziani de'Ferranti can only count four of the customary "sixteen ancestors" as of Venetian origin. Three of his grandparents are English, Flemish, and American, so that as things go he must be mainly a Teuton, like the rest of us. The article in *Cassier* is illustrated not only with portraits of its subject at the age of 3, 16, and 30 or so, but also of his machines in their development. One need not here refer to the history of the Grosvenor Gallery plant or the Deptford station, nor Mr. Ferranti's views on electrical distribution: these are well known. But his biographer thinks that what Mr. Ferranti is going to do in the future of electrical progress will bear comparison with what he has already done.

The Energy of the Cell.—The following abstract of a contribution to the *Zeitschrift für Physikalische Chemie* by J. M. Lovén on the subject of the temperature coefficient of the E.M.F. of silver cells is published in the *Journal* of the Chemical Society: The energy relations in a galvanic chain are given by the equation $\pi\epsilon = E + \epsilon T . d\pi/dT$, where π is the E.M.F., ϵ the electricity developed, and E the total energy of the change. The temperature coefficient, $d\pi/dT$, may therefore be either positive or negative, according as the total energy is less or greater than the electrical energy. Measurements were made in the chain, silver | silver chloride in potassium chloride solution | potassium nitrate solution | silver nitrate solution | silver, and similar chains with bromide and iodide. The current and E.M.F. were determined, and also the heat of precipitation of silver chloride (which is the chemical change of the process), as well as the temperature coefficient, which was in each case found to be negative. The value for $\epsilon T . d\pi/dT$ agreed fairly well with the difference between the electrical energy and the heat of precipitation, as indicated theoretically.

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The Westminster Company.—The institution of founders' shares offers many temptations when a company is started, and thereafter proves an unmitigated nuisance, and sometimes a positive danger. At the Westminster Electric Supply Corporation's meeting on Wednesday a gentleman, who should have a fairly distributed knowledge of London electric companies, called them the meanest and most disgusting sort of share going. There is no doubt that they are one of the things that are best got rid of. But the bargain that has to be struck to do so is a peculiar one, and it appears to be of the nature of shareholders that they are inclined to drive a close bargain when things are going well, though when prospects are bad they will consent to almost any terms. And it is only in the first case that anyone troubles about founders' shares. At the Westminster meeting, however, when the matter was fully explained, there was no difficulty, and some who came to object remained to support the resolution. Afterwards, as there happened (most curiously) to be an omnibus belonging to the Electric Traction Company down at Eccleston-place to be charged, there were some that rode to Victoria Station.

Phase Difference.—In the *Technological Quarterly* is a description of Dr. Louis Derr's apparatus for illustrating phase difference, suited for lecture-room illustrations. A wire carrying the current is stretched perpendicularly across the magnetic field, and has a force developed in it which moves it at right angles to the direction of the field and the current. This wire is connected with a small mirror, which reflects a beam of light on a screen. The wire is "tuned" by adjusting the tension so that the period of free vibration may be made to coincide with that of the current, and the line of light which would be formed is drawn out into a curve by means of the usual revolving mirror, the result being a perfect sine curve when the wire is vibrated mechanically. With two such wires the phase difference between the two currents is easily shown by a horizontal displacement of the curves. With a current of one ampere and a distance of 30ft. the amplitude of the curve will be 2ft., but the results are not quantitatively accurate; and if the currents are not truly sinusoidal—and though it is convenient for people to assume them so, that is just what they generally are not—the inaccuracy may be considerable. The instrument therefore belongs to the "-scope" rather than the "-meter" class.

An Absolute Electrometer.—An absolute electrometer for measuring small differences of potential (about one volt), which has been invented by Messrs. Pérot and Fabry, is described in the *Comptes Rendus*. The instrument is an attracted disc electrometer, in which the necessary sensitiveness is obtained by greatly reducing the distance between the plates. The attracting disc consists of the plane end of a glass cylinder about 6cm. in diameter and 1cm. high, this height being large compared with the distance between the two discs. The attracted disc consists of a thin circular disc of glass about 7cm. in diameter. These discs are lightly silvered, their parallelism is adjusted, and their distance measured by being traversed normally by a beam of mono-chromatic light, which forms interference bands between the light which has passed directly through the thin silver coating and that which has been reflected an even number of times at the silvered surfaces. The attraction is measured by comparing the deformation of the three springs which carry the movable disc with that produced by a known weight when placed on the disc. A comparison of the E.M.F. of a Clark cell measured in electrostatic units by this method with the known E.M.F. in electromagnetic units is stated to give $29{,}989 \times 10^6$ as the value of the ratio v.

Platinum.—Without platinum no (incandescent) lamps. Some time ago there were some that professed a belief in the possibilities of beryllium, but that we need not regard. Now most platinum comes from Russia. According to statistics with regard to the production of platinum there which were recently published by the Russian Minister of Finance, the annual output of that country is 40 times as great as that of all other countries combined. In 1880 the amount produced was 2,946 kilogrammes (under three tons, and not a very big lump to look at), and this had increased by 1895 to 4,413 kilogrammes. The turn-out, in fact, continually increased, the only exception being that the figures for 1895 were less than the 5,028 kilogrammes of 1894, owing to the wet weather prevailing during the summer. The metal is exclusively found in the South Ural, and it is exported in its raw state to Germany, where it is manufactured. If some gold-mine prospector would only leave the yellow metal and discover some new platinum mines he would not only provide those who look towards Capel-court with something new to play with, but would greatly benefit a deserving section of humanity. And he might get some gold after all.

Endowed Science in America.—According to the *Scientific American*, a formal recommendation is to be submitted to Congress in favour of the establishment of one great scientific department of science in place of the several existing separate Government bureaus, which are maintained at great expense for the promotion of science and the development of the resources of the country. Apart from the Government schools and the testing laboratories of the War and Navy Departments, the United States maintains no less than 28 scientific "bureaus" for the development and advancement of industrial resources. These bureaus employ over 5,000 persons, and are maintained at an expense of £1,600,000. As all the bureaus have a common purpose, and considerable money and time is wasted by the duplication of work, it is urged that they should be placed under the direction of a single head. The statistical records of the national resources and products of the country are collected and kept by eight different agencies connected with six different Government department bureaus, not counting the Census Bureau. It will, therefore, be seen that much of this relates to the collection of figures—a matter which is after all of very subordinate importance compared to the discovery of facts. At one time, of course, it was thought that the two things were identical; but we are beginning to know better now.

Tramways in New York State.—The New York State Board of Railroad Commissioners have come to the conclusion that level crossings of street tramways and railways should be done away with. Nothing, however, is more remarkable than the different feeling of the American and British public on the subject of the proper standard of safety, and one can therefore have no difficulty in agreeing with the *Electrical World* that the Commissioners' efforts will avail little without greater support from the American public. Signals, gates, and other appliances at crossings, while good in their way, cannot always be relied upon as preventitives of accidents. The Commissioners remark that a thoroughly efficient fender for electric cars does not seem to have made its appearance. This problem, if not impossible, is a much more difficult one to solve than most people realise, and it would seem that all the devices in the market lack the one essential quality of reliable action at all times and under all circumstances. As to the treatment of passengers by employés of the street railway companies the Board suggests that employés should be courteous to passengers. (In Europe we take

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that for granted.) An American contemporary is inclined to defend the men, and apparently on the ground that the public is rude to them. The matter is a thing which at once strikes a European traveller in the States, but it will be better in every way to let our Transatlantic cousins settle their own disputes in their own way.

Regulations in Spain.—A further instalment of the new regulations for public electric supply in Spain has been published in the *Revista de Obras Publicas*. For overhead lines the posts, whether metal or wood, must not be more than 110 yards apart, or more than 65 yards on curves; in towns they must "be placed and painted in such a manner as to conduce to public ornament." The wires are to be carried at a minimum height of 20ft., or 32ft. in streets, and one metre horizontally distant from any building, or 8ft. vertically above any roof. The factor of safety for the breaking strain of wires is to be 6, and the maximum heating is to be 50deg. C. Bare overhead wires are not allowed for high-tension currents. Then we come to the definition of high and low tension. This is 500 volts continuous, or 150 volts alternating is to be the limit of a low-tension current. It is only recommended, not prescribed, that high-tension conductors should not bear their own strain, but should be suspended from a wire by tags of non-conducting material. If taken into a house, high-tension conductors must be covered with a fireproof material, and be inaccessible except to the proper persons. Where high and low tension wires cross, the higher tension wire is to go below. There are to be guard wires or nets, and the upper wire is to have a certain length of insulating covering. It is put upon the undertakers to effect that "by induction there shall be no perturbations in the wires of the telegraphic or telephonic service." In the same way the undertakers have to arrange their conduits so that there shall be no accumulation of gas in them. The use of gas or water pipes as returns, and earth returns generally, is prohibited. For overhead wires (high-tension) the resistance of the insulating covering must not be less than 625,000 ohms/kilometres, and the insulation to earth or the return conductor, 28 to 30 megohms/kilometres. That is as far as we have got at present; the rest is to follow.

The Boilers Bill.—In the House of Commons last week, the Engines and Boilers (Persons in Charge) Bill came on, the second reading being moved by Mr. J. Samuel. The Government opposed it—and were beaten As it happened, the Bill did not get into committee; but as, according to the accepted principles of the British Constitution, it is not the duty of a Government to be wiser than a chance majority of members who were chosen certainly not because they knew anything about boilers, the Bill may get through and do unmeasured mischief. It concerns the interest of every central-station engineer. And it also concerns the safety of the general public that it should be possible to at least suspend a boiler tender who has shown signs of recklessness without having to stop working until another man is found who has passed the examination and acquired the Board of Trade certificate. The real object behind the Bill is pretty well known, but, of course, it is advocated on the grounds of public safety. Now upon every boiler explosion there is a sort of inquest, and statistics are available as to the cause of boiler explosions. It is therefore no mere matter of inference that ignorance on the part of the tender is not one of them. Carelessness may be, though, as a matter of fact, it seems very rare; but one cannot examine for carelessness. As might be expected, the Bill was debated in dense ignorance of the subject. Among those who were fortunate enough to catch the Speaker's eye were agitators or theorists; great employers of engines and boilers were overlooked. One member who employs 200 boilers utterly failed to get a chance of explaining to sensible men how things really stood. Mr. Courtney is not an employer of boilers, yet he was called upon, and Mr. John Burns, who employs no one, was called. Mr. William Allan, of Gateshead, who makes boilers but does not use them, was called. Mr. Allan's views are well known. For the present the Bill is shelved, but its reappearance should be watched for.

Royal Society of Edinburgh.—In the current issue of the *Proceedings* of the Royal Society of Edinburgh, Prof. Tait finishes a short contribution on linear and vector functions, which concludes with, if not a defiance, at any rate a defence of the superiority of quaternions against all other methods whatsoever. Incidentally, he is contemptuous of the particular kind of algebra invented and used by Mr. Oliver Heaviside, calling it Volapük, and declaring that when its results are translated to him he can get them much easier and more quickly by quaternions. Apparently as an example of the proper way, a quaternion treatment of the electric wave surface is appended. It is certainly admirably succinct, but these matters are so high that the writer would consider it almost presumption to understand and quite irreverence to hold an opinion of his own. What is known, however, is that even with the common and familiar Cartesian co-ordinates it is quite possible for a mathematician (to save trouble it may be said he was a foreigner), in treating the electric wave (not the wave surface), after some pages of calculus, to bring out and get reprinted in most of the technical and some of the scientific papers results which, if translated into the plain language of wave motion, will be seen to be at once well-known consequences of inadmissible assumptions and at the same quite inapplicable to the purposes for which they were wanted. Besides Prof. Tait, Dr. Thomas Muir has about 14 pages on a rather protean eliminant of a set of ternary quartics. But this is "pure," and one therefore is not compelled to enter the dismal country of determinants. Dr. J. Walker and Mr. Kay show reasons for believing that the "hypoiodite" of magnesium is a "solid solution," not a chemical compound. After all, it may be a question of degree. The president's address is also published in this issue. It deals with a multitude of subjects, including electric fishes and the feeling of sounds (electrically translated into microphone currents) by the skin. The rest is biological, and concerns us not at all.

Pressure and its Influence.—The following conclusions of G. S. Meyer on the influence of tensional and compressive stresses on the thermo-electric and magnetic properties of metals from *Wiedemann's Annalen* are published as an abstract in the *Journal* of the Institute of Electrical Engineers: "The author, as regards magnetic properties, discovered that the 'Villari point,' in very weak magnetic fields, may also be observed with cobalt, in addition to iron and nickel. The thermo-electric properties of the metals experimented upon (iron, steel, nickel, cobalt, copper, silver, brass, aluminium, gold, platinum, cadmium) may be described as follows: in non-magnetic metals the E.M.F. produced by extension may be stated to be proportional to the tension as a first approximation. Hysteresis is not perceptibly present. In the experiments on the magnetic metals attention had to be continually paid to the alteration in their magnetic condition which is simultaneously produced by the extension, since its influence may be of equal, or even greater effect than that of the load. It appears to the author that the neglect of this circumstance, even if it be not the sole reason, is directly responsible for there being so many contradictions in the results of earlier

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observers as regards the magnetic metals. With soft iron, the influence of the extension cannot be determined by itself, since it is always accompanied by alterations of magnetisation which probably mask the simple action of the tension. With nickel and cobalt, extension produces an E.M.F. which is in the same direction as that due to longitudinal magnetisation. Since, however, tensional stresses at the same time cause a decrease of the magnetisation, the E.M.F. produced is the difference between the E.M.F. due to the extension alone and that due to the decrease in the magnetisation. With stronger magnetisations the latter can be made greater than the former. The very slight alterations of the magnetisation in nickel and cobalt at the 'Villari point' do not affect the E.M.F. sufficiently to produce a point of reversal in the thermo-electric curve. The first application of the load with all metals influences the E.M.F. more than the succeeding ones."

Telegraphs in South America.—According to telegrams dated February 10 from a correspondent of the *Financial News*, there is serious trouble between the River Plate Telegraph Company and the Argentine Government, and the company states that it will institute immediate proceedings against the Argentine Government for what it considers to be an unwarrantable interference with its operations. Heavy damages will be claimed, as the office has now been closed for some time by order of the Government. This trouble between the South American cable companies and the Governments of South American States appears to have had its origin somewhat in the following manner: The Western and Brazil Company has been enjoying a monopoly of telegraph communication on the coast of Brazil, the concession running until 1913. This telegraph line is connected with the city of Buenos Ayres by lines operated by the River Plate Telegraph Company of Monte Video. In order to prevent competition in business destined for the United States and Europe, an overcharge of 50 cents in gold per word has been imposed on telegrams *vid* Galveston to Brazil since the year 1892. Representations to the different Governments concerned produced no effect until last June, when the Argentine Government ordered the River Plate Telegraph Company to stop collecting this overcharge in Argentine territory. Protests and proposals of arrangement followed, all tending to prevent the interference of Argentina, until October, when the Government of Argentina gave the River Plate Telegraph Company 24 hours in which to comply with its decrees. The governor sent a representative to the office of the River Plate Telegraph Company to prove that violation was being insisted upon, and at three o'clock stopped the service here because of the alleged evidence of insubordination. Since then the River Plate Telegraph Company has enquired of the Government concerning the terms under which the reopening of its office would be permitted, and the Government has replied that only on unconditional surrender without any reserve, expressed or implied, would the company be allowed to continue its business.

The "Warren Hastings."—Why the transport "Warren Hastings" should have run on to Réunion is one of those questions that are not within our scope, but the following details of the wreck and how it was met in the engine-room may be not without interest to our readers. They are part of a communication to the *Times* from one of the passengers on the ill-fated vessel. "It happened at 2.15 a.m. in torrents of rain and inky darkness. She could not possibly have remained above water for more than five minutes had she gone ashore anywhere else—it is an awful coast; but where she lies she has a hole right into the engine-room, which keeps her from slipping back. After striking she bumped and scraped with every great wave in the most appalling manner." . . . "The captain thought that the ship would stick for a bit, but almost immediately she began to heel over to starboard. The order was then given to get everybody on shore at once, and before long, as she heeled over more and more, 60deg. at least, the captain said that any man that could swim might do so. Boats were useless, they were dashed all to pieces on the rocks." In spite of the intrusion of a portion of the island of Réunion into their domain, the engineers stuck to their work. They "behaved splendidly. The forward boiler-room filled at once and all the natives bolted. The engineers opened the safety-valves, and so saved the ship, otherwise she must have blown up. The electric light went out for about two minutes (this was the worst time for us below), but one of the engineers somehow kept the dynamo going with another engine; had she listed to port, and not to starboard, and the dynamo been flooded, there would have been no light, and the affair would have had a different ending." Who he was we have not the slightest notion, but anyone who knows the addition made by darkness to the confusion of a wreck will see the considerable probability that the unnamed man, not to mention the makers to whom it is due that that dynamo was kept running at an angle of 60deg. from the vertical, and by the wrong engine, had a good deal to do with the fact that finally there were "all safe and sound, about 1,200 miserable objects sitting on the rocks in the rain."

The Indo-European Telegraphs.—From a note by the secretary of the Public Works Department reviewing the administration report of the Indo-European Telegraph Department for the year 1895-96, which has appeared in the *Gazette of India*, the traffic earnings of the department show an increase of Rs.72,248 over the previous year, due wholly to earnings in India on homeward traffic. Miscellaneous revenue also shows an increase of Rs.27,413, due to the sale of old cable core in England and to increased earnings by the cable steamer for work done for other departments. Expenditure shows a decrease of Rs.9,417 as compared with the previous year. The decrease is mainly due to fewer repairs to lines and cable steamer having been necessary. The net revenue shows an increase of Rs.1,08,108 as compared with last year, and gives a dividend of 7·42 per cent. against 6·50 on the capital. This is the highest dividend ever earned by the department. The general working of the department has been very satisfactory. No total interruption of traffic occurred. A very high rate of speed was maintained, and the percentage of errors fell from 0·284 in 1894-95 to 0·171 in 1895-96. The mechanical and electrical condition of the cables and land lines is also satisfactory. Mr. Ffinch reports that the system of automatic translation has been introduced on one circuit between Teheran and Kurrachee, and has been found very successful. It is hoped that when the necessary instruments are ready, the system may be extended to both circuits, and that a considerable reduction in the staff employed at Bushire may result therefrom (possibly eight employés). The report is considered a satisfactory one; for if the line can earn nearly 7½ per cent. on its large capital, the policy of reducing the existing rate for messages between Europe and India becomes apparent. The action of the Government of India's representatives at the last International Telegraph Conference at Budapest this year was strongly in favour of some such reduction, but their endeavours were defeated owing to the opposition of the Eastern and Indo-European Telegraph Companies. It is the intention of the department to raise this question again at the first suitable opportunity.

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Animal Electricity.—At the Royal Institution last Tuesday Dr. Waller mainly devoted himself to the experimental demonstration of the electrical effects that go with muscular action, taking the heart as the most convenient and typical muscle for that purpose. Normal muscle at rest gives no current from one part to another—it is isöelectric. If injured, the direction of the current (in an exterior circuit connecting them) is from the uninjured to the injured part. When the uninjured muscle is at work the direction is to the part in action from the part at rest, or acting less vigorously—that is, the portion in which for any reason there is greatest chemical change taking place acts to the other parts like the zinc which is attacked in a galvanic cell. (This statement contains at once the origin and justification of Dr. Waller's new term, "zincative.") In the heart the muscular contraction begins at the base and ends at the apex. It was shown with an isolated frog's heart and a capillary electrometer that at the beginning of the contraction the potential of a terminal connected to the base of the heart is higher than that of one to the apex, and at the end lower, while between the two effects there is a period of no P.D. corresponding to the whole organ being in a contracting state. The effect of a typical heart reagent, muscarine, was also demonstrated. On exhibition of the drug the frequency of the pulsations fell rapidly, and they ultimately ceased altogether. A notable point in the experiment (whether it is a constant phenomenon, with a meaning attached to it, or an accident of the arrangement of the instruments, the writer does not know) was that the amount of the muscular movement of the imperfect or incomplete pulsation decreased much more rapidly than that of the electrical effect corresponding to it. Although on consideration it will be seen that the attachment and contacts of the heart in the pericardium somewhat facilitate the matter, it will be to most people somewhat of a surprise that a difference of potential on the surface of the body due to the difference of potential between the apex and the base of the heart is measurable by means of a capillary electrometer. It can be done with a human subject, but for anatomical and other reasons a dog is better, and when, like Dr. Waller, you have one that will stand with his fore and hind feet in basins of salt and water, it is possible to connect up with the capillary electrometer and show the effect on the screen.

More Waves.—After a little more than three weeks (to the mere journalist how enviable seem the leisurely proceedings of these learned men), Prof. Case has arisen in protest against even a hypothetical existence being allowed to Prof. Crookes's private wave. His interpretation of what Mr. Crookes really means is not quite the same as the writer's, but that does not affect the general point—namely, the danger of indefinite speculation of the "may it not be" order of architecture. "Now, it makes all the difference in the world to the plausibility of the professor's hypothesis how it is expressed. Expressed as he expresses it in the misleading language of abstraction, it looks as if nothing could be simpler than a brain wave passing from one person to another. Expressed in accordance with the concrete reality of things, this apparently simple hypothesis bristles with difficulties. How does the thought of the influencing person, which in our experience only acts by slow nervous and muscular motion, makes particles vibrate with a velocity many times more rapid than that of light? What are these vibrating particles, and what their vibration? Surely not brain particles nor brain waves?" Mr. Crookes obviously meant, not brain waves, but ether or electric waves originated by the motion of the atoms of which the brain substance is composed. The real difficulty, of course, is that such waves would be immediately dissipated in transmission, and Mr. Crookes does not, at any rate intentionally, as his critic puts it, "hypothesise an unknown agent obeying unknown laws of action." The danger, of course, is not that Prof. Crookes will produce inaccurate and unscientific results, but that his example may encourage men of much inferior calibre to talk about waves doing this and that without having any clear ideas behind what they say. There has been a great deal of that sort of thing in America in connection with electric waves, and we are not without occasional instances of it in this country. Now, there is one region of possible applications of electricity which very few care to enter upon because, owing to loose and unscientific treatment at the outset, it became ultimately a happy hunting ground for charlatans. One does not want yet another established on the physical side, or, indeed, anything to delay the coming of the time when the investigator will be able to tell us what the thing we use and measure with such unfailing accuracy really is.

The National Physical Laboratory.—The *Times* has made up its mind on the proper form of State endowment of research, if other people have not. "In this matter of scientific training, our universities do not turn out the right sort of men, and our manufacturers do not demand the right sort of information. It is in these quarters that real reform must begin, and when it has been effected the State may be properly appealed to for assistance in crowning and completing the edifice. Our universities cram men with book knowledge and test it by everlasting examinations. Consequently they turn out pedagogues very competent to teach book knowledge to another generation and to set examination papers of the most formidable kind, but possessing neither the ability nor the inclination to deal with the application of their science to affairs." It is really our manufacturers, backed by the great unenlightened public, who are in fault. In the worship of the "practical man," we "go on by rule of thumb, while the German makers are always looking for something better by the aid of practically trained chemists. That is how German research is endowed and rewarded, and that is how German science becomes a power in German industrial expansion. We cannot get these results by setting up another State department in the Old Deer Park at Kew." There has been a great deal said about the Reichsanstalt at Berlin. Its outlay is put at £15,000 a year, but nothing is said of its revenue derived from manufacturers who find it worth while to have its warranty for their productions. It is proposed to govern our projected national laboratory by a committee appointed by the Royal Society, alone or in conjunction with other similar societies. But the Reichsanstalt, supposed to be the model, is not governed that way at all. "Its committee consists of three members selected from leading firms in Germany; of high scientific officials from the War Office, the Admiralty, the Royal Observatory, and the Royal Commissioners for Weights and Measures, and of professors or heads of observatories connected with the principal German universities. In other words, industry is directly represented by three members, and every other man is an active Civil servant in direct contact with affairs, and representing practical science in a scientifically organised State." The State sets up the institution, the manufacturers of Germany supply its revenue in fees, and the State manages it through men everyone of whom has to justify and retain his position by sound and practical work.

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THE LUNDELL MOTOR.

As mentioned in our last issue, Messrs. J. H. Holmes and Co., of Newcastle-on-Tyne, are taking up the manufacture of the Lundell motor in England. The design of the motor has been referred to in our columns before, but we have not previously illustrated the salient features. The patents for these motors, now owned and worked by Messrs. Holmes and Co., were issued in this country in 1892 and 1893 respectively, so that the type is comparatively recent.

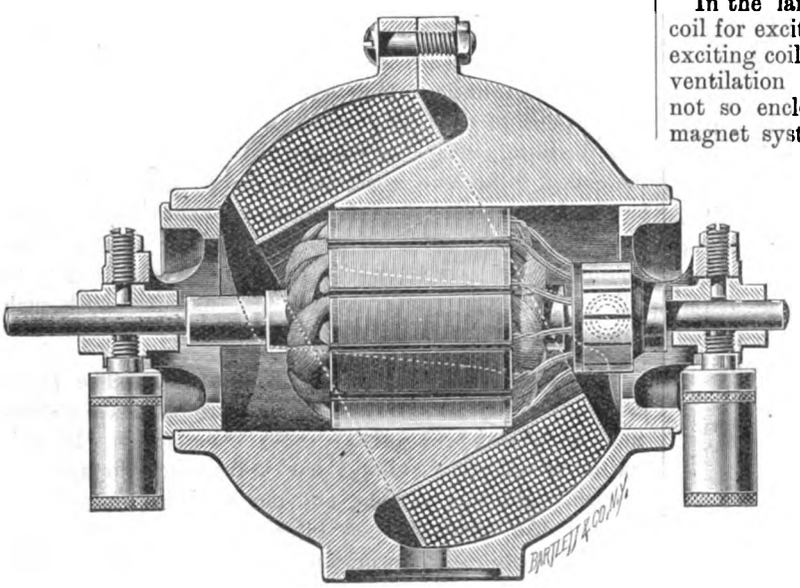

FIG. 1.—Section of the Small Lundell Motor.

These motors, however, have, owing to their compactness and efficiency, created a large demand in America. The purposes for which the smaller sizes are mostly used is for fan work, but the larger sizes have a practically universal application. Commencing with the small two-pole type, of which we give a section in Fig. 1, it will be seen that the whole motor is most compact. The spherical case is cast in two halves and bolted together. Each half has one polar projection, as shown. The great feature in this design is the use of a single exciting coil surrounding the poles and armature. In the two-pole type the axis of this coil is inclined so that space may be saved. The coil is wound on a former and then well insulated by tape, which binds the wires solidly together. It can thus be easily placed in position before putting the two halves of the casing together.

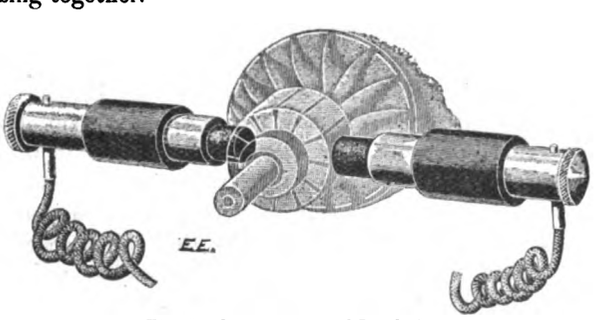

FIG. 2.—Commutator and Brush Gear.

When looking at the parts of the motor, one is first struck with an idea that there must be a good deal of magnetic leakage; but a more careful examination disproves this. The shortest path for stray lines is between the pole tips and the case opposite them, the lines passing through the exciting coil. A glance at the section (Fig. 1) will show that the resistance of this path is much greater than that through the armature. All the armatures in these motors are of the drum-wound, toothed-core type. The core plates in the smaller sizes are threaded direct on the shaft, but in the multipolar types a spider is used and the cores are ventilated. The armatures are most neatly wound in the recesses in the core, which are previously well insulated. The commutator and brush gear are shown in Fig. 2. The brushes in the smaller sizes consist of a wick of rolled-copper gauze on a carbon rod sliding in a tube, and held against the commutator by a compressed spring. The sockets for these holders are screwed into the case. The same spring which keeps the brush on the commutator serves to clamp the connecting wires from the source of supply. The bearings and lubricators are shown in Fig. 1. The wick lubricator (Fig. 3) is in the larger sizes replaced by ring lubrication. This motor lends itself to reproduction in quantity, and a glance at the section shows that the little machine work necessary can be done very quickly with a capstan lathe.

In the large machines of the multipolar type the single coil for excitation is still retained, but then the axis of the exciting coil cannot be inclined. There is a much better ventilation in these multipolar types, as the machines are not so enclosed as with the two-pole sizes. The field-magnet system in these large sizes is practically the same

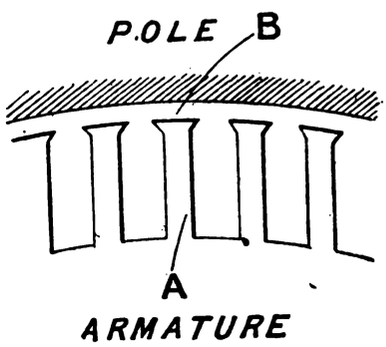

FIG. 4.

as those used by Messrs. Siemens Bros. and Johnson and Phillips for their alternators, except that the polar faces are inside instead of outside.

We had a most interesting conversation with Mr. Robert Lundell last week on the design of his motor and on kindred subjects, and the following statements will be of interest to our readers. The motors are made two-pole up to 20 b.h.p, unless specially low speeds are required for direct-coupling purposes. From 20 b.h.p. to 50 b.h.p. four-pole machines are used, and six-pole from 50 b.h.p. to 100 b.h.p. The 200-b.h.p. motors would have eight poles. The charge from one number of poles to the next is ruled by the fact that only one armature bar is placed in each slot in the core, giving one turn per section. With a two-

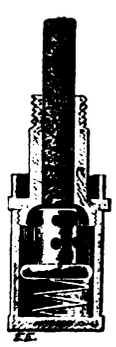

FIG. 3.—Wick Lubricator.

pole machine the point is soon reached at which the one turn per section requires to be subdivided, to give ease of commutation. In England this difficulty has been got over by winding two or three parallel circuits on the armature, and using brushes which span from three to four segments of the commutator. The multipolar design, by dividing up the flux, does away with this necessity, and also reduces largely the weight of the field.

The next point to be discussed was the air-gap with large-toothed core armatures. Mr. Lundell has paid great attention to this problem, and assures us that he can always work with an air-gap varying from $\frac{1}{8}$in. to $\frac{1}{4}$in. The first step in the development of his treatment is to proportion the iron teeth of the core so that they are always saturated. Thus (in Fig. 4) the induction in the

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air-gap, B, would be about 7,000 C.G.S. lines per square centimetre, and in the stem of the tooth, A, it would, from the design, rise to 18,000 at light loads. The teeth thus being worked over the bend of the curve require a large change in magnetising force to raise the induction. This tends to reduce the cross-induction, which, by weakening induction at the pole-tips near the brushes, is apt to cause sparking. The length of the tooth being comparatively short, this damping effect on the cross-induction is, however, not sufficient in the larger dynamos.

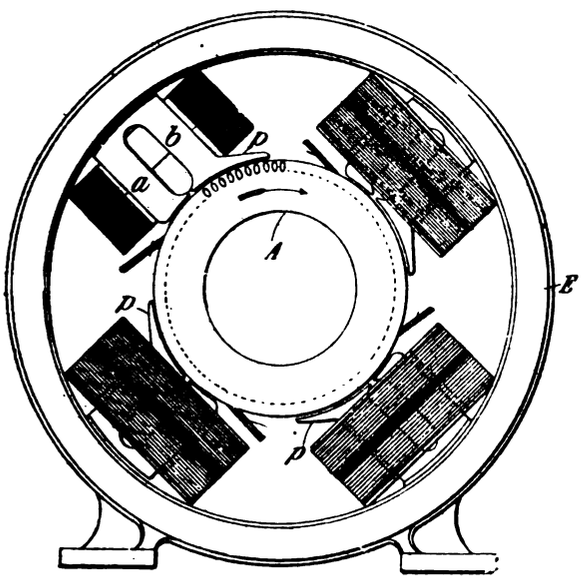

FIG. 5.—View of a Four-Pole Generator of Mr. R. Lundell's New Type.

Mr. Lundell's next development of this idea is explained in the patent No. 18,273, granted to him in 1896, dated August 18. The illustrations (Figs. 5, 6, and 7) are taken from the Blue-book, and give, perhaps, an exaggerated view of the modifications. The poles are divided up the centre into two halves, *a* and *b*, in accordance with a well-known method of reducing the cross-induction. The half, *a*, nearest the brush is provided with the normal pole-piece, but the other half, *b*, has about twice the polar area of *a*. The section *z z* is also so proportioned as to have half the area of *b*. The result of this construction is that the iron in *b* is saturated at no load, owing to the low magnetic

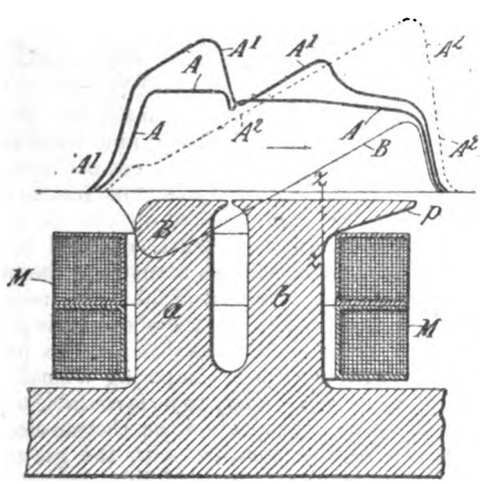

FIG. 6.—Enlarged Section of Differential Pole, with Diagram of Air-gap Induction.

resistance of the air-joint. To establish equilibrium, it follows that the air-gap induction opposite *a* is more than that opposite *b*. The curve A A shows the distribution of induction in the air-gap at no load. The magnetising effect of the cross-turns, as shown by the curve B B, tends to reduce the induction in *a* and increase it in *b*. Now, at no load the iron in *b* is magnetised to a point over the bend of the magnetisation curve, and a large force is therefore required to increase the flux through that limb. Hence the cross-turns can do little but alter the distribution of the flux immediately under each pole face. Again, at full load, owing to the back turns and the drop due to the armature resistance, an increased flux is required. This is obtained by the series turns, but owing to the saturated state of *b* these ampere-turns cannot produce much effect on that part of the magnet core. The limb *a*, however, is capable of taking a considerable increase in induction. This raises the induction at the approaching edge of the pole, or, at any rate, keeps the same at an approximate constant value as required for sparkless commutation. The final curve of distribution of induction is marked A_1 A_1, whereas A_2 A_2 shows what would be the distribution without this device. With suitably designed proportions the brushes can be kept in the same position for all loads, thus doing away with the necessity for shifting the lead.

The following are Mr. Lundell's claims under the patent: (1) The method of preventing shifting of the point of commutation in a dynamo-electric machine having shunt and series coils, by increasing the magnetic field, as the load increases, at the pole corner where the commutation takes place without corresponding magnetic increase at the

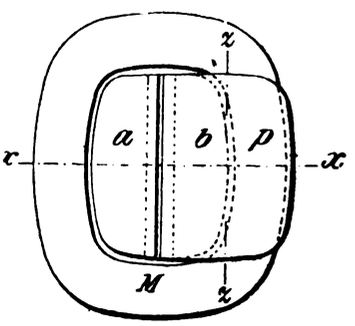

FIG. 7.—End View of Pole.

opposite pole corner, substantially as described; (2) a dynamo-electric machine having its magnetic field cores or poles arranged to have saturated and unsaturated portions as and for the purpose described; (3) for preventing the shifting of the magnetic field with an increasing load in a dynamo-electric machine, the employment of field cores or pole-pieces having low magnetic reluctance on the side where commutation takes place and high magnetic reluctance on the opposite side of the pole; (4) in a dynamo-electric machine a field-magnet coil surrounding a field-magnet pole or core which is divided into two parts separated by an air-space, one of said parts having an inner field-pole surface of greater area than the other for the purpose specified; (5) in a dynamo-electric machine a field-magnet coil surrounding two field-magnet poles separated from each other by an intervening air-space, one of said field-magnet poles having a wedge-shaped pole-piece, the inner face of which is of greater area than the inner face of the other pole-piece, substantially as described.

This latter patent, which marks the most decided advance we have noted in dynamo design for some years, has not, we believe, been yet disposed of in this country.

The following are particulars of a few of the motors now to be manufactured by Messrs. J. H. Holmes and Co., which may be useful for comparison with other types. The efficiencies in all but the first two are guaranteed figures.

B.H.P.	Voltage.	Speed.	Weight, lb.	Efficiency, %.
1/12	115	1,900	17	45
1/8	115	1 800	28	51
1/4	115 to 230	1,700	40	65
1/2	,,	1,500	75	70
5	115 to 500	1,100	—	82
25	,,	750	—	90
30 kw	230	650	1,800	—

We wish the new venture of the above firm every success, and trust that it will result in a fewer number of small motors being imported into this country, in spite of the growing demand for these machines.

THE COX THERMO-ELECTRIC GENERATOR.

We were invited last week to inspect the works and manufactures of the Cox Thermo-Electric Company at St. Albans. Mr. H. Barringer Cox, the inventor of the

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apparatus called by his name, showed us practically the whole process of manufacturing the generators, and also a goodly number of the same in operation. There is nothing particularly new to be said about the theory of the apparatus, although Mr. Cox assured us that the accepted theories were mostly wrong. As a result

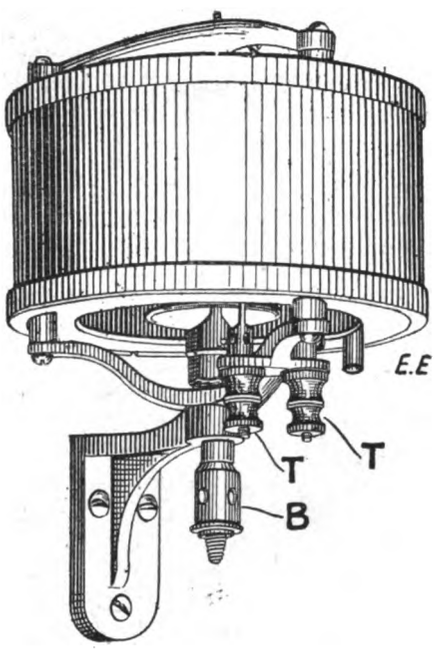

FIG. 1.—General View of the Cox Thermo-Electric Generator.

of a long conversation on the subject, we gathered that after all the old theories held good, and that it was due to careful attention to detail that the performance of the Cox generator excelled. A full view of this apparatus is shown in Fig. 1, in which T T are the terminals of the generator and B is a Bunsen burner supplying heat. The section of the apparatus (Fig. 2) gives more information as to the details of construction, while Fig. 3 is an horizontal section showing the arrangement of the elements. The segments, A A, are made of an alloy of zinc and antimony in the proportion of two parts of antimony to one of zinc. After the segments are cast they are exceedingly brittle till treated by some annealing process, which is kept a close secret. The connecting

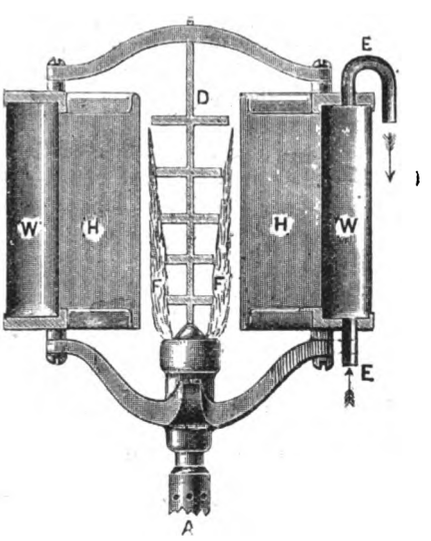

FIG. 2.—Section of the Generator.

strips, B B, are of copper. These pieces are brazed on to the segments, the strips being slit at the joints, J J, so that a good flow of metal can be obtained. About 15 of these segments form a complete circle, with space allowed for joints for inter-connecting the adjacent layers. Each layer is tested for resistance and mechanical strength before being passed, the resistance in the usual size varying from ·07 to ·13 ohm. The generator is then built up of a number of layers insulated from each other by a ring of asbestos. After the cross-connections putting all the elements in series have been made, a special cement is run round the inside and outside circumferences of the block. This cement sets hard on being baked, and securely binds the parts together. A copper plate, E, is then cemented on to the outside, while the inner fireproof tube is also inserted. A further baking completely binds the whole together, after which the flanges and the outer tube, D, are attached to form the water-jacket. The other attachments (Fig. 2) consist of an iron deflector in the centre of the tube, and the necessary terminals and pipes for connecting the electric wires and water supply. The Bunsen burner and proper flame to be used are also shown in the figure.

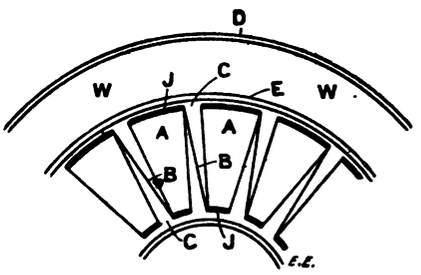

FIG. 3.—Horizontal Section showing the Arrangement of Elements.

Leaving now the construction of the machine, we have to consider its output. Mr. Cox has a method of describing the output which is apt to be misleading until understood. He gives the voltage on open circuit and the current at short-circuit. The usual way of multiplying the one by the other to get the watts of course gives a very erroneous result. Thus, one size gives 10 volts on open circuit and three amperes on short-circuit. This machine has about 11 layers of elements, as Mr. Cox estimates that about 15 couples give a volt. In the ordinary apparatus a smaller number of elements of larger cross-section are used. These give about five volts on open circuit and from four to five on short-circuit. Their internal resistance is about ·8 ohm. All the Bunsen burners are regulated to take from 2·5 to 3 cubic feet of gas per hour. It will be observed that the above figures do not represent the useful output the apparatus can give. The following table is more serviceable in this respect:

External resistance.	Volts.	Amperes.	Watts.
·07	·9	9	8·1
·10	1·1	8	8·8
·13	1·2	7	8·4
·16	1·3	6·4	8·3

These were taken on a low-voltage machine. From this it will be seen that the output of. say, nine watts is obtained with a consumption of about 3ft. of gas per hour.

This, with gas at 2s. 6d. per 1,000 cubic feet, is equivalent to 10d. per unit. We have looked up our old volumes to find figures to compare with the above, and find that in 1888 Mr. E. Raub, of Berlin, constructed a thermo-electric generator which gave an output of 80 watts, using 35 cubic feet of gas per hour. This on the above basis gives a cost per unit of 1s. 1¼d. This shows that Mr. Cox has effected a distinct advance, as we are comparing a small generator with a large one, which is likely to be favourable to the Raub type. In efficiency in production the thermo-electric generator cannot of course compare with the gas-engine and dynamo, but it can most successfully compete with the primary battery. The departments in which these thermo-electric generators have been put to work may be summarised as follows: telegraphy, fire alarms and bells, telephone exchanges, railway work, fan motors, electroplating, X-ray work, gas-engine ignition, and small motor and lighting equipments. The inventor does not make rash claims for his invention, but has by careful thought for detail provided against the faults found in the older types. The elements used are practically the same as advised by Prof. Seebeck in 1821, and differ only in mechanical details. The range of temperature between the hot and cold junctions is about 600deg. F.

We regret to have to announce that the laboratory at St. Albans in which these machines were being turned out

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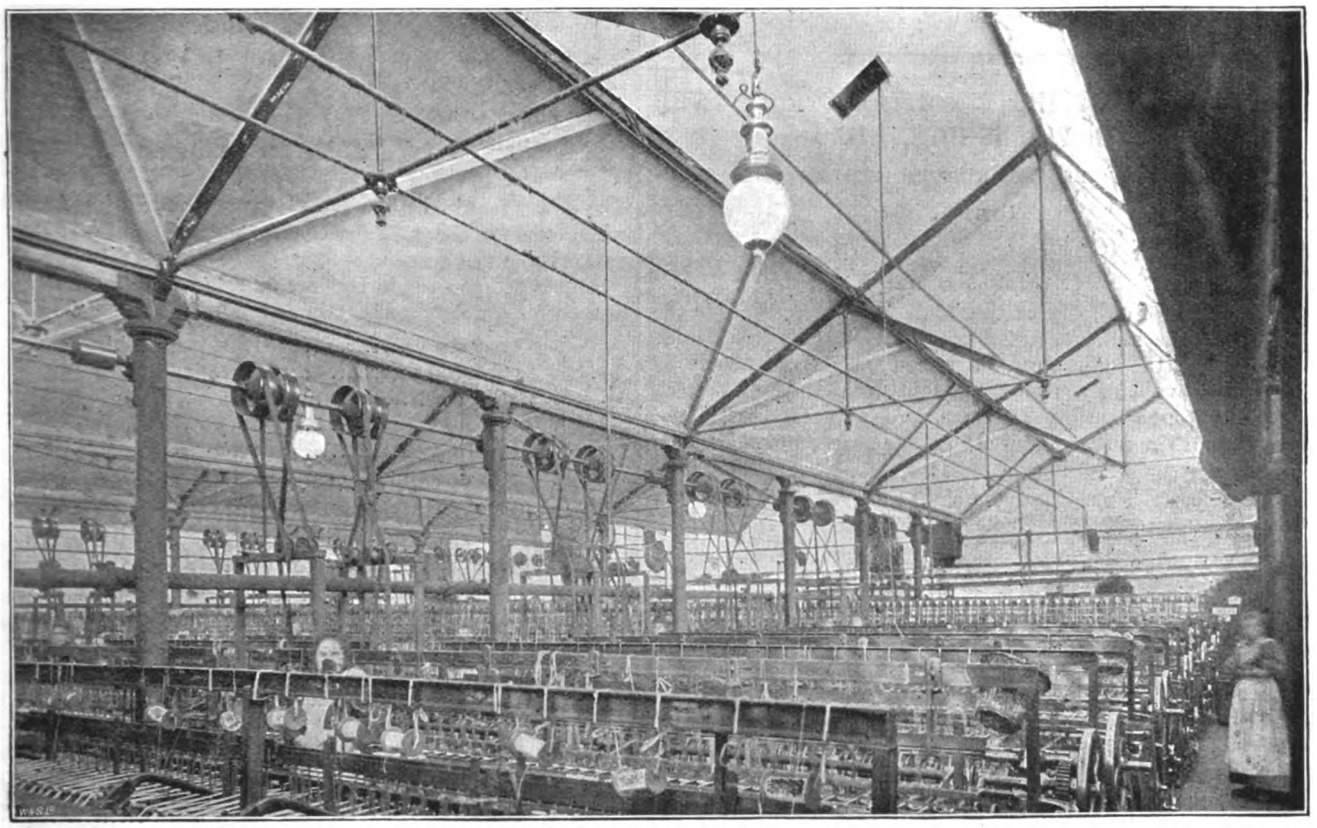
in quantity to meet the large number of orders was burnt down the day after we visited it. We trust that this unfortunate occurrence, which means a greater loss to Mr. Cox than to the company, who were protected by insurance, will not delay the apparatus obtaining an early trial in this country.



A Spinning-Room in Messrs. J. and J. Cash's Mills.

THE JANDUS ARC LAMP.

The lamps of the enclosed arc type are finding favour in this country on account of the length of time which they will run without being recarboned. The lamps also lend themselves for interior lighting, as shown by the two illustrations we give herewith through the courtesy of Messrs. Drake and Gorham. The views from which the blocks were prepared were taken in the weaving mills of Messrs. J. and J. Cash, where some 23 of the lamps are in regular use. The enclosed arc gives an additional security in the spinning-rooms against small pieces of heated carbon falling from the lamp. The point on which we wish information is that of the relative efficiency between the ordinary and enclosed types of arc lamp. The makers have been unable to supply us with this information, but say that the demand for lamps justifies the conclusion that the candle-power is satisfactory. A more definite answer may be obtained from an article by Mr. L. B. Marks to the *Western Electrician*. He there states and gives figures to prove that the mean spherical candle-power of lamps of the two types, taking the same power, are practically

View of the Packing-Room.

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identical. The polar curves of candle-power are, however, very different, the maximum ordinate in the open lamp being about twice that of the enclosed type lamp. In fact, Mr. Marks claims a slight excess of illumination from the enclosed arc. We shall be glad to hear of tests on this subject being made in this country.

THE LOCAL DISTRIBUTION OF ELECTRIC POWER IN WORKSHOPS, ETC.

BY ERNEST KILBURN SCOTT.

PART I.

(*Continued from page 201.*)

PLANING MACHINES.

The work of ordinary cutting tools varies according to the nature of the metal operated upon. Thus, cast iron, which is of a brittle nature, can be tooled most economically by taking heavy cuts; whilst wrought iron and mild steel, yielding tough curling shavings, are reduced by thinner cuttings. The power required to plane away different metals is given by the following formulæ:

Cast Iron.—Horse-power = weight removed per hour in lbs. $\times \left(\cdot0155 + \frac{1}{11{,}000 \times \text{area of shavings in sq. inches}} \right)$.

Mild Steel.—Horse-power = ·112 × weight removed per hour in lbs.

Wrought Iron.—Horse-power = ·052 × weight removed per hour in lbs.

Gunmetal.—Horse-power = ·0127 × weight removed per hour in lbs.

LATHES.

For turning off metals, the power required is less than for planing them off, and it has been found that the power is greater for smaller diameters than for large diameters.

Cast Iron.—Horse-power = ·0314 × weight removed per hour in lbs.

Wrought Iron.—Horse-power = ·0327 × weight removed per hour in lbs.

Steel.—Horse-power = ·047 × weight removed per hour in lbs.

The power required to drive lathes empty varies with the number of shafts between the driving shaft and main spindle. A light lathe with one or two intermediate shafts would require—

Horse-power = ·05 + (·0012 × number of revolutions of spindle per minute).

Whilst a heavy lathe with three or four intermediate shafts would require—

Horse-power = ·25 + (·18 × number of revolutions of spindle per minute).

DRILLING MACHINES.

For drilling metals, the power required to remove a given weight of material is greater than in planing. Volume is taken instead of weight in the following formulæ, which are applicable to holes of from ⅜in. to 2in. in diameter:

Cast Iron (Dry).—Horse-power = volume removed in cubic inches per hour $\left(\cdot0168 + \frac{\cdot00067}{\text{dia. of hole in inches}} \right)$.

Wrought Iron (with Oil).—Horse-power = volume removed in cubic inches per hour $\left(\cdot0168 + \frac{\cdot0269}{\text{dia. of hole in inches}} \right)$.

When running empty, the power varies according to the construction of the machines. An ordinary drill with gearing for the spindle would require—

Horse-power = ·0006 × number of turns per minute of gearing shaft + ·001 × number of turns per minute of drill.

And a radial drill with gearing—

Horse-power = ·04 + ·0006 × number of turns per minute of gearing shaft + ·004 × number of turns per minute of drill.

SHAPING MACHINES.

In the use of shaping machines the resistance is greater for notch cuts than for cuts on flat surfaces, and for skin cuts than for under cuts. Shaping cast iron:

Skin Cuts.—Horse-power = ·1087 × weight removed per hour in lbs.

Under Cuts.—Horse-power = ·0604 × weight removed per hour in lbs.

Wheel Teeth (Notch Cuts).—Horse-power = ·118 × weight removed per hour in lbs.

SLOTTING MACHINE.

For a slotting machine having a stroke of 8in. and a tool-holder and slide weighing 93½lb., the horse-power required running empty was—

$$\text{Horse-power} = \cdot045 + \frac{\text{number of strokes per minute} + \text{stroke in inches}}{4{,}000}.$$

The power required to move a shaping or slotting machine when empty is about 15 per cent. of the whole power required to work the machine.

The cutting speeds in feet per minute for planing, slotting, and turning are approximately as follows:

Cast steel	12ft. per minute.
Cast iron	18ft. ,, ,,
Mild steel	20ft. ,, ,,
Wrought iron	23ft. ,, ,,
Hard brass.....	50ft. ,, ,,
Soft brass and copper	100ft. ,, ,,

MILLING MACHINES.

The above is for the ordinary tools with single cutting points always in work. In the case of milling cutters with their many cutting edges the case is different, and the speeds of the cutters will vary according to the material being worked upon and also on the diameter of the cutter.

The following formula gives the speeds generally employed:

$$\text{Revolutions per minute of milling cutter} = \frac{\text{Constant}}{\text{Diameter of milling cutter in inches}}$$

Constant	
Cast steel.....	180
Cast iron.....	200
Mild steel	220
Wrought iron	250
Hard brass	330
Soft brass and copper	400

The feed per minute for cast steel, cast iron, mild steel, and wrought iron varies from ¼in. to 1¼in., and for brass and copper about 2in. per minute.

The following tests made by Mr. E. H. Wise are very interesting, as they give the actual power consumed by the different machines of a rolling mill.

Roll-turning lathes are distinguished from ordinary lathes in that the rolls are carried on centres during the turning of the bearings only. After the bearings are finished, the roll is supported by them in housings in order to secure greater rigidity, and this naturally leads to much greater friction than in common lathes. The tool takes a broad, scraping cut, and the speed of the roll is very slow on account of the hardness of the material.

Table IV. gives particulars of tests made on four of these lathes—namely, a 61in., a 40in., a 63in., and a 73in.

Cold Saw.—2-h.p. individual shunt motor; speed of motor, 1,000 revolutions per minute: diameter of saw, 20in.; width, $\frac{3}{16}$in.; speed, 8 revolutions per minute; number of teeth, 192.

Readings.	A.	V.	E.H.P.
Sawing 9in. rails weighing 108lb. per yard	8 to 13	220	2·4 to 3·8

Straightening Press.—15-h.p. individual shunt motor; speed of motor, 650 revolutions per minute; speed of press, 41 strokes per minute; operating on rails weighing 80lb. per yard.

Readings.	A.	V.	E.H.P.
Starting press	50 ...	220 ...	14·8
Running press, idle	5 to 10 ...	220 ...	1·5 to 3·0
Moderate blow on rails	6 to 30 ..	220 ...	1·8 to 8·8
Hard blow on rails	40 to 50 ...	220 ...	11·8 to 14·8

Multiple Drills.—15-h.p. shunt motor, operating three multiple-spindle presses through a line shaft 70ft. long, 2½in. diameter, with 10 hangers; speed of shaft, 200 revolutions per minute; speed of motor, 800 revolutions per minute.

Readings.	A.	V.	E.H.P.
Running shaft and presses, idle	15 ...	220 ...	4·4
Drilling seven ¾in. holes in thin part of rails.....	40 to 60	218	11·7 to 17·6
Drilling seven ¾in. holes in thick part of rails, fuse blown	75 ...	218 ...	22·0

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TABLE IV.— POWER CONSUMED ON FOUR ELECTRICALLY-DRIVEN ROLL-TURNING LATHES.

Type of Lathe.	Size of motor.	Speed of motor. Revs. per min.	Material of roll, etc.	Dia. of roll. Inches.	Speed of roll.	Readings	Cut.	Amperes	Volts.	E H.P.
61in.	5-h.p. shunt.	1,000	Cast iron carried in housings.	35	1 rev. in 1 min. 25 secs.	Turning round.	No cut.	3½ to 4	210	1 to 1·1
						Average cut.	2¼in. wide, $\frac{5}{16}$in. deep	9 to 10	210	2·5 to 3·4
						Excessive cut.	2½in. wide $\frac{5}{8}$in. deep	10 to 17	210	2·8 to 4·8
40in. Garrison lathe.	10-h.p. shunt.	800	Steel carried in housings.	39	1 rev. in 1 min. 15 secs.	Turning round.	No cut.	6	200	1·6
						Maximum cut.	2¼in. wide, $\frac{1}{32}$in. deep	25	200	6·7
						Lathe broken without damage to motor.	Prop support 15in. by 2in. sheared off.	40	200	20·7
63in. Bement lathe, double back gear.	10-h.p. shunt.	1 000	Steel carried in housings.	35	1 rev. in 1 min. 30 secs.	Turning round.	No cut.	9	200	2·4
						Maximum cut.	1¾in. wide, $\frac{1}{16}$in. deep.	38	200	10 2
73in. Bement lathe.	10-h.p. shunt.	—	Steel pinion carried in centres.	28 at bearings being turned.	—	Turning round starting.	No cut.	37	210	10·4
						Turning round running.	No cut.	5	210	1·4
						Average cut.	2in. wide, $\frac{5}{64}$in. deep.	14 to 17	210	3·9 to 4·8

Drills.—15-h.p. shunt motor, operating two Sellers rail drill presses through a line shaft 70ft. long, 2½in. diameter, with 10 hangers; speed of shaft, 200 revolutions per minute; speed of motor, 800 revolutions per minute.

Readings.	A.	V.	E.H.P.
Motor and line shaft (belts on loose pulleys)	15	220	4 4
Drilling six 1$\frac{1}{8}$in. holes in web of rail ½in. thick	55	220	16·3
Drilling six 1$\frac{1}{8}$in. holes in web of rail ¾in. thick	70	220	20·7

The increase of power for the deeper hole is due to the clogging of the drillings.

Power Punch for Rails.—5-h.p. individual shunt motor belted to machine; speed of motor, 1,000 revolutions per minute; speed of punch, 34 strokes per minute.

Readings.	A.	V.	E.H.P.
Starting punch, because of heavy flywheel	30	220	8·9
Punching three 1¼in. holes in neck of rails, ½in. thick	6 to 10	220	1·8 to 3·0

Sellers's Overhead 30-ton Travelling Crane.—Loaded with 28 tons; speed of hoist, 20ft. per minute; 25-h.p. motor for hoisting; 25-h.p. motor for bridge travel; 5-h.p. motor for trolley travel; speed of bridge travel, 350ft. per minute.

Readings.	A.	V.	E.H.P.
Starting hoist	120	190	30·6
Hoisting	90	190	23·0
Lowering load	30	100	4·0
Starting bridge	60	120	9·7

Wire-Rope Operated Rail Conveyor.—Conveying rails from hot bed to finishing machines; 15-h.p. shunt motor belted to gearing, which drives ¾in. wire rope. Conveyor rollers have grooved sheaves, which drive them by friction from the rope; length of conveyor, 650ft.; number of rollers, 72; diameter of roller, 18in.

Readings.	A.	V.	E.H.P.
Starting motor and conveyor, no load	50	220	14·8
Starting motor and conveyor, loaded with seven rails, each 60ft. long, weighing 100lb. per yard	80	220	23·7
Running conveyor with above load	30 to 40	220	8·9 to 11·8

Feed Table for Three High Roll Train.—Fitted with three railway type series motors, which hoist and lower table, operate rolls for feeding rails in and out and traverse entire machine lengthwise of the mill to deliver the rails to the various passes. The blooms handled when making test were sufficient to make these rails 30ft. long, each weighing 60lb. per yard, which are the heaviest for which the mill is adapted; Morgan type B controller used:

Readings.	A.	V.	E.H.P.
25-h.p. motor starting to hoist with load, slow	90	220	26 6
25-h.p. motor starting to hoist with load, fast	140	220	41·4
25-h.p. motor running with load	50	220	14·8
25-h p. motor starting to traverse machine with load, slow	100	220	29·6
25-h.p. motor starting to traverse machine with load, fast	150	220	44 3
25-h.p. motor running with load	60	220	17·8
10-h.p. motor starting rollers with load, slow	60	220	17·8
10-h p. motor starting rollers with load, fast	90	220	26·6
10-h.p. motor running with load	22	220	6·5

Average temperature in air gap of roller after a run of 12 hours, 175deg. F.

This class of work is very severe on the motors, owing to the repeated reversals, which occur as follows:

Hoist motor, 1,400 times in 12 hours.
Roller „ 1,400 „ „ „
Traverse „ 700 „ „ „

These repeated reverses must be made very quickly to avoid loss of time and cooling of the blooms. The control has to have a wide neutral space to ensure sufficient time to permit the motor to stop before the reversal of the current. In addition to this, the hoist and traverse motors are fitted with magnetic brakes, which are applied automatically as soon as the current is cut off, and are released when the current is re-established.

TABLE V.—Speed and Horse-power Required to Drive Wood-Working Machinery.

Description of machinery.	Revs. per min.	H P.
Circular sawbench. Size of saw, 14in. diameter	2,500	1
„ „ „ 24in. „	1,500	2
„ „ „ 30in. „	1,150	3
„ „ „ 36in. „	1,000	4
„ „ „ 42in. „	830	5
„ „ „ 48in. „	700	6
Band saws. Diameter of saw pulleys, 24in.	500	
„ „ „ 30in.	450	¾
„ „ „ 36in.	400	1
„ „ „ 42in.	350	1½
Vertical timber frame saw for 12in. logs. Speed of crankshaft	180	3
„ 18in. logs. „ „	160	4
„ 24in. logs. „ „	140	5
„ 34in. logs. „ „	130	7
Double deal frame for deals 11in. by 3in. „ „	400	4
„ 14in. by 4in. „ „	350	5
„ 18in. by 4in. „ „	300	7
Single deal frame for deals 11in. by 3in. „ „	400	2
„ 14in. by 4in. „ „	350	3
General joiner	1,500	3
Boring, chamfering, and shaping machine	4,000	½

The following electrical tests upon the power required for running wood-working machinery have been made by Prof. O. G. Dodge, of the United States Navy:

Circular Rip Saw, 28in. diameter.—Speed, 1,200 revolutions per minute, or 8,800 lineal feet per minute. Arbor pulley, 5¼in. diameter × 8½in. face, hand feed. Motor belted to saw shaft. Motor and saw, idle, 3·4 e.h.p. Ripping seasoned heart oak, 7$\frac{5}{8}$in. thick, feed 10ft. per minute, 19·3 e.h.p.

Circular Rip Saw, 34in. diameter.—Speed, 1,500 revolutions per minute, or 9,429 lineal feet per minute, hand feed. Motor belted direct to 7in. pulley on saw shaft. Motor driving saw, idle, 3·2 e.h.p. Ripping seasoned heart oak, 3in. thick, 10ft. per minute, 12·8 h.p. Ripping seasoned white pine, 6½in. thick, 15ft. per minute, 9·4 e.h.p. Ripping seasoned yellow pine, 2in. thick, 45ft. per minute, 10·7 e.h.p.

Circular Rip Saw, 14in. diameter.—Speed, 2,200 revolutions per minute, or 8,067 lineal feet per minute. Arbor pulley, 3in. diameter, 5in. face, hand feed. Motor belted to saw shaft. Motor idle, ·96 e.h.p. Motor and saw idle,

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2·7 e.h.p. Ripping seasoned heart oak, 3½in. thick, 12ft. per minute, 6·3 e h.p.

Circular Rip Saw, 12in. diameter.—Speed, 2,200 revolutions per minute, or 6,914 lineal feet per minute. Hand feed. Belt pulley, 3½in. diameter, 3in. face. Motor belted direct to 3½in. pulley on saw shaft. Saw set to wobble for cutting grooves. Motor idle, ·96 e.h.p. Driving saw idle, 2·2 e.h.p. Cutting grooves in seasoned walnut, ⅜in. × ⅞in., 12ft. per minute, 3·6 e.h.p.

Band Saw.—Pulleys, 42in. diameter; speed, 350 revolutions per minute, or 3,850 lineal feet per minute. Belt pulley, 16in. diameter × 5in. face, hand feed. Motor belted to saw shaft. Motor idle, ·96 e.h.p. Motor and saw idle, 2·9 e.h.p. Ripping seasoned oak, 12in. thick, feed 3ft. per minute, 5·7 e.h.p. Cross-cutting seasoned oak, 8in. thick, feed 5ft. per minute, 5·7 e.h.p. Ripping live oak, 10in. thick, feed 3·2ft. per minute, 5·7 e.h.p.

Band Saw.—Pulleys, 28in. diameter; speed, 480 revolutions or 3,520ft. per minute. Belt pulley, 12in. diameter, 3½in. face, hand feed. Motor belted to saw shaft. Motor idle, ·96 e.h.p. Motor and saw idle, 1·7 e.h.p. Ripping seasoned oak, 3in. thick, feed 2½ft. per minute, 2·3 e.h.p. Ripping seasoned pine, 3in. thick, feed 4ft. per minute, 2·3 e.h.p. Cross-cut seasoned oak, 3½in. thick, feed 4ft. per minute, 2·3 e.h.p.

Hand Cylinder Planer or Jointer.—Size of machine, 24in. Belt pulley, 4in. diameter by 5in. face; speed, 3,200 revolutions; speed of cutter edge, 4,000ft. per minute. Hand feed. Motor belted to shaft of tool. Motor idle, ·96 e.h.p. Driving machine idle, 2·40 e.h.p. Planing white pine, cut $\frac{11}{100}$in. deep by 18in. wide, 25ft. per minute, 4·8 e h.p.

Cylinder Planer.—Size of machine, 24in. Belt pulley, 5ft. by 5ft face; 2,250 revolutions. Speed of cutting edge, 3,105ft. per minute Power feed. Motor belted to shaft of tool. Motor idle, ·96 e.h.p. Driving machine idle, 2·4 e.h.p. Planing pine, cut $\frac{1}{16}$in. deep by 18in wide, 11ft. per minute, 3·6 e.h.p. Planing oak, cut $\frac{1}{16}$in. deep, 6½in. wide, 11ft. per minute, 3·6 e.h.p.

Boring Machine.—Speed of bit, 375 revolutions, hand feed. Motor belted to bit shaft. Motor idle, ·96 e.h.p. Driving machine idle, 1·7 e.h.p. Boring 4in. hole in seasoned oak, 9·6ft. per minute, 2·3 e.h.p.

Boring Machine.—Belt pulley, 8in. diameter, 3in. face. Speed, 750 revolutions, hand feed. Motor belted to machine shaft. Motor idle, ·96 e.h.p. Driving machine idle, 1·9 e.h.p. Boring 1in. hole in oak, feed 3¾in. in five seconds, 2·2 e.h.p. Boring 1⅝in. hole in oak, feed 1in. in seven seconds, 2·2 e.h.p.

Patternmakers' Lathe. — Speed, 888 revolutions. Motor belted direct to lathe. Motor idle, ·96 e.h.p. Driving lathe idle, 2 e.h.p. Turning seasoned poplar, 12in. diameter by ½in. cut, 3·2 e.h.p.

(To be continued.)

SHEFFIELD.

REPORT ON TRAMWAY TRACTION.

In this issue we commence the detailed information upon which the conclusions of the deputation of the Sheffield Corporation are based.

Elberfeld.	Population,	140,000	260,000
Barmen.	Do.	120,000	

The deputation were taken over the lines at Elberfeld and Barmen by the company's engineer, who furnished all necessary explanations. The streets are generally narrow (two of the streets through which tramways pass being only 14ft. 9in. and 16ft. wide), and some of them are very steep, the curves, too, being very acute. Occasionally the lines are run within 1ft. of the kerbs. The streets, both as to width and gradient, and class of properties abutting upon them, are similar to the streets in Sheffield along which the present tramways and the proposed extensions run. Elberfeld and Barmen are manufacturing towns, and some of the principal streets have to accommodate a great amount of vehicular traffic. The paving, which is of granite, extends across the lines, and for 18in. outside. There is concrete under the rails of those lines upon which the cars run at high speed, but not where the speed is low. The setts are bedded on sand on a stone-pitched foundation. The steepest gradients are 1 in 16 and 1 in 20, and the sharpest curves have a radius of about 52ft. Accompanying the report are two sketches showing how the lines are laid in narrow streets with sharp curves, and also how the trolley wires are suspended in the wider streets without the aid of poles.

There are two lines—the Barmen-Elberfeld line and the Elberfeld North to South line. The former belongs to a company, the latter to the Municipality. Both the lines are worked by the company. The total length of the two lines is about 10 miles. The gauge of the Barmen-Elberfeld line is 4ft. 8½in., and the track is double; that of the North to South line is 3ft. 3in., and the track is single. Double line is as a rule preferred to single on account of convenience, and the manager gave it as his experience that on double lines more passengers can be carried at a proportionately reduced cost. Where the streets are too narrow to permit of a double line, the "up" line takes one route and the "down" another, the two lines meeting again at a point where the street is of suitable width. The principle is exactly the same as that adopted for the Heeley and other 'buses, which use High-street, Fargate, etc., for the out journey, and Norfolk-street for the return. In some of the narrow streets single lines with cross-overs are used. The North to South line is new, but the Barmen-Elberfeld line was originally worked by horses. The system is overhead electric, and the lines were fitted up by the Union Electric Company, Berlin. Duration: 44 years (broad gauge) and two years (narrow gauge). The Municipality allow the company to use poles if necessary. The company pay 5 per cent. interest on the cost of the narrow-gauge line and power station, the capital for which was found by the Municipality. The net profits are to be divided between the company and the Municipality. For the Barmen-Elberfeld line the company pay about £120 per mile of double line per annum for repairs to paving only, and also 2 per cent. on the gross takings. When worked with horses this line paid a dividend of 5 per cent. The lines were only opened with electric traction in January, 1896. Rosettes are chiefly used for suspension of the overhead wires. There is no power to compel the owners of buildings to consent to the fixing of rosettes, but pressure is put upon them, and if consent is not given poles are used. The height of the trolley wire is generally from 15ft. to 16ft., and higher in the suburbs according to the height of the trees. The distance between the rosettes or poles varies from six or seven yards at sharp curves to about 40 yards on the straight. The power stations for the broad and narrow gauge lines are entirely separate. The station for the broad-gauge line is very well built, with a liberal use of glazed brick and tiles for the walls and floor. The machinery is of the best description and in beautiful condition. There are three 250-h.p. engines and one of 500 h.p. The Siemens and Halske Company, of Berlin, were the makers. This station, in addition to supplying power for the Elberfeld-Barmen Tramway, also supplies a small mountain railway, but not the power for lighting. Power for electric lighting is obtained from another station, but the deputation were told the streets might eventually be lighted with power from this one. The price paid for electricity is 12·8pfg. per unit (about 1¼d.). There are no accumulators at the station. The station for the narrow-gauge line has two engines, with an aggregate of 300 h.p., but as a rule only half this power is in use. The voltage permitted is from 500 to 570, and the current is direct. The cars are of the usual small pattern, without outside seats. There are 15 cars on the narrow-gauge line and 65 on the broad-gauge. The former have two motors and the latter one. The horse-power of the motors is from 15 to 25. The weight of the cars on the narrow-gauge line is 7 tons 6cwt. full and 5 tons 8cwt. empty. According to the information furnished, those on the broad-gauge line weigh 7 tons 17cwt. full and 6 tons 7cwt. empty. The cars carry 26 and 28 passengers (inside and on the platforms),

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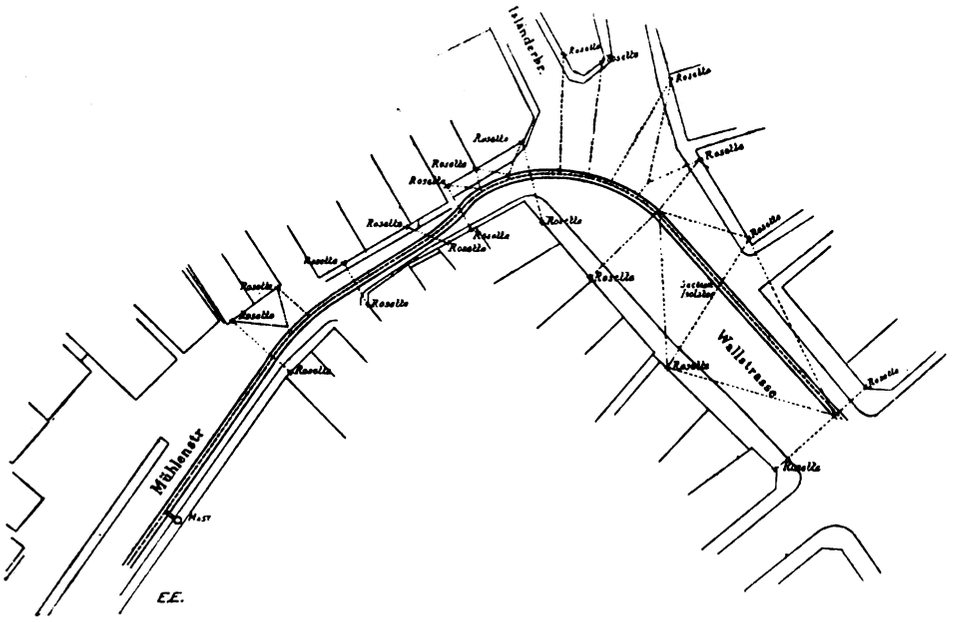
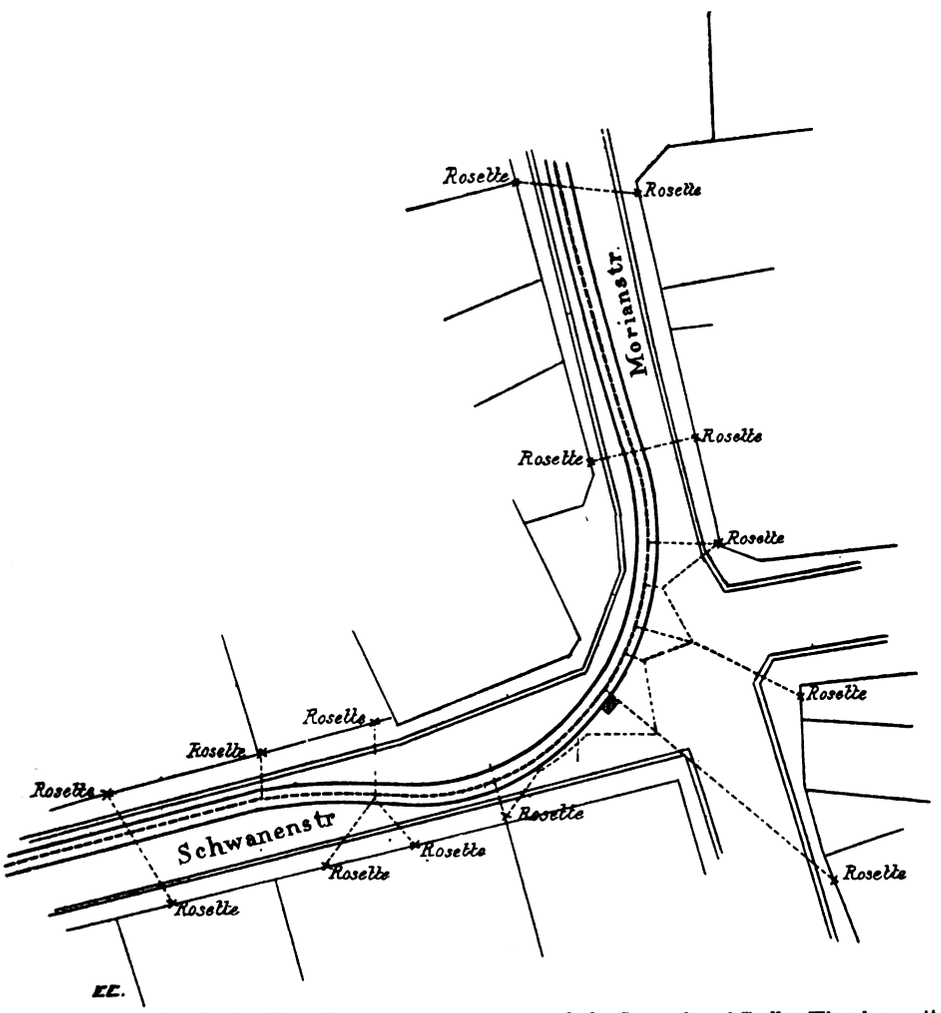
and are not divided into classes. The distance travelled per car per day is given at about 93 miles. Since the opening of the line in January last there have been two fatal accidents, but these are attributed to the fact that the too fast round a curve there is a very apparent jerk. The service on the Barmen-Elberfeld line is every 2½ minutes, and on the North to South line every five minutes. The cars run from 6.50 a.m. to 11.30 p.m. On the narrow-gauge line



Elberfeld and Barmen Tramways—Plan showing Sharp Curves in Narrow Streets, and also Suspension of Trolley Wires by rosettes affixed to buildings. Thick dotted lines show trolley wires, thin dotted lines show guy wires. Gauge 3ft. 3in.

public were not then used to the change. What other accidents there have been were only of a slight nature, and are attributed to the carelessness of the public. The traffic has never been interrupted through a breakdown of the the fare is 1d. On the broad-gauge the lowest fare is about 1d. for 2½ miles, and the highest 6d. for the total length of the line (about 7½ miles). From 6.50 a.m. to 8 a.m. there are ½d. fares, and cars are run for the school



Elberfeld and Barmen Tramways—Plan showing Sharp Curves in Narrow Streets, and also Suspension of Trolley Wires by rosettes affixed to buildings. Thick dotted lines show trolley wires, thin dotted lines show guy wires. Gauge 4ft. 8½in.

machinery. The speed varies, a maximum of about 11 miles per hour being allowed, but the cars are capable of travelling at 18 and 24 miles per hour. There is apparently no difficulty in negotiating the sharp curves, but if a car is driven children. On part of the line tickets are used; on the other part the fares are put into a box, which the driver can see, and there is no conductor. This arrangement, however, is said to be unsatisfactory, and will be altered.

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Stopping places are provided about 200 to 300 yards apart, indicated by specially painted poles, and the public make no difficulty about this. The drivers receive from 3s. 4d. to 3s. 6d. per day, and the conductors from 3s. to 3s. 3d., but gratuities are allowed to the latter. The men work 10 hours per day, and are in uniform, for which they pay.

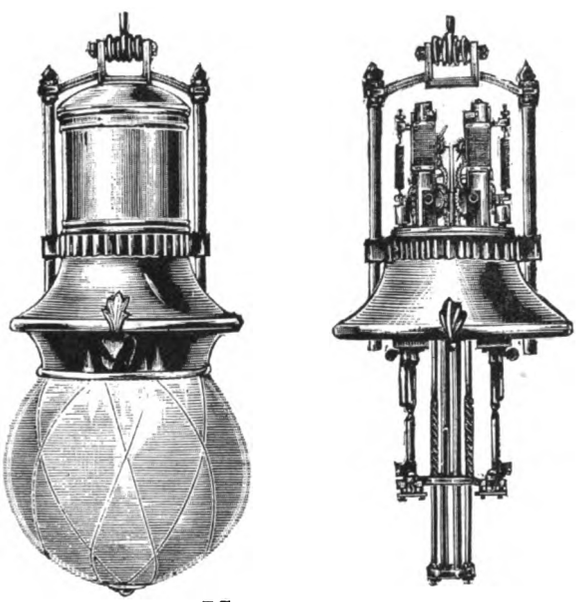
The tramways in Elberfeld and Barmen are a very good example of the manner in which difficulties caused by steep and narrow streets and sharp awkward curves can be overcome. There is no objection on the part of the citizens to the overhead apparatus, but on the contrary, in the opinion of the municipal authorities, the system is satisfactory in every respect.

ELECTRICITY SUPPLY AT 230 VOLTS.*

BY ALFRED H GIBBINGS, MEMBER.

(Concluded from page 237.)

It would be invidious for me to make any comment here as to the facilities of adjustment in the various makes of arc lamps, but I may at least say this, that for accuracy of adjustment, for feeding at a definite potential across the arc, and for perfect steadiness, I am strongly in favour of the simple shunt type, especially where there is any pretension to keep an unvarying voltage on the mains.



CLOSED. OPEN.

The second class of consumer with whom we had to deal was he with only two arc lamps. At the discussion on high-voltage supply at the meeting of the Municipal Electrical Association last year I remember that the question of two arc lamp customers was considered even a greater obstacle in the way of supply at 230 volts than that of four or more arc lamp customers. Our experience has been exactly the reverse of this; we have had no difficulty whatever, and the change was made as simply as with incandescent lighting only. The accompanying illustration shows a form of five-ampere double-carbon arc lamp, which has been designed by myself to take the place of the ordinary 10-ampere single-carbon lamp, and I have brought one here for inspection. In addition to these double-carbon arc lamps, there has also been used those of the enclosed type with an inner globe. Both types have given great satisfaction.

VI.—Incandescent Lamps.

At this stage of the paper there should be little necessity for me to support the statement that the high-voltage incandescent lamp, as it is now designed and made, is equal in durability, efficiency, and excellence of construction to the best types of those of the lower pressures. I make the comparison with the best types of lower-voltage lamps advisedly, because there are many forms of indifferent and therefore worthless lamps of both high and low voltages, and also because in lamps of either pressure we can sacrifice length of life for diminished watts per candle and *vice versâ*. The watts per candle for which we stipulate in all consignments of high-voltage lamps are 3·6, and after many hundreds of tests of promiscuous lamps, the average is as near that figure as possible. With regard to so-called high-efficiency lamps, cheap 115-volt lamps, and others which have been correctly designated "worthless," I was glad to see some time ago an excellent article in the London *Daily Telegraph* on the subject, in which the general public, users of the electric light, were very properly warned against purchasing these inferior makes. This article has been reproduced by the Edison and Swan United Electric Light Company, and issued in the form of a pamphlet. But the public, unfortunately, will still buy cheap lamps, whatever the supply pressure may be—ignorant, we will assume, that it means a rapidly decreasing light, expensive renewals, and a heavy electricity bill. It will be giving away no secret, nor will it be anything to the detriment of 230-volt lamps, when I say that it was an unexpected repetition of experiences showing the worthlessness of cheap lamps which led to the strong recommendation I made last year to the Bradford Corporation, and which they unanimously adopted, to supply renewals of lamps free of charge. This decidedly new departure is in itself, of course, a welcome boon to the consumer; but it is to bring in its train a still more acceptable thing to at least 75 per cent. of our customers—viz., a reduced consumption of electricity. The innovation has justified itself in two ways. First, in the decrease in the accounts of our consumers during the last half-year; and, secondly, in the diminished load at the station compared with the estimated load through the ordinary increase in new consumers. The experiences to which I have referred, and the results of which I have just mentioned, are yet other instances of the outcome of taking careful tests of every consumer's installation. I consider that it very largely supersedes the hitherto theoretical argument used by some engineers as to the comparative efficiency of low over high voltage lamps. These experiences, or rather observations, of which we were not directly in search, came about as follows: Upon entering on the practical business of changing the pressure, and consequently the lamps of each consumer, we invariably used the opportunity to take the maximum current demanded first with all the old lamps on, and again with all the new lamps on. Of course, some difference in consumption was naturally to be expected between old and new lamps, but the very wide differences we discovered entirely in favour of the high-voltage lamps could only be explained by great inefficiency in the 115-volt lamps. I have thought that after the statements just made it would be interesting to place before you some of the photometric and efficiency tests to which I submitted some of these cheap lamps taken from consumers' installations. The lamps tested were new lamps taken from the consumers' spare stock.

Test of Various Types and Makes of 115-Volt Incandescent Lamps.

Type No.	Voltage.	Nominal c.p.	Mean volts when testing.	Actual c.p.	Amperes.	Watts per nominal c.p.	Watts per actual c.p.
1	115	16	114·99	12·94	·465	3·34	4·13
2	115	16	115·85	11·99	·450	3·23	4·42
3	115	16	115·76	12·38	·570	4·10	5·30
4	115	16	115·80	12·10	·550	3 94	5·22
5	115	8	115·87	9·6	·364	5·23	4·46
6	115	8	115·93	7·24	·374	5·38	5·94

The only further remark I have to make in connection with the foregoing test is that if we in Bradford have found such evidences of the extensive purchase of inferior lamps, then in all probability other towns are suffering from similar drawbacks, and my advice is to get rid of them in the only effective and satisfactory manner—viz., by supplying from headquarters the best lamps that can be obtained, on a basis likely to attract the user of the current.

With reference to our tests of high-voltage lamps, it is only fair to say that I have met with specimens equally disreputable. For instance, two nominal 16-c.p. lamps were submitted to me in October last as samples, for which orders were asked, and although sample lamps at least, one would think, would be carefully tested, the results certainly seem to point to the contrary in this instance. The actual candle-power of each lamp was 17·6 and 22·3 respectively, and the watts per actual candle-power 6·15 and 6·02. Of course, no orders were given, and with our free supply of renewal lamps I do not think our consumers in Bradford are likely to get them.

Before leaving the subject of high-voltage incandescent lamps, I wish to say a word particularly with reference to those of 8 c.p. The 8-c.p. 230-volt lamps have proved satisfactory beyond our expectation, and if reference is made to the list of lamps in the first part of the paper it will be seen that we have now no fewer than 2,492. A considerable number of these (about 525) have been in continual use in the Great Northern

* Paper read before the Northern Society of Electrical Engineers, February 8, 1897.

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Hotel, Bradford, since May 3, 1896, when the lamps were changed, and the manager, Joseph Weber, Esq., has written us the following reference as to his experiences of them—viz.: "I have found the 8-c.p. lamps perfectly satisfactory, and we have a better light than with the previous lamps. The account has also been reduced by about £50, owing to the substitution of some 8-c.p. lamps for 16-c.p." The better light mentioned by Mr. Weber is undoubtedly due to the lessened fall of potential within the building. The 8-c.p. lamps in use at this hotel were made by the Zurich Incandescence Lamp Company, and out of the general consignment supplied to me I took six for the purpose of testing their candle-power, efficiency, and life, and these six lamps I have here on the table before you. They were put in circuit on April 21, 1896, and were taken out on December 30, 1896, having been continuously on circuit for 6,072 hours. As they are still each intact, it is impossible to say what their life may be. The following tests were made of two of the lamps at different periods:

TEST OF TWO "STEARN" 8-C.P. 230-VOLT INCANDESCENT LAMPS.

Hours in circuit.	No.	Mean volts at test.	Actual c.p.	Amperes	Watts per nominal c.p.	Watts per actual c.p.
New	1	230	9·1	·141	4·05	3·56
	2	230	9·3	·137	4·05	3·50
1,000	1	230	7·6	·141	4·05	4·26
	2	230	7·5	·141	4·05	4·32
3,844	3	230	4·26	·150	4·31	8·00
	4	230	6·24	·150	4·31	5·54
6,072	1	230	3 8	·141	4·05	8·76
	2	230	3·7	·141	4·05	8·53

If we take the average life of a lamp at 1,000 hours, which is the basis upon which the free lamps are distributed in Bradford, it will be seen that the efficiency at that life in the preceding test is very good. There are now many manufacturers of high-voltage lamps, and the difficulty which was once experienced in obtaining them no longer exists. A healthful competition has now set in, and if a fair and reasonable price is paid and the lamps are each marked with the candle-power, voltage, and the maker's name, these guarantees ought to be amply sufficient, and after all it will be merely taking the same precautions as are equally necessary when purchasing 115-volt lamps.

VII.—CHANGING OVER.

In bringing my paper to a conclusion, it may be of interest to give a short description of the methods adopted for changing over from the lower pressure to the higher. During the latter end of 1895, and the first half of 1896, many alterations in the system of supply were completed which were commenced prior to my advent. They included (1) the laying the third main in about half of the town, which had not up to that time been supplied on the three-wire system; (2) laying an additional service cable in each consumer's premises, thus enabling the supply to be given either from the outers or the middle and outer mains; (3) altering the winding on some of the dynamos at the station and recalibrating instruments for 230 volts.

The additional wire for each consumer was therefore put in under peculiarly favourable conditions, enabling us also to accomplish the actual change in each case with a minimum of time and trouble. At the present moment we are working on a simple two-wire system at 230 volts, the middle wire lying useless, until the time of light load in the summer, when we shall proceed as follows: the middle wire at the station and at the feeder ends will be connected together, and all consumers will be transferred from the coupled outer to the middle wire. This appears a large undertaking, but it will be seen that as we have the three cables in each premises, and a single-pole fuse-box on each cable, the operation entails transferring only the installation wires from one box to another, an act of a few minutes' duration. All our consumers having then been transferred to the middle wire, the coupled outer main will be freed from its connection with the middle both at the feeder ends and at the station, and the three-wire system at 460 and 230 volts will thus be established. It will only then remain to retransfer a portion of the consumers and equally distribute the machines at the station to obtain a properly balanced three-wire system. The additional and third service cable, which it has been necessary to provide for this purpose, will not entirely end its functional usefulness at that time. It will no doubt in many instances in the future give great facilities for nicely regulating the balancing of the maximum demand as the supply increases and new consumers are added, as it will always be an easy matter to take any section of the mains and distribute the load upon it in equal proportion on either side of the system.

Finally, I wish to say that, in dealing with the subject of my paper, I have endeavoured to place before you the facts and experiences in detail just as we have found them. Experience has been wanting, I believe, with regard to details: the broad and general principles and the advantages of such a change are better known. I have endeavoured to show, first, the practicability of supply at 230 volts, and, secondly, the obstacles and alterations which will have to be taken into consideration and encountered when changing any low-tension three-wire continuous-current systems to the higher voltage. Where a borough or district has any pretension to size, and is at present supplied on the lower-pressure system, I believe that the trouble entailed in the change over is not to be considered side by side with the resultant advantages. As regards the battle of the systems, however, I am not taking up the argument here, nor do I espouse the entirely one-sided view professed by some engineers. I think the 230-volt lamp has a future of its own, both in alternating and continuous current systems of supply, and as such its wider adoption and use is merely a matter of time and confidence.

FORTHCOMING EVENTS.

The following are some of the announcements for forthcoming week:

TO-DAY (FRIDAY).—Physical Society, Burlington House, 5 p.m. ("Photography of Ripples," by J. H. Vincent").—Henley's Telegraph Company's meeting.—Electro-Harmonic Society's concert (ladies' night).—Royal Institution (Lieut.-Col. C. R. Conder on "Palestine Exploration"), 9 p.m.

TO-MORROW (SATURDAY).—Royal Institution (Mr. Lord's third lecture).

MONDAY, MARCH 1.—Royal Institution, monthly meeting, 5 p.m.—Society of Arts, John-street, Adelphi, 8 p.m. (Mr. Cross's third Cantor lecture on "Cellulose").

TUESDAY, MARCH 2.—Royal Institution, 3 p.m. (Prof. A. D. Waller, on "Animal Electricity," seventh lecture).—Institution of Civil Engineers' meeting (monthly ballot and discussion of Messrs. Worth and Crimp and Mr. Dibden's papers on "The Main Drainage of London"), 8 p.m.—Society of Arts (Mr. N. Webb on "Gesso"), 8 p.m.

WEDNESDAY, MARCH 3.—Institution of Electrical Engineers' students' meeting, 28, Victoria-street, 7.30 (Mr. Graham on the "Lighting of Country Houses").—Society of Arts (Mr. Gordon on "English Orchards"), 8 p.m.—Crystal Palace, 8 p.m ("Sixty Years of Astronomical Research," by Sir Robert S. Ball).—And at Liverpool, Liverpool Engineering Society.—Chelsea Company's meeting, at the Offices, Chelsea, 12 noon.—Hove Company's meeting, Cannon-street Hotel, E.C., 12 noon.

THURSDAY, MARCH 4.—Royal Institution, 3 p.m. (Prof. Percy Gardner on "Greek History and Extant Monuments").—Chemical Society meeting, Burlington House, 8 p.m.—Institution of Civil Engineers' students' visit to the Brook Green Electric Lamp Works, 2 30 p.m.—Society of Arts (Prof. Ewing's fourth Howard lecture on "The Production of Cold"), 8 p.m.

FRIDAY, MARCH 5.—Institution of Civil Engineers' students' meeting ("Expansion Bearings for Girders," Messrs. Baynham and Dobree).—Royal Institution (Mr. Shelford Bidwell on "Some Curiosities of Vision"), 9 p.m.—And at Paris, Civil Engineers of France meeting.

SATURDAY, MARCH 6.—Royal Institution, 3 p.m. (The Right Hon. Lord Rayleigh on "Electricity and Electrical Vibrations" Lecture I.).—Conversazione of the Junior Engineers, Westminster Palace Hotel, 7.30 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS, Feb. 25.

At last night's meeting of the Institution the following candidates were balloted for:

Members.—C. P. Hammond, 56, St. Douatt's-road, New Cross, S.E.; Hermann Charles Warburg, 35, Wolseley-gardens, Gunnersbury, W.

Associates—Robert Buckland Miller, Stuart House, Chepstow, Monmouthshire; George Archibald March, 59, Ravensdale-road, Stamford Hill, N.

Students—Wilfrid Birks Cleeves, 8, Acton-square, Salford; Frederick William Fawdry, 14, Guion-road, Fulham; J. H. Grieve, Glenholm, Greenock, N.B.; Robert Grigg, 36, Chaplin-road, Willesden Green, N.W.; John M. A. Margetts, Lisbon Villa, Moulsham-street, Chelmsford; George Masinier, 15, Cambridge Gardens, North Kensington, W.; William Denton Perrott, Arc Works, Chelmsford.

Arcs in Threes.—According to *L'Eclairage Electrique*, Mr. Hegner has succeeded in running three arcs in series on a 110-volt continuous-current distribution. His method is not explained.

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THE

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TO CORRESPONDENTS.

All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notice of Meetings, Issue of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C Anonymous communications will not be noticed.*

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BOUND VOLUMES.

Vol. XVIII. of new series of "THE ELECTRICAL ENGINEER" can be had bound in blue cloth, gilt lettered, price 8s. 6d. Subscribers can have their own copies bound for 2s. 6d., or covers for binding can be obtained, price 2s.

WAVES AND WAVES.

The old architects and builders took a keener interest in their work than do many of their modern descendants. The same may be said of literature producers. Nowadays we are flooded out with the cheap, and the cheap is usually nasty. Millions of readers obtain these ephemeral productions, and take for granted the answers to questions to be correct. When, therefore, a new departure is made, either in pure or applied science, the discoverer or inventor is probably mulcted of a part of the credit he ought to receive because the general mass of mankind has been led to expect wonders of the "Arabian Nights' Entertainment" kind. This is especially the case with electrical matters. A little boom is being given just now to the idea of "seeing by electricity." This is pronounced as not being so very unlikely, because the sensation of light is the result of wave action, as is the sensation of sound. The writer does not seem to recognise any difference between the short wave-lengths and enormous velocities of the hypothetical ether (a material of an imponderable character) and the sound-waves due to the vibrations of ponderable matter. It is quite enough to know that scientific men recognise sound-waves and light-waves to make the ordinary man think they are somehow interconnected. Perhaps the inexpert writer may have been led into error by electricians writing of the transmission of plans, maps, photographs, etc., by electrical methods, but such transmission has nothing to do with seeing by electrical means. Or, again, he may have thought that because electrical and light-wave velocities are approximately, if not actually the same, therefore there must be some method of interchanging. Perhaps there is, but at present we have no indications of such a method, nor is it hardly possible to conceive it probable by electrical means. Of course we always have to write under the stress of immense responsibility, expecting adverse judgment pronounced upon our opinions by flippant critics, posing as Daniels, in next week's contemporaries. We really must say, however, that in certain directions we have a little failing that way ourselves, and would see all technical journals wage consistent and persistent warfare against misleading statements of the kind we refer to. It is a great pity for many reasons that there is so little unanimity among us, and that what A calls black, B in its next issue calls white. The outsider looks upon us all as fools or knaves, and wisely so, in that he is unable to discriminate as to what is honest amongst so many conflicting opinions. The application of our text is not far to seek. Applied science is inextricably connected with pounds, shillings, and pence. A general public misled in any direction as to the possibilities of electrical applications is some day or other merely a sheep in the hands of a shearer. A new departure is made, and in the usual way is brought before the public. They having imbibed from various sources exaggerated notions as to what can be done, are very easily led to believe in the promises made as to the scope of the new departure. To return

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to the question of what can be transmitted electrically. Really, we have hardly progressed in this direction since the days of Bakewell, though every now and again we hear of some wonderful apparatus which is going to revolutionise telegraphy by sending complete messages in fac-simile. There is not much difficulty in doing this, but time and cost prevent the adoption of such apparatus. The present method of sending messages by signs or sounds is far more expeditious than any apparatus as yet devised for sending messages by Bakewell's copying method.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

THE LUNDELL MOTOR.

SIR,—We notice in your issue of 19th inst., under the heading "The Lundell Motor," certain particulars of efficiencies and weight. Considering the prominence given to the article, and the wording of the paragraph, it appears to be implied that the performance of these motors as stated is something out of the common. We do not know the speeds at which these motors are run, but the weight is no less and the efficiencies are no higher than in motors made by ourselves and by other manufacturers of high-class machines—in fact, we have considerable doubt whether the commercial article would come out as good in efficiency on trial as our trade motor.—Yours, etc.,

GREENWOOD AND BATLEY, LIMITED.

ELECTRIC INTERLOCKING.

SIR,—I have read with great interest your account of Mr. Hollins's paper on electric interlocking, and also the report of the discussion thereon in last week's issue. Several of the members drew attention to the "treadle" as being the salient feature of any interlocking block system, inasmuch as it is depended upon for tangible proof that a train or engine has passed out of the block section. There was some discussion upon the reliability of treadles, and I was pleased to see that Major-General Webber made an enquiry as to the success of an alternative—viz., the "rail circuit"—as used in America.

Having had 10 years' practical experience in railway signalling throughout the United States, I have no hesitation in saying that in America the rail circuit has proved a splendid success, in spite of the early adverse criticism of experts. We thought it would not be possible to maintain the circuit when the ballast was thoroughly soaked by rain for weeks, but experience showed that the principal troubles arose from the presence of metallic ballast, and through the lack of knowledge as to the elementary laws of electricity. The necessary features are as follows—viz.: (1) the use of low-resistance and reliable bond wires at the rail joints; (2) the use of a non-metallic ballast; (3) the resistance throughout the circuit should be as small as possible; (4) the pressure at battery should not exceed one volt; (5) the length of a circuit should not exceed half a mile of railway, although the protection is carried through a whole section by means of relays; (6) the relay must be suitably proportioned.

Before adopting the rail circuit we tried several very good treadles, but although we got few failures to "Release" it seemed to us that the treadle was wrong in principle owing to its failure to take care of coaches that are uncoupled and left foul of the main line at inopportune times. In other words, the passage of one pair of wheels over the treadle does just as much as would the whole train.

The rail circuit thoroughly safeguards such everyday occurrences, and also when applied to a whole block section in exceptionally dangerous cases, such as the eight sections in the Fourth-avenue tunnel, New York (Sykes system). Where tail-markers cannot be seen from the cabins there is a very desirable assurance that the whole train has passed out of section.

In order to explain to what a great extent the rail circuit has been applied by the principal lines in America, I will say that the most important divisions of the New York, Newhaven, and Hartford, the New York Central, and the Pennsylvania are equipped therewith—the two former in connection with electric lock and block, and the last in connection with the Westinghouse pneumatic system. The fact is, that treadles will not compare with rail circuit as regards the protection afforded, and as regards adaptability to junction and siding work.—Yours, etc.,

ARTHUR H. JOHNSON.

Late consulting engineer to the Johnson R. R. Signal Company and the Hall Signal Company, of New York.
132, Clapham-road, London, S.W., February 21, 1897.

OBITUARY.

HENRY CHARLES FORDE, M.I.C.E., M.I.E.E.

It is with the deepest regret that we announce the sudden death of Mr. H. C. Forde, which occurred last Sunday whilst on a visit at the house of a relative near Epsom.

Mr. Forde was one of the old generation of engineers who have made submarine telegraphy what it now is—an ordinary everyday accomplishment. Formerly associated with the late Sir Charles Bright, Mr. Latimer Clark, and others, he has of late years acted in professional partnership with the last named and Mr. Herbert Taylor as consulting engineers to the bulk of the cable companies which control our electric nerves all over the world. Mr. Forde was for several years a member of council of the Institution of Electrical Engineers, and he was one of the oldest members of the Institution of Civil Engineers, to which profession he belonged in the strictest sense. An enthusiastic churchwarden at the parish church, Wimbledon, it is no exaggeration to say that he was beloved by all who knew him, partly on account of his unbounded kindness and generosity, partly owing to his eminently genial personality. In such cases the title "gentleman" has something more than its conventional significance. His professional achievements leave their mark behind him; we, however, prefer to call to mind the charm of his personal characteristics. Death with a man of the type we have described, though creating a sad void for his friends, was an event for which the deceased himself must have been thoroughly prepared—and in the best sense.

A CONVECTION-SCOPE AND CALORIMETER.*

BY ALFRED R. BENNETT, M.I.E.E.

(*Continued from page 244.*)

A modification, shown in Fig. 5, has been made, by which the vane runs forward during the day and backwards during the night. In this case the motor is fixed directly on a pipe, M^1, which descends to nearly the bottom of the tank, the shade being in communication with the space between the pipe and the walls. During the day the warm motor surfaces draw air up the pipe, and heat is stored in the reservoir. On the approach of night solar radiation ceases, the motor surfaces become cooler than the tank walls, the air in contact with which thereupon rises into the shade and descends the chimney and the pipe, M^1, in the reverse direction to that indicated by the arrows. Owing to a long column of inert air in the pipe having to be kept in motion by the heating surfaces during the day, this arrangement is not so sensitive as the one shown in Fig. 4.

The convection mill in its simple form will not operate in the interior of a room when withdrawn from sunshine or other high-temperature source of radiation, since in such circumstances both the motor and the shade soon acquire the temperature of the surrounding objects: and owing to the absence of a difference of temperature between the two, there can be no rotation. But if a supply of heat above the temperature of the room be by any means conveyed to the vane or motor surfaces, the instrument works quite well within doors. Such a supply can be managed in many ways, as by mounting

* Paper read before the Manchester Literary and Philosophical Society, January 26, 1897.

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the vane on the apex of an electric glow lamp, Q, in Fig. 6; by suspending a glow lamp in the chimney, as in Fig. 7; by leaving an aperture, R (Fig. 8), in the baseboard, so that ends of hot bars, tubes, etc., may be introduced below the vane; by providing a thermally-insulated chamber, S (Fig. 9), within which hot objects, or pipes conveying warm liquid or gas, may be located. The modification shown in

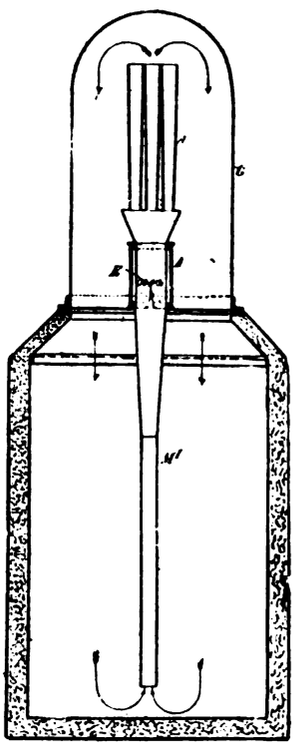

FIG. 5.

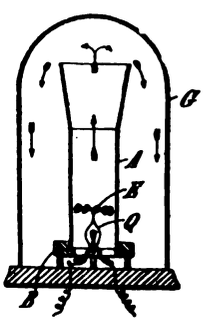

FIG. 6.

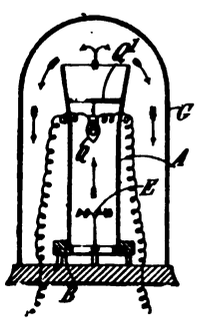

FIG. 7.

Fig. 10 may be worked by grasping the coiled pipe, T, in the hand or by dipping it into warm fluid. The warmth of the hand causes the air to rise in T, ascend through the chimney, and return *vid* T^1 and T^2. By grasping T^1 and T^2, and leaving T cold, the motion is reversed.

This brings me to the question of the adaptability of the instrument to useful ends.

If an instrument be in a room, removed from a window, and consequently at rest, the application of ice or cold water to its shade will immediately induce rotation, which will continue until the temperature of the vane and all the contents of the shade have been reduced to about 3-10ths deg. F. (the exact point will vary with the barometrical pressure and the distribution of water vapour on the shade and other surfaces) above that of the ice or cold water. This fact has enabled me to construct a calorimeter in which the energy of heat introduced into it becomes manifested in the form of mechanical action, and is measurable by the convective effect produced as revealed by the rotations of the vane.

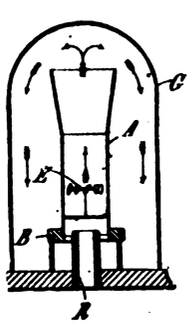

FIG. 8.

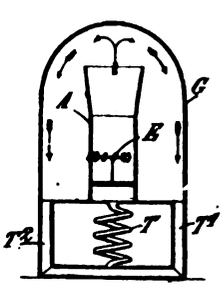

FIG. 10.

Packing the shade in ice is unsatisfactory unless very carefully done, and is also inconvenient, as it prevents a view of the vane. A plan which I have adopted with success is shown in section and in plan in Fig. 11. G is a glass gas-jar having a long neck and a mouth provided with an airtight fitting stopper, G^1. The base of the gas-jar is cemented watertight into the bottom of a tank, U, which has at least two of its sides of glass. U^1 is a watertight vessel upon which the tank, U, stands. U and U^1 communicate by means of the pipe and tap, U^2, and water coming from U is compelled by the mid-feather, U^3, to circulate under the top plate of U^1, down, and under the mid-feather before reaching the waste-tap, U^4. U^5 is a tube passing through U^1, serving to introduce gas or connecting wires into G, or to keep its contents at atmospheric pressure. Before U has been placed on U^1 a convection mill with the upper part of its chimney, A, thickly coated with non-conducting material, is fixed upon U^1 so as to be covered by the gas-jar. The joint between U and U^1 is made airtight by indiarubber packing or otherwise. To prepare the calorimeter for use, water at a lower temperature than that of the room is turned on, and when the tank, U, and vessel, U^1, become full, the waste-cock, U^4, is opened, and a copious stream of water allowed to run through the apparatus. Two sensitive thermometers, not shown in the drawing, are placed respectively in the running water and inside the chimney, A. Soon after the water has been turned on the vane, E, will begin to rotate, and will continue in motion until the temperature of everything covered by the gas-jar, G, initially at that of the room, has been reduced to about 3-10ths deg. F. above that of the running water. The vane will then stop, but the inside thermometer will continue to fall until it registers only 1-10th deg. above that of the water. I have found that the temperature of water from the London mains varies but little during the day, sometimes not at all for many consecutive hours, so that for rough measurements water straight from the mains suffices. But when strictly accurate results are aimed at a perfectly constant water temperature is indispensable, as a variation of even 1-20th deg. F.

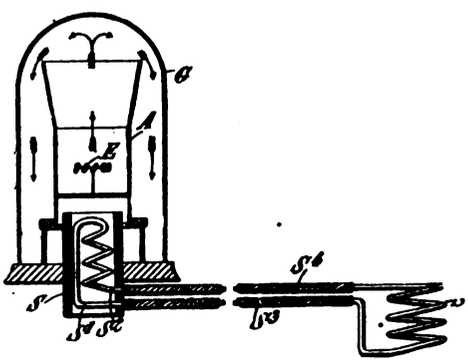

FIG. 9.

makes itself felt. This may be obtained by causing the water to flow through a tank, V (Fig. 11), kept well supplied with broken ice, and which is divided in the centre by a partition, V^2, which descends nearly to the bottom. The water entering at V^3 sinks through one mass of ice, passes under the partition, rises through the other mass of ice, and flows away by V^1 to the calorimeter tank, U. By this means any temperature differences of the mains' water are obliterated.

Being sheltered from daylight or other high temperature radiations the instrument can receive no access of heat from the outside, and is independent of sky variations and all exterior influences except pressure. When the inner thermometer registers

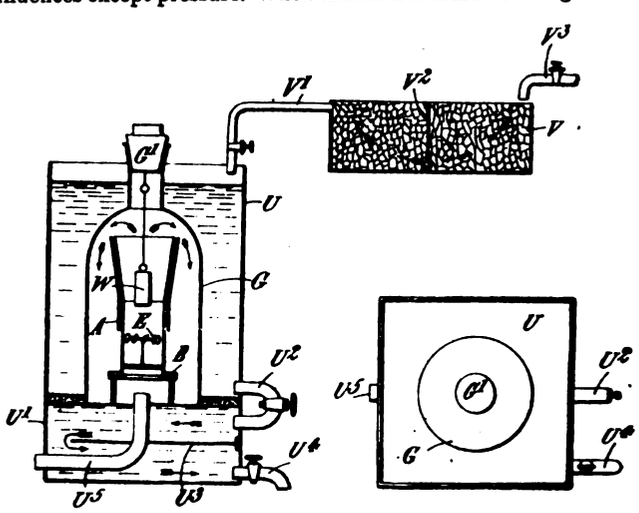

FIG. 11.

1-10th deg. F. above that of the running water, and the vane is consequently at rest, the instrument is in an extremely sensitive condition and ready to start on the slightest provocation in the shape of introduced heat. If, now, a substance, W (Fig. 11), at any temperature above that of the running water be suspended by a silk thread within the chimney the vane will immediately begin to rotate, and will not stop until all the heat in W has been conveyed by convection to the running water, and the temperature of the whole enclosure once more reduced to 3-10ths deg. F. above that of the water. I have found that the number of rotations made by the vane under such circumstances constitutes a very accurate measure of the quantity of heat introduced with W. It is not

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difficult to understand why this should be so. W, when hung in the chimney, can radiate heat downwards to the vane, circumferentially to the chimney, and upwards to the stopper. As the exterior of the chimney is well coated with non-conducting compound, the upward is the only direction in which loss by radiation is likely to occur, and this may be minimised by silvering the top of the gas-jar and bottom of the stopper so as to reflect errant rays into the chimney. Loss by conduction through the base is insignificant owing to the interposition of the badly-conducting mica tube; while direct conduction by molecular diffusion between the heated substance, W, the motor surfaces, and the glass cannot occur, since all these surfaces are continually swept by currents of a strength sufficient to suppress molecular convection. Thus nearly all the introduced heat is expended in causing air currents.

To test the ability of the apparatus to measure specific heats, I caused four cylindrical boxes to be made, respectively of lead, copper, iron, and aluminium, each box being of exactly the same size and shape, and the last three being made equal in weight—viz., 6oz.—to the lead by attaching extra pieces of metal to their insides.

(To be continued.)

VESTRY OF CHELSEA.

The following is the report of Mr. T. W. E. Higgens, surveyor to the Vestry, to the Works and General Purposes Committee on street-lighting:

I was instructed to report fully to this committee upon the question of street-lighting in the main roads, both by means of electricity, incandescent gas and other burners, and as to the suitability of the present lamp-posts and lanterns, etc.

Suitability of Lamp-Posts.—When the question was last under consideration the pattern and suitability of the lamp-posts and lanterns now in use was discussed, and I was directed to report as to their possible adaptation for electric lighting and as to whether improved lanterns could be fixed on the existing posts. As regards electric lighting, it may be said at once that the present lamp-posts are not suitable for arc lighting. Electric lamps of any power, placed so low, would dazzle drivers and frighten horses, and the light from them would not be properly distributed. It has been found that where arc lamps are placed in the centre of roadways, the middle of the arc should be 25ft. above the street-level, and where the lamps are at the sides of the streets, about 23ft. above street-level; whereas, in ordinary street lamps, the burners are only about 11ft. above the roadway.

Variety of Posts used in Chelsea.—When we come to consider the pattern of the present lamps, even the most casual observer cannot fail to have been struck with the remarkable variety of lamp-posts in Chelsea. For instance, in Lowndes-square, a special form of lamp, consisting of an extremely ugly base and a stem adorned with a little meretricious ornament, was fixed when the houses were built; in other parts of the parish you meet with such patterns as a stem projecting from the mouth of a sham cannon; a short post with a base 18in. above the ground marked "C. V."; the "Embankment" pattern post, used on new estates; the "panel" post, which is the best proportioned and most suitable of small posts (the first lamp in Sydney-street is of this pattern); and lastly, there is the post now in use, except where the Embankment pattern are used—a feeble attenuated concern, which looks top-heavy with a lantern on it, but possesses two apparent merits: it is cheap, and takes up little space with its base. In my humble opinion, it is an eye-sore, but I spare this post, as I believe it possesses the official approval of the Vestry, which it received in the days of my predecessor, who greatly admired it. I am not, however, desirous of inflicting a new post upon Chelsea, but I think that a reversion to a former type, the "panel" post for preference, might be advantageous in every way if it is used for a gas-burner of moderate illuminating power.

Difficulty of Fixing Larger Posts.—If the Vestry are desirous of adopting larger gas-burners, I think larger lanterns and posts are to be desired. But when larger posts are used, there is always a difficulty in placing the posts well back from the kerb on account of the projecting of the vaults. If the vaults are according to the Vestry's regulations, only 15in. back from the face of the kerb, there is no room for a post with a large base to be inserted. The Embankment pattern post, for instance, are 16in. square at the base, and beyond this there is a flange, which makes the base in all 22in. square, so that the vaults must be cut away to allow it to be fixed.

Irregularity of Lamp-Posts.—In considering the question of street-lighting generally, and the positions of the existing lamps, it may be as well to say a few words as to the progress of street illumination. When street lamps were first introduced, they were few and far between. They were used more for the demarcation of the roads than for the purpose of giving light, and this idea, no doubt, accounts for the bad lighting in many parts of London. It used also to be the practice in Chelsea to allow part of a new street to be completed and occupied before any lamp-posts were fixed, and even then the inhabitants usually drew attention to the want of light before anything was done. Hence, in some places, lamps are fairly regularly distanced; in others they are far apart, as the inhabitants were more or less importunate. Of late years, however, on new estates, the Vestry have authorised me to fix lamps at reasonable distances as soon as the streets are completed, and the result has been that on such estates the lamps are fixed with some regularity and regard to the requirements of the neighbourhood.

Lighting of Main Roads.—It is now acknowledged that a more efficient illumination of the main roads is a necessity, and it is felt that the street-lighting should not, to a very large extent, be left to the enterprise of the various tradesmen who have premises fronting on the main road. In streets where this is the case, the effect of an early closing movement is very marked. The streets have a dark and mournful aspect, it looks like Sunday, and the average omnibus, which never carries a light, is a source of danger to persons crossing the street.

How to Improve Lighting.—A district, however, can be well lighted if the lighting authority care to increase the cost of this service. It can be done (*a*) by adding new lamp-posts fitted with ordinary burners, (*b*) by increasing the power of the existing burners, (*c*) by using incandescent gas burners, or (*d*) by means electricity.

Additional Lamps.—(*a*) If it is thought advisable to erect new lamps with the ordinary 4ft. burners, the annual charge for gas and lighting amounts to £2. 10s. 1d., and the cost of fixing each new small post and lantern complete, to about £2; while a new Embankment pattern post complete would cost for fixing, etc., £6. 4s., the cost of gas being the same.

Larger Burners.—(*b*) If the size of the burners on the existing posts were increased, the cost for gas, lighting, etc., would be:

Lamp burning per hour.	Price of gas at 2s. 3d. per 1,000ft.
5ft. of gas	£2 18 10
6ft. ,,	3 7 7
8ft. ,,	4 5 2
10ft. ,,	5 5 8
12ft. ,,	6 5 3
15ft. ,,	7 6 6

But in each case where more than 5ft. per hour was burnt, an improved lantern, costing from 30s. to 40s., would be required; an a larger post than the ordinary small lamp-post now in use should be fixed if a 12ft. or 15ft. gas-burner is used.

Incandescent Gas.—(*c*) The cost of incandescent burners and mantles complete is now 5s. 6d. each for the ordinary burner, and about 10s. 6d. for a burner with an anti-vibration frame—such as made by the Anti-Vibration Incandescent Lighting Company, of Bradford. One of these latter frames has lately been fixed in the lamp opposite No. 248, King's-road, and up to the present has given good results. With regard to my last report to the Vestry on this subject, the Incandescent Gas Light Company wrote me on November 26, 1896: "The results obtained by you are peculiarly unsatisfactory, more especially when compared with the results reported to us by the local authorities at such places as Winchester, Dover, Folkestone, Margate, Ipswich, Leicester, etc., in most of which, with the exception of Leicester, the light is being used universally. There is, however, an explanation of this, which, I think, deserves some attention. Firstly, you have not got our street-lighting burner, but our ordinary burner. Secondly, this burner is neither attached to a suspension frame nor fitted with springs. The burners we are now fixing in different parts of London are almost invariably fitted with the anti-vibration suspension frame, especially in busy thoroughfares, such as the King's-road, where the burners are subjected to very heavy vibration. Our experience is that the average number of mantles required—and by the average I mean town and country—does not exceed six per burner per annum; in many cases it is considerably less, and it is very rarely more. This, however, presupposes that the burners have been fitted with due regard to the local conditions rather than with regard to economy in the initial installation."

Electricity.—(*d*) Where lighting streets by electricity is suggested, it is usually taken for granted that arc lights and not incandescent lamps are intended. At present very little street-lighting by means of incandescent lamps is carried out in this country. It has been tried in places, but not, as a rule, successfully. At Kingswood, near Bristol, a system of series lighting by means of incandescent lamps has been tried for nearly five years, and is said to be a success. Such a system, however, is not suitable for Chelsea.

Arc Lamps.—Arc lighting has found favour in most places where it has been tried, because it thoroughly illuminates the street for some distance around the lamp-post. The lamps most commonly used are 10-ampere arc lamps absorbing 500 watts each, two of them being placed in series on a 100-volt main, as each lamp takes 50 volts. But this, of course, means that every two lamps must have a separate circuit taken off the main, and might mean a new cable and casing in places where the electric

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light company have no spare room in their conduits. Arc lamps can be fixed on either a direct-current or alternating-current supply. The Chelsea Electricity Supply Company's system is that of a direct current, and this will be an advantage in arc lighting, as it is found that an alternating current, while, perhaps, giving a little more light when used in an arc lamp, throws a large amount of that light both upwards and horizontally, while with the direct current the rays are thrown downwards, and the crater which is formed in the top (positive) carbon rod appears to intensify the downward rays, and give very little light above the level of the lamp, where, of course, it is not required in street-lighting. A new form of arc lamp has, however, lately come into favour, its distinguishing feature being the enclosed arc. The best-known form is, perhaps, the Jandus lamp. This lamp will work on a 100-volt circuit, and can, therefore, be used on the Chelsea Electricity Supply Company's mains without any trouble. The lamp is made with two glass globes. In the inner ones the carbons are placed so that fresh air is as much as possible excluded. It is found by this arrangement that the carbons are consumed very slowly, as they are burning in an atmosphere free from uncombined oxygen—in fact, in an atmosphere that will not support combustion. In such lamps the brilliant spot of light in the centre of the arc, which is so dazzling to the eye, is not seen. If the Vestry should determine to make a trial of arc lamps for street-lighting, lamps of this description seem suitable for the Chelsea Company's circuit, and as they are only recarboned at comparatively long intervals, 200 hours, while ordinary arcs are recarboned every other day, there would also be a saving in this respect as compared with ordinary arc lamps. The drawback to this enclosed arc type of lamp is that the interior of the enclosed vessel is liable to become coated with brown dust, which obscures part of the light. The most important feature, however, in any arc lamp used for street-lighting must be its regulation of the carbons. Those lamps which go out for a few seconds occasionally are to be avoided at all costs.

Candle-power of Arcs.—When we consider the candle-power of arc lamps we find a great difference of opinion. Lamps which are intended to give 1,500 or 2,000 nominal candle-power are said to give only 1,000, and, taking the average of all angles, the result would probably be very much less.

Chelsea Electricity Supply Company's Offer to Light Arcs.—I have been in communication with the Chelsea Electricity Supply Company as to the cost of arc lamps, and they say that their price for a minimum of 50 10-ampere lamps, to be lighted during the ordinary lighting hours, would be £32 per lamp per annum, the main being provided by the company and the lamps and lamp-posts by the Vestry, the contract so be for not less than seven years; they do not include any maintenance or the cost of switching on and off, which apparently would have to be done for each lamp separately. The price of each electric standard and lamp would be about £20, but I have no figures as to the cost of maintenance except that Prof. Robinson estimates the annual expenses of a 7-ampere lamp at Leyton at £20. The cost of electricity is low as compared with this company's usual charges; the £32 works out at less than 4d. per Board of Trade unit for the 3,898 hours of lighting. If the ordinary 10-ampere lamps were used, two of them would be in series at 50 volts each, but a Jandus lamp would be a 5-ampere lamp at 100 volts. The Chelsea Electricity Supply Company also suggest that the Vestry should fix two arc lamps as an experiment, opposite the town hall, or suspend them from brackets, and they would temporarily fix a meter.

Cost of Lighting Main Road.—In 1895 this company submitted a scheme for lighting Sloane-street, Sloane-square, and King's-road, as far as Church-street. They then proposed to fix 12 lamps in Sloane-street, four in Sloane-square, and 17 in King's-road as far as Church-street. The lamps were placed at from 40 to 60 yards apart. If these lamps were fixed at similar distances as far as Stanley Bridge the number required for the whole of King's-road, Sloane-square, and Sloane-street would be about 57. This number, at £32 for the current, apart from maintenance, would amount to £1,824, and the cost of the new electric standards and lamps to £1,140. The cost of gas, and the cleaning, lighting, maintenance, etc., of the gas lamps which would be displaced amounts to less than £600. The total amount spent in gas for the home district does not exceed £3,500; therefore, an extra £500 or £600 spent in gas and improved appliances for the main roads would quite alter the character of the street-lighting.

Where Lamps are Urgently Required.—There are, however, certain dark places where extra lamps of some description are required. For instance, there is only one lamp on the north side of King's-road between the east side of Paultons-square and Park-walk, and there is only one lamp on the south side of King's-road between Milmans-street and the refuge at the World's End. Lamps are also needed at the junction of Edithgrove and Cremorne-road; at the junction of Lots-road and Tadema-road; in Tite-street, between Christchurch-street and Tedworth-square; and Tedworth-square should have at least one extra lamp.

Rowan Lamps.—In this report I have not dealt with the Rowan lamps, as the Vestry has now under consideration a further offer from that company to light Lower Sloane-street, and have also asked what is likely to be the cost of maintaining their burners in other parts of the parish, should the trial in Lower Sloane-street prove satisfactory.

Cost of New Lamps.—In conclusion, may I add, if the Vestry desire to improve the lighting of the parish, the extra cost for each new lamp will be—

	Cost of post, lantern, etc.	Annual cost of maintenance, gas, etc.
Small post, with ordinary 4ft. burner.	£2 0 0	£2 10 1
Embankment post, with 4ft. burner...	6 4 0	2 10 1
Small post, with 5ft. burner	2 0 0	2 18 10
Embankment post, with 5ft. burner...	6 4 0	2 18 10
,, ,, 6ft. ,, ...	7 14 0	3 7 7
,, ,, 10ft. ,, ...	7 14 0	5 5 8
,, ,, 12ft. ,, ...	8 4 0	6 5 3
,, ,, with anti-vibration incandescent burner	6 14 6	3 10 1
Small post, with anti-vibration incandescent burner.....	2 10 6	3 10 1
Electric arc*	20 0 0	52 0 0

*This does not include switches, resistances, connection to mains, or fixing posts.

If, however, larger or improved burners were fixed on the existing lamps, an arrangement which it is most desirable to carry out if the Vestry are not disposed to adopt arc lighting, the extra cost would only be the difference in cost between £2. 10s. 1d., which the present lamps cost, and the cost of the maintenance, gas, etc., of the suggested larger burner in the second column of the above table, plus £2 for fixing a new lantern. For instance, if it was proposed to substitute 10ft. burners for the present 4ft., the extra cost would be £2. 15s. 7d. +£2=£4. 15s. 7d.

Lamps in Main Roads.—The number of lamps in the principal thoroughfares are as follows: King's-road: 69 4ft., 4 12ft., total 73; Sloane-street: 41 4ft., 1 6ft., 1 8ft., 1 12ft., total 44; Lower Sloane-street and Pimlico-road: 6 4ft., 10 5ft., 3 12ft., 1 large refuge lamp, total 20; Oakley-street: 12 4ft.; Sloane-square: 14 4ft., 2 8ft., 4 12ft., 2 large refuge lamps, total 22; Fulham-road: 33 4ft., 1 8ft., 1 12ft., total 35; Harrow-road, 23 4ft. Totals: 198 4ft., 10 5ft., 1 6ft., 4 8ft., 13 12ft., 3 large refuge lamps. Grand total, 229. The lamps in King's-road include 5 Rowan lamps and 9 incandescent lamps. Those in Sloane-street include 1 Rowan lamp, and those in Oakley-street 3 incandescent lamps.

LEGAL INTELLIGENCE.

THETFORD ELECTRIC LIGHT AND POWER COMPANY, LIMITED.

At the Norwich County Court on February 17, before his Honour Judge J. E. W. Addison, Q.C., a petition, presented by Mr. Wm. Jackson, of Knottingley, in the county of York, gentleman, for the winding-up of this company was heard.

Mr. T. C. Blofeld (instructed by Messrs. Stevens, Miller, and Jones) appeared for the petitioner. Mr. A. H. Poyse represented Messrs. Burrell Company; whilst for the shareholders and contributories appeared Mr. W. P. Eversley. Messrs. Houchen and Houchen, of Thetford, instructed the counsel for the respondents.

Mr. Blofeld informed his Honour that the company was incorporated in 1890, the nominal capital being £5,000, divided into 500 shares of £10 each, and of this £3,680 were allotted, Mr. Jackson being the holder of £1 750 worth of share capital out of the total issue. The objects for which the company was established were to carry on the business of electricians, mechanical engineers, and manufacturers, makers and dealers in electricity, motive power, light, etc. The petition set forth that an agreement was made between Burrell Hiring Company, Limited, on the one part, and the electric company of the other part, for the hire and purchase of electric lighting machinery and plant, to be used for the purposes of the above company. The first directors were Mr. Charles Burrell, jun, Mr. Robert George Burrell, and Mr. Fredk. John Burrell, and Mr. Jackson, and the articles of association were signed by the above, and, in addition, Mr. John Houchen, jun., Mr. Frederick Vauker Houchen, and Mr. Thomas Lumley, each of whom agreed to take one share in the capital of the company. The Burrells were carrying on a large business at Thetford as engineers, under the style of Charles Burrell and Sons, and this had since been converted into a private company, the whole of the shares of which were issued to and were still held by the members in the said partnership and their friends and employés. The Messrs. Houchen were solicitors to the Burrell Company, and also on its incorporation to the electric lighting company. Burrell's Hiring Company in the articles of association was and is a private company, the shares being held by the Burrell family and their friends, and of the 368 shares 175 were held by the petitioner, five each by the three Robert George, Charles, and Frederick George Burrell, one each by John Houchen,

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jun., and F. V. Houchen, and 175 by Charles Burrell and Sons, Limited. Petitioner contended that he paid to the company £1,750 in respect to his shares, and that the whole, or substantially the whole of the other issued capital, was issued as full paid up under one or other of the agreements that had been specified. The petition further set out that the company had (except in the year 1893) been carried on at a loss until 1896, when it was alleged the net loss was £1.186. 19s. 11d. For a long time the petitioner had been dissatisfied with the state of the company's affairs, but he had been unable to do anything effectual by reason of the preponderating influence of the Burrell family, their friends, and employés, in whose hands was the voting power. At the meeting of the directors held on January 11, 1897, at which it was decided that it was impossible to carry on the company, and a resolution passed to take the necessary steps for the winding-up of the company, under the direction of the Court, petitioner was not present. Petitioner further alleged that the company's assets were of considerable value, and if prudently realised would be sufficient not only to satisfy the debts and liabilities, but pay a substantial dividend to the shareholders. For his (Jackson's) protection, it was necessary that the investigation of the company should be made by some independent person, and this could not be secured in a voluntary winding-up unless an independent liquidator was appointed by the Court. The realisation of the assets of the company ought also to be in the hands of an independent person. The petition, therefore, prayed (1) that the Thetford Electric Light and Power Company, Limited, may be wound up by the Court under the provisions of the Companies Acts, 1862 to 1890, and that for such purpose all necessary and proper directions may be given; (2) that in the event of resolutions being passed before the hearing of this petition for the voluntary winding-up of the company an order may be made for the continuance of such voluntary winding-up subject to the supervision of the Court with an independent liquidator appointed by the Court.

Mr. Poyser contended that this was one of the most ill-conceived petitions that could be made to Court. The shares were allotted at a meeting at which Mr. Jackson was present, and the question was whether a majority was to rule a minority or *vice versâ*. Mr. Jackson was not entitled to ask for a compulsory order. Assuming that the company could not go on, the Court would decide whether the winding-up was to be voluntary or compulsory. On the petitioners was the burden to show that a compulsory winding-up should take place. There was a great difference between share holders' and creditors' opposition. A creditor might come and ask for an order of winding-up, but if the majority opposed the application would fail.

His **Honour**, in giving judgment, said the resolution came to for winding-up of the company could only be upset by him on the ground that there was a screw loose somewhere—that there was something wrong which required careful investigation by the Court, and by such proceedings familiar to the Court; but he (his Honour) failed to find that there could be any suggestion of the kind. The only suggestion made by Mr. Jackson was based on his belief that a great many of the shares were not paid in cash, but there was the clearest evidence of the Messrs. Burrell, who had given in their affidavits, the dates, times, and cheques, that they had paid, and also the vendors of the company. He failed to find a trace of anything wrong after looking at the affidavits on either side. Mr. Blofeld suggested that something wrong might be found in Messrs. Burrell's disinclination to the winding-up of the company under the supervision of the Court. But why should they mind being examined by the official liquidator and have their affairs looked into? The answer was simply this, that everyone preferred to conduct his affairs in a quiet manner rather than come into Court. Under the circumstances he thought the petition failed. Costs would follow the event.

CLAIM BY ELECTRICAL ENGINEERS.

In the Westminster County Court, on Friday, the case of Barlow *v.* Tyndall was tried before his Honour Judge Lumley Smith, Q.C. It was an action by the plaintiffs, Messrs. H O. Barlow, electrical engineers, carrying on business at 237, Shaftesbury-avenue, to recover the sum of £28 for electric fittings alleged to have been supplied to the order of the defendant at his flat in Army and Navy Mansions, Victoria-street, Westminster. Mr. Leonard Barlow and other witnesses were called, and gave evidence in support of the claim.

The defendant's case was that his landlord was liable, as the electric light was arranged for in the agreement of tenancy.

After hearing the evidence, his **Honour** gave judgment for the defendant, and remarked that it did not affect the plaintiffs' right as against the landlord of the premises.

MADEIRA ELECTRIC LIGHTING COMPANY.

In the Lord Mayor's Court, on Monday, before the Common Serjeant, application was made by Mr. Preston in the case of Haywood *v.* Carlton, Hessey, and Co., and the Madeira Electric Lighting Company, Limited, to have the Madeira Electric Lighting Company dismissed from the action. **Mr. Preston** said the action had been brought to recover £2,333. 6s. 8d, being a third share of a profit of £7,000 realised by the defendants, or some of them, upon the flotation of the Madeira Electric Lighting Company, Limited. There were, he said, two objections to the claim, one being that the date of the agreement was alleged after the date of the incorporation of the company, and the other that there was no allegation that the persons through whom the contract was alleged to have been made had the authority of the company to enter into it.

Mr. Crispe opposed the application on behalf of the plaintiff.

In the result, the learned **Judge** dismissed the application.

COMPANIES' MEETINGS AND REPORTS.

INDIA RUBBER, GUTTA PERCHA, AND TELEGRAPH WORKS COMPANY, LIMITED.

The thirty-third ordinary general meeting of this Company was held at Cannon-street Hotel, yesterday (Thursday).

The **Chairman** (the Hon. Henry Marsham) stated that after provision for doubtful debts there was a net profit for the past year of £51 888. 17s. Adding £20,239. 9s. 4d. brought forward, and deducting £12 500 interim dividend paid in July, there remained a disposable balance of £59,628. 6s. 4d. The directors recommended the distribution of a dividend of 15s. a share, free of income tax, amounting to £37,500, making, with the interim dividend paid in July, a total payment of 10 per cent. for the year, and leaving £22,128. 6s. 4d. to be carried forward. The Company's debenture issue was carried out last year, and now stood at £300,000, bearing 4 per cent. interest. Mr. T. J. Lloyd had been appointed secretary in the place of the late Mr. W. J. Tyler.

Messrs. Marsham and Jarvis were re-elected directors, and Messrs. Turquand, Youngs, Bishop, and Clarke were re-elected auditors.

HOUSE-TO-HOUSE ELECTRIC LIGHT SUPPLY COMPANY, LIMITED.

Directors: Henry Ramié Beeton (chairman), William Page (managing director), William Reginald Davies, Robert Arthur Germaine, and William Francis Leese. Manager: Henry W. Bowden. Secretary: Thos. J. Owens.

Abstract of the report of the directors and accounts for the year ended December 31, 1896:

The revenue account shows a credit balance of £9,031. 18s. 1d., which, with the balance of £64. 19s 4d. brought forward, £58. 12s. 7d. dividend on 300 £5 fully-paid ordinary shares in the Yorkshire House to-House Company, Limited, and £28. 11s. 4d. interest on deposit, makes a total of £9,184. 1s. 4d. After deducting £2,312. 1s. 9d. for interest on debenture stock paid and accrued and other interest, and £955. 12s. 1d. for interim dividend paid on the 7 per cent. cumulative preference shares, the directors recommend that the sum remaining—viz, £5,916. 7s. 6d.—be dealt with as follows: to credit of depreciation account, £2,600; to payment of the remainder of dividend to December 31, 1896, on the 7 per cent. cumulative preference shares, £1 168 13s.; in reduction of preliminary expenses account, £600; in reduction of the construction business development account, £1,504. 2s; and that the balance of £43. 12s. 6d. be carried forward to the next account — total, £5 916. 7s. 6d. The amount of £839 received as premiums on the last issue of shares has been applied in further reduction of preliminary expenses account, thus reducing that item to £2,142. 11s. 5d. The increase in the number of lights connected during 1896 was equivalent to 11,103 8 c.p. (35 watt) lamps. Notwithstanding that from the end of the first quarter of 1896 the maximum price charged for current has been 6 1 per Board of Trade unit in place of 8d., the revenue from electricity increased for the year by £1,836. 10s. 7d, while the working expenses show a decrease of £143. 12s. 6d. During the year additions and alterations to the plant and mains have been made at a cost of £31,407. 10s. 5d., and the expenditure for 1897 is estimated at £24 000. In order to provide for this outlay a further issue of capital will shortly be made. The directors have again been advised that the accounts of the Leeds and London Electrical Engineering Company, Limited (to whom the business in connection with the construction business development account has been leased), do not admit of the distribution of any profit. In the event of the agreement with the Leeds and London Electrical Engineering Company, Limited, being determined during the ensuing year, it will be necessary to reinstate such proportion of the above asset as may be deemed irrecoverable. During the year 1896 a further 1,678 ordinary and 1,678 7 per cent. preference shares were issued. Mr. W. F. Leese and Mr. W. Page retire from the Board by rotation, and, being eligible, offer themselves for re-election. Messrs. Miall, Wilkins, Randall, and Co., the auditors of the Company, offer themselves for re-election.

Dr. General Balance-Sheet, Dec. 31, 1896.	£	s.	d.
Capital—10,000 ordinary shares of £5 each	50,000	0	0
6,678 preference shares of £5 each	33,390	0	0
100 founders' shares of £5 each	500	0	0
	83,890	0	0
4½ per cent. debenture stock	50,000	0	0
Loan from bankers	4,000	0	0
Sundry creditors on open accounts and for debenture interest accrued	12,847	2	8
Doubtful debts reserve account	215	16	11
Depreciation account—provision against depreciation of leasehold buildings and other expenditure, included in capital account	7,000	0	0
Net revenue account, balance at credit thereof	1 212	5	6
	£159 165	5	1

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Cr.	£	s	d.
Capital account—amount expended for works ..	133,787	19	0
Stores on hand at Dec. 31, 1896—coal, £199. 11s 10d.; oil, waste, etc., £256. 13s. 9d.; general, £25	481	5	7
Sundry debtors for electricity supplied to Dec. 31, 1896	7,193	3	11
Other debtors and prepaid charges	417	11	4
Cash at bankers—Messrs. Glyn, Mills, Currie, and Co.. £667. 13s. 5d.; Parr's Bank, Limited, £194. 1s. 1d.	861	14	6
Cash at office	30	19	4
Preliminary, debenture and preference share issue expenses, and foundation of business account—as per last balance sheet, £3,569. 0s. 3d ; expenses of issue of 4½ per cent. debenture stock, £12 11s. 2d. ; less written off, £600, and premiums on the last share issue, £839—£1,439	2,142	11	5
Construction business development account—as per last balance-sheet, £15,829. 9s. 4d.; expenditure during the year, £4. 2s. ; less premiums on the issue of debenture stock, 1895, £829. 9s. 4d., and written off, £1,504. 2s.—£2,333. 11s. 4d.	13,500	0	0
150 £5 fully-paid ordinary shares of the Yorkshire House-to-House Electricity Company, Limited, at cost	750	0	0
	£159,165	5	1

REVENUE ACCOUNT YEAR ENDED DEC. 31, 1896.

Dr. To Generation of Electricity.				£	s.	d.
Coal or other fuel, including dues, carriage, unloading, storing, and all expenses of placing the same on the works	£2,615	17	7			
Oil, waste, water, and engine room stores	334	18	0			
Proportion of salaries of manager and superintendents	721	6	6			
Wages and gratuities at generating station	1,192	17	6			
Repairs and maintenance as follows: buildings, £36. 9s 5d. ; engines and boilers, £288. 11s. 2d. ; dynamos, exciters, motors, etc., £111. 15s. 1d. ; other machinery, instruments, and tools, £151. 18s. 2d.	588	13	10			
Cartage of ashes	48	11	0			
				5,502	4	5
To Distribution of Electricity.						
Proportion of salaries of manager and engineers	45	0	0			
Wages	98	16	3			
Repairs and maintenance of mains of all classes	51	12	7			
Repairs, maintenance, and renewals of transformers, meters and other apparatus on consumers' premises.	38	1	7			
				233	10	5
To Rents, Rates, and Taxes.						
Rents payable	359	10	7			
Rates and taxes	500	9	4			
				859	19	11
To Management Expenses.						
Directors' remuneration, £1,500 ; less amount waived, £1,000	500	0	0			
Managing director's special remuneration	200	0	0			
Salaries of secretary and clerks	456	6	6			
Collector's salary	110	0	0			
Stationery and printing	76	7	6			
General establishment charges	225	12	7			
Auditors of Company	26	5	0			
Auditors of the Board of Trade	39	16	0			
				1,634	7	7
Law and parliamentary charges				9	5	6
Special charges—insurances				150	0	6
Remuneration to trustees of debenture stockholders				21	0	0
				8,410	8	4
Balance carried to net revenue account				9,031	18	1
				£17,442	6	5

Cr.	£	s.	d.
Sale of electricity per meter (less discounts)	16,226	4	7
Rental of meters and other apparatus on consumers' premises	1,082	11	3
Transfer fees, £14. 5s.; students' instruction, £119. 5s. 7d.	133	10	7
	£17,442	6	5

The annual meeting was held yesterday (Thursday) afternoon at Winchester House, Mr. R. H. Beeton presiding. There was a very small attendance of shareholders.

The **Chairman,** in moving the adoption of the report and accounts, said that during the year there had been a great increase in the business, with an attendant growth in the profits. This was in a measure due to the fact that they had reduced the price of current from 8d. to 6d. per unit. He hoped that next year the directors would be able to recommend the payment of a small dividend to the ordinary shareholders. Had it not been that they had paid £600 in reduction of the preliminary expenses account, and £1,500 in reduction of the construction business account, there would have been the sum of £2,000 available for dividend this year.

The directors and the auditors were re-elected, and a vote of thanks passed to the chairman for presiding.

CHARING CROSS AND STRAND ELECTRICITY SUPPLY CORPORATION.

The annual general meeting of this Company was held on Wednesday at the offices, Maiden-lane, Strand, Mr. G. H. B. Glasier presiding.

The **Chairman,** in his speech, said that the Board congratulated the shareholders on the satisfactory report which was presented to them that day. The directors had to announce with deep regret the loss of one of their managing directors, Mr. Agostino Gatti. Mr. J. M. Gatti had been elected director in his place. The Bill confirming the provisional order enabling the Corporation to supply electricity in the district of the Strand Board of Works had received the Royal assent. Judging by the results already obtained, the directors had reason to congratulate the shareholders on obtaining the increase of their powers. The new central station had been erected and equipped in the most modern and approved manner. An extensive electrical plant capable of supplying energy to 80,000 8-c.p lamps had been erected. During the year they had added five miles to the mains already laid in the St. Martin's parish, and the total already laid in the Strand district was 41 miles. The efficiency of the station had been well maintained ; the plant, machinery, and mains were working in a most satisfactory manner. The demand for current, both in the St. Martin's parish and the area of the Strand District Board of Works, had considerably exceeded expectation, and the number of lamps to which the Company were supplying energy on December 31, 1896, was 73 464, or an increase of 22,164 8-c.p. lamps over those supplied in the year 1895; these totals including 12,641 8-c.p. lamps connected in the Strand district, although the Corporation had only commenced to supply electrical energy there in August last. Owing to the growth of the business, the directors were proposing to take immediate steps for issuing the remaining £50,000 of preference share capital. The net earnings amounted to £15,288. A sum of £7,461 remained, which, added to the undivided profit of £1,397. 6s. from last year's account, made £8,858, and which the directors proposed to deal with as follows: to provide for dividend on 4½ per cent. preference shares apportioned to December 31 (less tax), £797 ; to pay a dividend (less tax) at the rate of £7 per cent. for the half-year ended December 31, on the ordinary shares, making, with the interim dividend paid in August, £6 per cent. per annum for the whole year, £5,075 ; and to carry forward £2,986.

Mr. J. P. Mendoza and Mr. J. M. Gatti were re-elected directors.

CITY OF LONDON ELECTRIC LIGHTING COMPANY, LIMITED.

The ordinary general meeting of the City of London Electric Lighting Company Limited, was held on Wednesday at Winchester House under the presidency of Sir David L. Salomons, Bart., the chairman of the Company.

The **Chairman,** in moving the adoption of the report, said that document showed that the advance of the Company had been exceedingly rapid. He was glad to say that notwithstanding the large number of lamps which had already been applied for, there was still room for a very considerable extension of their business. applications for lamps came in in undiminished numbers, but the Board had naturally taken the view that this could not go on for ever, and in their calculations for the future they had not proposed to create an undue amount of capital which might hamper the business of the Company. It was hoped, and even expected, that the capital expended in the future would not in any way diminish the returns to the ordinary shareholder, or in any way endanger any class of holders in the Company, but that, on the contrary, it would strengthen each class very considerably ; in fact, the directors thought that almost every pound judiciously expended from this date would improve the commercial value of the Company, the benefit of which would be felt by debenture, preference, and ordinary shareholders alike. The number of lamps applied for up to the present moment was 268,500, and the number actually connected 256,650. There was another matter of considerable interest which at one time caused great anxiety. There had been an impression that during a fog there would be a tremendous load put on the machinery at the station, and that this would be of such a nature that it would require some heroic measures in order to get over the difficulty. There was good reason for believing this at the outset, when comparatively few lamps were on the installation, because the company's first customers were those who required, at any time when artificial light was necessary, the whole of their lamps or none, so that when a fog came on practically all the lamps were used or none at all. Now, however, normal conditions had been reached, and an average could be struck, and the directors found that the evening load was greater than, or at any rate equal to, the load during the greatest fog, and that was a matter upon which they might congratulate themselves ; in other words, in the greatest fog there was no more

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strain put upon their station than there was during the ordinary business of the same day. There was, however, one disadvantage, and that was that it was necessary, when fogs threatened, that at the works an increased number of boilers should be kept in readiness for the strain that might come on at any moment. But this must be looked upon as insurance money paid in the way of extra coal to prevent the possibility of a breakdown should the day prove of such a nature that it became necessary that a large proportion of the lamps in the City should be put in use. Some of the alternators at the works had been remodelled with excellent results, and some were in progress of alteration. The output of these remodelled alternators had been greatly increased, and they could be worked now without the least fear of breakdown to the maximum output. They had ordered some more very large machines to meet the increased demand in the coming winter, and for the necessary reserve. Although the Company had made experiments in the lesser streets, at the expense of the Commissioners of Sewers, no order had yet been given them to supply light for those streets. They must all congratulate their manager that he had succeeded in bringing Thames water into the Company's works. A large sum of money had been expended in condensing plants and laying great pipes into the river, but until recently, in consequence of the accumulations of straw and other rubbish in the river, the strainers became completely choked after a very few minutes by suction from the river. A most ingenious device—a revolving drum of a special nature—has been devised by Mr. Bailey. This had overcome the difficulty referred to, and many of their engines were now condensing. The whole system, when complete, would effect a very considerable saving in the coal consumption. It would be satisfactory to the shareholders to learn that Mr. Bailey was in no way trading on the Company by having taken out a patent in this matter, for the Company had the right to use the apparatus free of royalty. He wished again to refer to a point which was very often overlooked—namely, the large amount of capital which remained idle in the shape of conduits in the City streets, since it was determined, if possible, not to reopen those streets a second time. The advantage to be gained by such a proceeding was obvious. The engineer was able to give current to almost any house in the City the moment it was applied for, which otherwise would be impossible, and it was in consequence of that policy having been followed from the very first that the progress of the Company had been so rapid. He would now refer to one or two of the general outgoings. In the matter of insurance, electric lighting stations had been unfairly treated by their all being placed on one basis without any consideration as to the circumstances which ought to apply to each. Some were entirely or practically fireproof, while others were in a very bad condition, and yet there was a uniform tariff of 10s. 6d. per cent. charged. After a great many efforts this Company had got the tariff reduced to an average rate of 7s. per cent. ; this, however, they still considered very high, and negotiations were going on in the hope of getting a further reduction. A short time after the formation of the Company the Board decided to give up Wool Quay, which they were practically compelled to take over in taking the various orders, it being unsuitable as a generating station. He was glad to say they had come to an arrangement with a shipping firm which would relieve them of that tenancy, but the benefit to be derived therefrom would not be felt in the present year. Turning to the accounts, it was satisfactory to observe that the depreciation and reserve funds were represented by investments, and not mere book entries.

Mr. Geo. Herring seconded the resolution. The report, he said, was a good one, and he must congratulate the Board and his fellow-shareholders on the increased dividend.

In reply to **Mr. Smart**, the **Chairman** said the Board did not pay an interim dividend in the past year because there was only sufficient revenue earned in the first half of the year to pay the debenture interest and preference dividend. It was in the latter half-year—the "fat" half—that the bulk of their revenue was earned. As soon, however, as it was possible an interim dividend would be paid.

The report was unanimously adopted and the preference dividend declared. A 7 per cent. dividend on the ordinary shares was declared, and a resolution was subsequently passed increasing the capital of the Company by the sum of £400,000, divided into 40,000 ordinary shares of £10 each.

WESTMINSTER ELECTRIC SUPPLY CORPORATION, LIMITED.

The ordinary general meeting of this Company was held on Wednesday at the offices, Eccleston-place, S.W., Lord Suffield presiding.

The **Chairman**, in the course of his speech, referred mainly to the report, a copy of which has already appeared in our columns. He congratulated the shareholders upon the satisfactory progress made by the Company during 1896. The supply of current, which on December 31, 1895, was provided for the equivalent of 210,982 lamps of 8 c.p , had increased by December 31, 1896, to the equivalent of 249,318, and at the present time there are on circuit the equivalent of 253,383 lamps of 8 c.p., and applications have been received for a further 4,624. Taking 7s. as the amount of annual revenue yielded per lamp, which was below the actual figure, they had been adding about £13,000 a year to the income derived from lighting alone, the average increase during the past four years having been 37,000 lamps. The rate of progress was being fully maintained at the present moment, and although they could not expect it to continue to that extent, there was still plenty of room in their district, for much of it was practically untouched. The net revenue of the year amounted to £33,973. After payment of 7 per cent. the holders of the founders' shares became entitled to a share of the profits. The net revenue, after payment of the 7 per cent., showed a balance of £10,208, of which one quarter, or £2,552, was due to the founders' shareholders, which, added to the sum of £335 brought forward from last year, made a sum of £2,887 due to the founders, or £28. 17s. 4d. per share, less income tax. An interim dividend at the rate of 6 per cent. per annum for the half-year ending June 30, 1896, had been distributed. The balance to the credit of the ordinary shareholders, including the sum of £1,004 brought forward from last year, was sufficient for payment of a dividend of 9 per cent. for the past year. The Board therefore recommended the payment of a dividend at the rate of 12 per cent. per annum, less income tax, for the past half-year, making 9 per cent. for the year ending December 31 last, carrying forward a balance of £1,646.

Mr. E. Boulnois seconded the resolution for the reports and accounts, and it was carried unanimously.

Formal resolutions for the dividend and for the re-election of the retiring directors were carried, and the meeting was then made special to consider, "That in order to redeem the founders' shares the directors be empowered to offer to the holders of the founders' shares 80 ordinary shares of £5 each fully paid (out of the unissued capital of 12,000 shares) for each founders' share of £5."

Mr. Hayes Fisher, at the request of the **Chairman**, explained the arrangements which had been made for redeeming the founders' shares. He stated that these shares were mainly held by Mr. J. Brown Martin and Mr. R. W. Wallace (two of the directors), the other members of the Board having only one founder's share each. The proposal was to give 8,000 fully-paid ordinary shares of £5 each for the 100 founders' shares, a sum equal to £40,000. Of course, if the shares were sold at their market value the amount represented by the 8,000 shares would be much larger. He was one of the largest ordinary shareholders, and believing that the redemption of the founders' shares would be greatly to the advantage of the general body of shareholders. The question was, not what the holders of founders' would get under the arrangement, but whether the ordinary shareholders would make a good bargain. Mr. Fisher then showed that if the dividend were to go back the bargain proposed would be a bad one; if it remained the same it would be a fair one, and if, as he and they all anticipated, the dividend progressed, it would be greatly to the advantage of the ordinary shareholders. Mr. Martin and Mr. Wallace had only been induced to consent to the terms offered because they did not wish there to be the possibility of a divided interest on the Board. He (Mr. Fisher) looked in the future to a progressive increase of dividend, and if motorcarts came into use and they got a day load it would be a certainty. Their system was specially adapted for charging motorcarts.

Mr. Boulnois seconded the resolution, and said that when the directors met to determine what terms should be offered for the redemption neither Mr. Wallace nor Mr. Martin were present.

Mr. Harold Young thought the price agreed upon was too stiff, but on hearing that it could not be reduced said he would not oppose the motion.

The **Rev. Mr. Heber** also expressed himself as satisfied by what Mr. Fisher had said, that the redemption was the best thing to be done and the resolution was carried unanimously.

It will require formal confirmation at a subsequent meeting.

NATIONAL TELEPHONE COMPANY, LIMITED.

The nineteenth ordinary general meeting of the National Telephone Company, Limited, was held on 18th inst. at the Cannon-street Hotel, E.C., Mr. James Staats Forbes (the chairman of the Company) presiding.

The **Chairman**, in moving the adoption of the report and accounts, said that the income for the half-year showed an increase of £17,258 over the corresponding half-year. The expenses were £28,741 more, and the profit balance was £154,982, or a decrease of £12,891 compared with the same period of last year. The explanation was that the Post Office had taken over the trunk lines, and that left the Company with £40,000 less revenue. With regard to the general position of the Company, the great factor was the increase in wires, and he was glad to say that there was a remarkable expansion in that direction—an increase during the half-year of 50 per cent. During 1896 they had had to erect 12,314 new wires, compared with 8,740 in 1895. They heard from time to time of people who were proposing to erect in large commercial centres telephones for imaginary sums. He could say that the 12,314 wires they had to erect cost £39. 12s. 3d. each. The 8,740 erected in the year before cost on an average £38. 13s. each. They had spent during the half-year £233,112, the bulk of which went to the erection of new wires. They were at the same time doing a great deal more for the efficiency of their service. In London and the great centres the Company were rapidly completing the installation of the metallic or twin-wire system, for which subscribers would not have to pay anything extra. The whole object of their expenditure was to fulfil their obligations to the Government and to the commercial centres, especially in the North, to whom they believed they were giving a service which was not to be equalled anywhere else. He hoped the shareholders would feel justified in supporting the directors in the expenditure they were making. The Company got a considerable benefit from the taking over of the trunk lines by the Government, and the directors were very well satisfied with the arrangements that had been made.

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There was, however, no doubt but the loss of £80,000 per annum was a serious thing, although there were compensations. While they lost the gross revenue they received the interest on the purchase-money, they had a considerable saving in maintenance, and they got rid of the Government duty of 10 per cent. on the gross revenue The Government had not only committed itself to the purchase of the trunk lines, but also to extensions on a scale which the Company could never have adopted. They began with a grant of £1,000,000 of which the Company received nearly one-half, and with the balance the Government had been laying down wires and carrying out more costly works than the directors would have thought it prudent for the Company to undertake. A further grant of £300,000 had also since been made. There was no doubt that the necessity for trunk lines was becoming more apparent every day, and as those lines could not be carried on without assistance from the Company's local exchanges, the extensions ought to prove very advantageous to the National Company in the future. They had really no other course open to them but to adopt the proposals which were made to them by the Government. The chairman concluded by moving, "That the report and accounts be received and adopted, and that dividends be paid for the half-year ended December 31, 1896, at the rate of 6 per cent. per annum, less income tax, on the first and second preference shares, at the rate of 5 per cent. per annum, less income tax, on the third preference shares, and at the rate of 6 per cent. per annum, free of income tax, on the ordinary shares."

The Right Hon. Sir James Ferguson seconded the motion.

Mr. Kingsbury wished to know whether, in the event of the Company being wound up, the third preference shareholders would participate in the surplus assets.

The **Chairman** said that was a debatable point. The directors had been asked the question several times by letter, and had taken the best advice, with the result that they were told that the third preference shareholders would participate with the ordinary shareholders in any division of surplus assets. However, that could only be determined by their winding-up, and he did not think it would happen in his time.

The motion was carried unanimously.

The meeting was then made special to consider alterations in the articles of association, and resolutions were passed for inserting in the memorandum of association the words, "including the Channel Islands and the Isle of Man" after the words "in any part of the United Kingdom," and inserting at the end of Clause 1 of the articles of associations the following words: "(*f*) 'United Kingdom' shall include the Channel Islands and the Isle of Man."

NORTH STAFFORDSHIRE TRAMWAYS, LIMITED.

The thirty-second ordinary general meeting of this Company was held on Tuesday at the Guildhall Tavern, Gresham-street, E.C., Mr. W. J. Carruthers-Wain (the chairman of the Company) presiding.

The **Chairman** in the course of his speech on moving the adoption of the report, said: There have been negotiations with regard to electric traction going on for a considerable time past—now nearly two years—and I hope the results of those negotiations will shortly be seen. At the same time I am bound to tell you that only recently—so recently as an hour before I came into this room—we have received a certain proposal involving delicate and complicated negotiations, and therefore we hope you will allow the matter still to remain in the hands of the directors, with confidence that your interests will be protected. You will be glad to learn that a large amount of material for the electrical equipment of the line is ready, and that we hope, if we can bring our new negotiations and the continuation of the old ones to a satisfactory conclusion, that the line may be electrically equipped within a very short time and worked by means which I trust will be productive of considerable benefit to the shareholders. Further than that, I must ask that you will not press me to-day, but I can assure you that as soon as we have anything more definite to state upon the matter we shall call you together to a special meeting—although we shall be sorry to put you to that inconvenience—and ask your approval of any further suggestion that may be made. You will be glad to have noticed the success of electric traction elsewhere, and we hope it may have the same result in connection with this Company.

Mr. Hammersley supported the motion, and it was carried unanimously.

YORK TRAMWAYS COMPANY, LIMITED.

The report of the directors to be submitted to the shareholders at the half-yearly ordinary general meeting to be held at the Station Hotel, York, on March 3 states that the gross receipts for the period amount to £2,126. 3s. 2d., and the working and general expenses to £1,602 1s. 6d., showing a balance of £524 1s. 8d., which it is proposed to appropriate as follows: interest on 5 per cent. debenture stock (less income tax), £145; dividend at the rate of 6 per cent. per annum (free of income tax) on share capital, £266. 5s.; balance carried to reserve fund for renewals and contingencies (bringing the fund up to £439. 13s. 5d.), £112. 16s. 8d.—total, £524. 1s. 8d. The number of passengers carried during the half-year has been 468,265. In view of the progress made in the systems of electric traction, an application has been made to the Board of Trade for an order to permit its use on the tramways, and the terms of the order are now being settled by the Board of Trade and the Corporation. The directors are using their best endeavours in the matter.

CHELSEA ELECTRICITY SUPPLY COMPANY, LIMITED.

Directors: J. Irving Courtenay, chairman; Major-General Webber, C.B. (retired R.E.) deputy chairman; Nugent Daniell; Emile Garcke; G. N. Martin. Managing engineer: Frank King. Secretary: S. J. Cluer.

Report of the directors (with abstract of accounts) to be presented to the shareholders at the annual ordinary general meeting to be held at their central station, Chelsea, S.W., on Wednesday, March 3, at 12 noon:

The increase of the nominal share capital of the Company from £100,500 to £200,500 was authorised by the shareholders on April 30, 1896, and in May an issue of 12,000 ordinary shares of £5 each was made, and was fully subscribed. The final instalment on these shares, due on January 1, 1897, has now been paid, and a Stock Exchange quotation for the new issue is being applied for. The balance of premiums on the above, after deducting the expenses of issue, amounts to £18,184. 16s. 5d., and, following the course adopted in the accounts of the previous year, a portion of this has been applied to the extinction of the legal and other extraordinary expenses incurred during the year in connection with Cadogan-gardens station. The balance remaining, £14,818. 7s. 5d., has been placed to the reserve fund, making the total of that fund £15,865. 14s. This and some further capital not required in 1896 has been invested in Government and Colonial stocks The net revenue for the year, after payment of interest on debenture stock (£2,700), is £9,164. 7s. 4d., and the directors recommend that it shall be applied as under: renewals and depreciation fund, £2,000; interim dividend of 6 per cent. per annum on the preference shares for the half-year to June 30, 1896 (paid July 1, 1896), £900; dividend of 6 per cent. per annum on the preference shares for the half-year to December 31, 1896, £900; 2½ per cent. per annum on the instalments paid up on the new issue of ordinary shares (as stipulated in the prospectus), £337. 10s; 5 per cent. for the year 1896 on the fully-paid ordinary shares (old issue), £3 500; balance to be carried to next account, £1,526. 17s. 4d. The number of lamps connected on December 31, 1896, was 80,460, an addition of 23,106 during the year, or three times the average increase of the last three years. A corresponding increase will be seen in the capital expenditure; and in view of this large increase in demand, and the future development of the business, the leasehold interests on a portion of the Company's freehold have been acquired, and a new generating station, capable of considerable extension, has been erected and equipped. The retiring directors are Mr. J. Irving Courtenay and Major-General C. E. Webber, C.B., who, being eligible, offer themselves for re-election. The auditors, Messrs. Cooper Bros. and Co., also offer themselves for re-election.

REVENUE ACCOUNT YEAR ENDING DEC. 31, 1896.

Dr.				£	s.	d.
To Generation of Electricity.						
Coal or other fuel, including expenses	£3,001	14	3			
Oil, water, cotton waste, and engine-room stores	604	4	8			
Wages of men	1,023	11	6			
Repairs, maintenance, and renewals as under—buildings, £141. 19s. 10d.; engines and boilers, £477. 19s. 10d.; dynamos, £8. 2s. 7d.; instruments, tools, and sundries, £65. 8s. 8d.	693	10	11			
				5,323	1	4
To Distribution of Electricity.						
Wages at out-stations, meter winding, and reading	628	5	6			
Stores used at out-stations	83	17	0			
Repairs, maintenance, and renewals as under—mains, £78. 17s. 1d.; accumulators and apparatus at distributing station, and motor transformers, £128. 17s. 5d; meters on consumers' premises, £20. 9s. 3d.	228	3	9			
				940	6	3
To Rent, Rates, and Taxes.						
Rents payable	774	2	6			
Rates and taxes	975	1	4			
				1,749	3	10
To Management Expenses.						
Director's remuneration	1,000	0	0			
Salaries of staff	1,259	16	3			
Salary or commission of collector	120	0	0			
Stationery and printing	125	16	2			
General establishment charges	134	17	2			
Auditors of Company	35	0	0			
				2,675	9	7
Law and parliamentary expenses				119	16	3
To Special Charges.						
Insurance	179	16	0			
Wayleaves	6	0	0			
				185	16	0
Balance carried to net revenue account				10,361	16	8
				£21,355	9	11
Cr.				£	s.	d.
Sale of current (less allowances made)				19,961	14	11
Rental of meters				823	13	2
Transfer fees				31	7	6
Rents receivable, discounts, and sundry small accounts				538	14	4
				£21,355	9	11

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GENERAL BALANCE-SHEET, DEC. 31, 1896.

Dr.	£	s.	d.
Capital account—amount received	210,712	0	0
Sundry creditors for plant and buildings	12,238	1	5
Sundry creditors on open accounts	3,483	13	2
Debenture stockholders for interest accrued	1,305	0	0
Reserve fund, being balance of premiums	15,865	14	0
Net revenue account—balance at credit thereof, £7,164. 7s. 4d.; less interim dividend paid on preference shares, £900	6,264	7	4
	£249,868	15	11

Cr.	£	s.	d.
Capital account — amount expended, £214,611. 18s. 3d.; less renewals and depreciation fund account, £4,840	209,771	18	3
Stores on hand—coal, £124. 11s. 8d.; general stores, £1,406. 7s. 1d.	1,530	18	9
Sundry debtors for current supplied, etc., less bad debts deducted	9,553	7	0
Investments in Government and Colonial stocks at cost	23 322	1	6
Cash at bankers, £5,643. 1s. 4d.; cash in hand, £47. 9s. 1d.	5,690	10	5
	£249 868	15	11

ISLE OF MAN TRAMWAYS AND ELECTRIC POWER COMPANY.

The report of the directors of the Isle of Man Tramways and Electric Power Company, Limited, for the past year shows an available profit of £15,847. Interim dividends on the preference and ordinary shares of 6 and 7½ per cent. had been paid, and further distributions of 6 per cent. on the preference and of 8½ per cent. on the ordinary were now declared, adding £2 000 to reserve and carrying forward £2,047. The traffic over the several systems showed satisfactory results. The cable tramway had exceeded the most sanguine expectations, and the Snaefell Mountain Railway had proved most beneficial. There was an enormous traffic on the Douglas and Laxey sections.

SCARBOROUGH ELECTRIC SUPPLY COMPANY, LIMITED.

Directors: G. Alderson-Smith, Esq, chairman; John Dale, E-q.; John Woodall Woodall, Esq.; George Lord Beeforth, Esq.; John Bell Simpson, Esq., M.I.C.E.; the Hon. Charles A. Parsons, M.I.C.E.; Gilbert Wilkinson, Esq.; John Edward Ellis, Esq., M.P.; A. A. Campbell Swinton, Esq, A.M.I.C E., M.I.E.E., managing director. Mr. John Hall, secretary. Mr. G. S. Peck, A.I E.E., resident engineer.

Report of the directors, with abstract of accounts, for year ending December 31, 1896:

During the past year 63 new customers, and the equivalent of 4,939 8-c.p. additional lamps, have been connected to the Company's mains, making a total of 298 customers and 17,727 8-c.p. lamps connected at the present time. To meet these requirements 1,175 yards of additional mains have been laid, while the capacity in cables and transformers has also been correspondingly increased. During the past year electric energy to the amount of 179,360 Board of Trade units has been supplied to customers at a revenue, including meter rent, of £4,383. 5s. 11d., as against 141,101 units and £3,466. 10s. 5d. revenue for 1895. The Company has made a profit on the year's working of £1,617. 8s. 8d., as against £937. 9s. 8½d. in 1895. Adding the balance of £304. 8s. 2d. carried from the previous year, there is, after paying income tax, 1895-6, £13. 18s. 8d., and bank interest £31. 18s., and writing off the sum of £275. 6s. 8d. from the preliminary expenses account, a sum of £1,600. 13s. 6d. available for distribution. The directors recommend that this should be applied in paying a dividend of 4½ per cent, which will absorb £1,456. 17s. 6d., leaving a balance of £143. 16s. to be carried forward. It will be observed that no direct appropriation has yet been made on account of depreciation, but that £275. 6s. 8d. of the preliminary expenses account is proposed to be written off. The directors consider that this covers a sufficient depreciation to date, seeing that all the machinery and plant is new and is maintained in good working order. Mr. Geo. Alderson-Smith, Mr. Geo. L. Beeforth, and the Hon. C. A. Parsons, retire by rotation, but are eligible and offer themselves for re-election as directors. The auditor, Mr. C. E. Bradley, C.A, also offers himself for re election.

BALANCE-SHEET, DEC. 31, 1896.

Dr. Liabilities.	£	s.	d.
Capital—nominal, 5,000 at £10 each	50,000	0	0
Subscribed— 3,434, £9 called up	30,906	0	0
Since issued— 566, £4 called up ... £2,264 0 0			
Calls in advance 26 0 0			
4,000	2,290	0	0
	33,196	0	0
Bankers	596	0	2
Sundry creditors	348	9	3
Unclaimed dividends	6	10	6
	34,146	19	11
Revenue account—balance at credit, as below	1,600	13	6
	£35,747	13	5

Cr. Assets.	£	s.	d.
Capital expenditure—Amount expended for land, buildings, machinery, mains, transformers, meters, electrical instruments, tools, telephone, arc lamp, etc., to date of last statement	30,627	15	1½
Additional expenditure during year	2,431	18	5
	33,059	13	6½
Provisional order	525	0	0
Formation and preliminary management expenses (less amount received for current, rent of meters, bank interest, etc., up to December 31, 1894)— balance as per last statement £350 0 0			
Expended since last statement 25 6 8			
375 6 8			
Less amount written off to revenue this year 275 6 8			
	100	0	0
Office furniture and fittings, stock of stationery, books, etc.	190	0	0
Stock of stores and repairing materials (per resident engineer)	78	5	2
Stock of lamps (per resident engineer)	39	14	8½
Sundry debtors (less provision for discount) £1,791 19 4½			
Less provision for bad debts ... 36 19 4½			
	1,755	0	0
	£35,747	13	5

Dr. REVENUE ACCOUNT, YEAR ENDING DEC. 31, 1896.	£	s.	d.
Expenses of generation and distribution of electricity and expenses of management as follows:			
Wages, salaries, rent, rates, etc.	1,077	2	5½
Stores, fuel, lighting, etc.	1,092	4	9½
Maintenance, repairs, and renewals	349	4	1
Stationery, office, and general expenses	109	9	7½
Directors' expenses and 1895 remuneration	118	10	0
	2,746	10	11½
Provision for bad debts	20	3	9½
	2,766	14	9
Balance for year carried down	1,617	8	8
	£4,384	3	5

Cr.	£	s.	d.
Electric energy, etc., supplied, less discounts	4,255	0	2
Meter rents	128	5	9
Sundries	0	17	6
	£4,384	3	5

Dr.	£	s.	d.
Income tax, 1895-6, Sch. D	13	18	8
Bank interest	31	18	0
Amount of formation and preliminary management expenses written off this year	275	6	8
	321	3	4
Balance at credit at date	1,600	13	6
Proposed to be divided as follows:			
Dividend of 4½ per cent. per annum £1,456 17 6			
Amount forward to next year 143 16 0			
1,600 13 6			
	£1,921	16	10

Cr.	£	s.	d.
Balance from last year's revenue account brought forward	1,051	5	11
Deduct dividend of 2½ per cent., less tax, declared at general meeting, March 16, 1896	746	17	9
	304	8	2
Balance from 1896 revenue account as above	1,617	8	8
	£1,921	16	10

NOTTING HILL ELECTRIC LIGHTING COMPANY, LIMITED.

Directors: William Crookes, Esq., F.R.S., chairman; Arthur Ellis Franklin, Esq.; Alexander Howden, Esq; James Thomas Jervis, Esq; Francis Radford, Esq. Engineer and manager: Geo. Schultz. Secretary: R. G. Rawkins.

Report of the directors and abstract of the accounts to be submitted to the shareholders at the tenth ordinary general meeting to be held at the offices of the Company, Bulmer-place, Notting Hill, on Tuesday, March 2, at 5.30 p.m.:

The expenditure on capital account at the date of the last balance-sheet stood at £83,998. 14s. 1d. During the past year a further sum of £15,106. 3s. 5d. has been expended, mainly accounted for by £11,415. 15s. 8d. for mains, and £2,029. 0s. 11d. for machinery. The total capital expenditure is therefore £99,104 17s. 6d. The balance of the preference shares, £11,380, was issued during the year at a premium of £2 per share. The amount of the premiums (£2,276) has been written off in reduction of the preliminary expenses, compensation and charges during construction, making a total amount written off these items of £2,829. 12s. 7d. The provisional order to enable the Company to

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supply current to the northern part of Kensington, obtained in 1895, but not confirmed owing to the dissolution of Parliament, received the Royal assent on March 31, 1896. This was sufficiently early in the year to enable considerable progress to be made with the necessary works, over £6,000 of the capital expenditure for the year having been incurred on this account. Further expenditure of about £2,000 has already been contracted for, and it is intended to expend an additional sum of £10,000 in the course of 1897. As the whole of the share capital is now issued the directors propose to make use of their borrowing powers. The following table shows the progress of the Company:

1891	Lamps	6,050	Loss	£554	18 6
1892	,,	9,438	Profit	112	6 1
1893	,,	12,153	,,	1,481	7 1
1894	,,	15,669	,,	2,101	17 8
1895	,,	20,307	,,	3,227	14 10
1896	,,	25,716	,,	4,736	9 8

The directors recommend the following allocation of the available profit: (1) to depreciation, renewals, and reserve fund, £1,000; (2) a dividend of 6 per cent. less income tax on the ordinary preference shares for the year ending December 31, 1896 (already paid), £1,172. 10s. 3d.; (3) a dividend of 4 per cent. less income tax on the ordinary shares, £2,580. 16s. The directors have decided to put aside each year out of the profits 1 per cent. on their capital expenditure to form a fund for depreciation, renewals, and reserve. The amount already standing to the credit of this fund is £2,340. In view of the fact that in the earlier years of the Company no such provision could be made, the premiums obtained from the sale of the debentures will be added to this fund. The directors have decided to reduce their charge to 6d. per unit to customers willing to take current at a pressure of 200 volts. Mr. George Schultz, engineer and manager, reports that the machinery, plant, and mains are in good condition, and that no accident of any kind has occurred during the year. It is with deep sorrow that the directors have to announce the death of their colleague, Mr. Sidney Waters, which took place on December 14 last, at the early age of 45. It was to Mr. Waters, who combined business training with a practical knowledge of electricity, that the Company mainly owed its origin, and from the very first until a few days before his death he was untiring in his devotion to its interests. The directors do not consider it necessary for the present to fill up the vacancy thus created. The directors who retire are Messrs. Alexander Howden and James Thomas Jervis, who, being eligible, offer themselves for re-election. The shareholders' auditors, Messrs. Fox, Sissons, and Co., retire, and, being eligible, offer themselves for re-election.

Dr. Revenue Account Year ending Dec. 31, 1896.	£ s. d.	£ s. d.
Generation of Electricity.		
Coal and other fuel, including dues, carriage, etc.	£683 6 8	
Oil, waste, water, and engine-room stores	174 0 9	
Wages and gratuities at generating station	413 12 8	
Repairs and maintenance as follows:		
Buildings	52 10 1	
Engines, boilers	143 12 8	
Dynamos	39 12 9	
Other machinery, instruments, and tools	62 15 4	
Accumulators	110 0 0	
		1,679 10 11
Distribution of electricity.—Repairs, maintenance, and renewals of mains of all classes, including materials and laying the same		39 5 3
Rents, rates, and taxes		263 10 0
Management Expenses.		
Directors' remuneration	550 0 0	
Salaries of engineer and manager, secretary, clerks, and messengers	799 2 6	
Stationery and printing	41 5 2	
General establishment charges	89 10 3	
Auditors of Company	31 10 0	
Auditor appointed by the Board of Trade under the provisions of the order	25 0 0	
		1,536 7 11
Special Charges.		
Insurances	82 4 9	
Rent of wayleave	5 0 0	
		87 4 9
Connecting installations, and sundry stores		210 4 9
		3,816 3 7
Balance carried to net revenue account		4,736 9 8
		£8,552 13 3

Cr.	£ s. d.	£ s. d.
Sale of current per meter at 8d. per B.T. unit (230,787 units), less discounts, and after providing for bad debts		7,365 18 10
Rental of meters and other apparatus on consumers' premises		397 10 0
Connecting installations, sale of stores, etc.		513 3 9
Rents receivable		265 14 8
Transfer fees, etc.		10 6 0
		£8,552 13 3

Dr. General Balance-Sheet, Dec. 31, 1896.	£ s. d.
Capital account—amount received	96,840 0 0
Sundry tradesmen and others, due on contracts for fuel, stores, etc.	3,291 12 2
Sundry creditors	1,245 9 9
Depreciation, renewal, and reserve fund account	2,340 0 0
Net revenue account—balance at credit thereof, £3,757. 1s. 2d.; less interim dividend paid on ordinary preference shares, £544. 16s. 5d.	3,212 4 9
	£106,929 6 8

Cr.	£ s. d.
Capital account—amount expended for works, including cost of provisional order	99,104 17 6
Sundry debtors for current supplied, etc.	3,224 8 10
Other debtors	81 0 0
Stores on hand—lamps, £39. 18s. 8d.; coal, £78. 3s. 9d.; general, £307. 13s. 5d.	425 15 10
Stock (movable plant and tools)	247 13 8
Cash at bankers, £1,449. 18s. 1d.; cash in hand, £20	1,469 18 1
Preliminary expenses, compensation, etc., £4 651. 12s. 9d.; less premiums received on issue of 1,138 ordinary preference shares (£2 per share), £2,276	2,375 12 9
	£106,929 6 8

TELEGRAPH CONSTRUCTION AND MAINTENANCE COMPANY, LIMITED.

The report of the directors of this Company, with accounts to December 31, states that the accounts for the year show a net profit of £88,300 after charging interest on the debentures. To this sum must be added £18,870 brought forward from last year, making a total of £107,170. From this amount is deducted the interim dividend of 5 per cent., paid July 21, 1896, amounting to £22,410, leaving £84,760 to be dealt with. Of this sum the directors propose to distribute a dividend of £1s. 4s. per share, absorbing £44,820, being at the rate of 10 per cent., and making, with the amount already paid, a total dividend for the year of £1. 16s. per share, or 15 per cent., free of income tax, leaving £39,940 to be carried forward. The business of the Company has been satisfactory, and shows some improvement over last year. Both the Company's factories have been fairly active, and the steamships have been employed in laying or repairing submarine cables under contracts and also on charter. The factories and machinery, which are constantly undergoing improvement, are at the present time in a higher state of efficiency than they have ever been before. The steamships have been thoroughly overhauled, and are now in good and thorough repair.

HOVE ELECTRIC LIGHTING COMPANY, LIMITED.

Directors: Colonel A. J. Filgate, R.E. (chairman), Colonel H. Wood, C.B. (vice-chairman), Harold A. Hoare, Esq., Carleton F. Tufnell, Esq. Engineers: Messrs. Crompton and Co., Limited, London and Chelmsford. Secretary: Francis R. Reeves, Esq.

Fifth report of the directors to be presented at the annual general meeting of the shareholders at the City Terminus Hotel, Cannon-street, E.C., on Wednesday, March 3, 1897, at 12 noon:

The revenue from the sale of current has increased to £6,161. 17s. 2d., while the costs of generation of electricity, distribution, and management expenses amount to £3,404. 8s. 8d., and after crediting the profit and loss account with meter rents and transfer fees there remains a balance of net profit for the year of £3,114. 5s. 6d. After adding to the above profit the balance brought forward from last year of £152. 14s. 6d., and deducting £980. 14s. 11d. for interest on loans and debentures and income tax, and £625. 9s. 9d. for interim dividend paid in October last year, there remains a net balance to the credit of the revenue account of £1,660. 15s. 4d. The directors propose to write off the sum of £150 from the preliminary expenses account, to place £300 to the reserve fund, to declare a dividend, payable on April 15 next, at the rate of 6 per cent. per annum for the half-year on the share capital (making, with the interim dividend, 5 per cent. for the year), and to carry the balance, £183. 7s. 10d., forward. The number of lamps attached to the Company's mains has now increased to the equivalent of 21,794 8-c.p. lamps, and the number of consumers to 313. The amount realised from premiums on shares and on debentures issued during the year has, after deducting broker's commission on the same, been placed to the reserve fund, which will now show a credit balance of £1,563. 17s. The sum of £260. 6s. 11d., the balance of the amount set aside for repairs and maintenance in accordance with the contract with the Hove Commissioners, after deducting amounts actually expended, has been placed to the depreciation and maintenance reserve account, bringing the total of this account up to £523. 16s. 1d. The directors have pleasure in stating that the whole of the share capital has now been placed, the last shares having been issued at a premium of 10s. per share. Since the date of the last report the directors have paid off the whole of the £12,500 of 5 per cent. debentures, and have also paid off at par £200 of the 4½ per cent. debentures; in lieu thereof they have issued £14,600 of 4 per cent. debenture stock. As announced in last year's report, the directors have established the method of charging for current on what is known as the "demand meter" system, being satisfied that this arrangement is a fair one,

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both for the consumers and the Company. They have now, from January 1 this year, made a further reduction by requiring only one hour's consumption per lamp at 8d. per unit, all current afterwards being charged at 4d. per unit. It is already apparent that the new rate of charging is giving satisfaction, as the returns for the current year to date show a considerable increase upon those of last year. In addition to the machinery added to the plant last year the directors have made several extensions of the mains, which they have no doubt will add considerably to the number of consumers, as also to the Company's revenue. In accordance with the articles of association, Colonel A. J. Filgate retires from the Board by rotation, but offers himself for re election. Mr. Robert Payne, F.C.A, the auditor of the Company, also offers himself for re-election.

REVENUE ACCOUNT YEAR ENDING DEC. 31, 1896.

Dr. Generation of Electricity.	£	s.	d.
Coal or other fuel, including dues, carriage, unloading, storing, and all expenses of placing the same on the works £654 17 8			
Oil, waste, water, and engine-room stores 131 1 3			
Proportion of salaries of engineers, superintendents, and officers 204 12 0			
Wages and gratuities at generating station 526 14 2			
	1,517	5	1
Repairs and Maintenance.			
Amount expended 339 13 1			
Balance set aside in accordance with the contract with Hove Commissioners ... 260 6 11			
	600	0	0
Rents, Rates, and Taxes.			
Rents payable 145 13 4			
Rates and taxes 76 17 0			
	222	10	4
Management Expenses.			
Directors' remuneration 450 0 0			
Salaries 321 11 8			
Stationery and printing 47 12 4			
General establishment charges 143 1 5			
Auditor of Company 10 10 0			
	972	15	5
Special charges—insurances.....	91	17	10
Total expenditure	£3,404	8	8
Balance carried to net revenue	3,114	5	6
	£6,518	14	2

Cr.	£	s.	d.
Sale of current per meter (200,562 units)—Private consumers, after allowing rebates and providing for bad debts	5,973	3	2
Public lighting	188	14	0
	6,161	17	2
Rental of meters and other apparatus on consumers' premises.....	353	4	6
Transfer fees.....	3	12	6
	£6,518	14	2

GENERAL BALANCE-SHEET, DEC. 31, 1896.

Dr. Liabilities.	£	s.	d.
Capital account—amount received.....	38,032	0	0
4½ per cent. debentures.....	7,300	0	0
4 per cent. debenture stock	14,600	0	0
Loans from bankers	1,500	0	0
Sundry creditors, due on construction of plant and machinery, fuel, stores, etc., to Dec. 31, 1896.....	961	13	5
Consumers' deposits	112	0	0
Creditors for interest.....	160	18	3
Unclaimed dividends.....	53	15	6
Reserve fund	1,263	17	0
Depreciation and maintenance account reserve fund	523	16	1
Net revenue account, balance at credit.....	1,660	15	4
	£66,268	15	7

Cr. Assets.	£	s.	d.
Capital account—amount expended for works	62,022	10	8
Stores on hand Dec. 31, 1896—coal, £58. 10s.; oils, waste, and general stores, £43. 18s. 3d..	102	8	3
Sundry debtors for current supplied, etc, to Dec. 31, 1896.....	2,822	13	4
Cash at bankers, £1,184. 16s. 3d.; in hand, £36. 7s. 1d.....	1,221	3	4
	£66,268	15	7

The London Tramways.—The London Tramways Company are not satisfied with the recent award given, and have served notice on the London County Council that the High Court will be moved to set aside the award of the referee as to the value of the undertaking to be purchased by the Council; or, as an alternative, to remit the award to him for further consideration. The Highways Committee replied that they had given directions for counsel to be retained, and had received an intimation that, in view of the proposed proceedings, the company would not be prepared to treat for leasing.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

The Hague.—The Dutch Waterstaat Ministry will receive on March 5 tenders for posts and stays for the State telegraphs.

Lyons.—Tenders are wanted by March 10 for installing the electric light at the lunatic asylum at Bron. Application should be made at the Prefecture of the Rhône, Lyon.

Tunbridge Wells.—The Corporation invite tenders for the supply and erection of a 350-kw. steam alternator, with engine combined. Tenders to be delivered not later than March 13, 1897. For full particulars see advertisement in another column.

Braila (Roumania).—The Local Authorities are prepared to receive up to March 15 offers for a concession for the construction and working of a system of electric tramways. The aggregate length of line would be about 13 miles, and applications and enquiries should be addressed to the Mairie, at Braila.

Plymouth.—The Plymouth Corporation are prepared to receive tenders for the various engineering works in connection with the electricity works of the borough. Sealed tenders, endorsed "Engineering Contract, No. —," must be delivered to Mr. J. H. Ellis, town clerk, Plymouth, not later than March 26, 1897. Full particulars appear in our advertisement columns.

Glasgow.—Tenders are invited for supplying and fixing in the Olympia, New City-road, during the month of April, a 25-h.p gas-engine, together with 20 arc lamps, each of 2,000 c.p., and a quantity of small incandescent lights, together with all the necessary wire cable, switches, etc. Address tenders to E. H. Bostock, care of Lithgow and Son, printers, 76, West Howard-street, Glasgow.

Edinburgh.—The Municipal and Police Department require tenders for electric lighting materials for Powderhall destructor. Patterns and samples may be seen by applying to the Inspector of Lighting and Cleansing, the Burgh Engineer, the City Road Surveyor, and the Chief Constable; and forms of tender will be supplied by these officials. Tenders are to be sent to the Town Clerk by March 6.

Dresden.—The Saxon State Railway Authorities will receive on March 10 tenders for miscellaneous telegraphic stores, including 3 tons of bronze wire, 59 tons of galvanised iron wire (4mm.), 10 tons of copper wire (6mm.), 2½ tons copper gauze, 1 ton insulated copper wire (strong), 15,000 porcelain insulators, and 10,000 zincs for Meidinger cells. Application to die Königl. Betriebs-Telegraphen Oberinspektion, der Sachsischen Staatseisenbahnen, Dresden.

Torquay.—The Electric Lighting Committee of the Town Council are prepared to consider proposals containing terms and conditions upon which companies and others will undertake the free wiring of houses and premises in the borough. Information as to the streets to be lighted in the first instance and other particulars may be obtained of Mr. W. H. Trentham, consulting electrical engineer, 39, Victoria-street, S.W., or of Mr. Fredk. S. Hex, town clerk, Torquay, and tenders, endorsed "Free Wiring," should be sent to the Town Clerk by March 13.

Morecambe.—The Electric Lighting Committee of the Urban District Council are prepared to receive tenders for the supply and erection of the following plant (the whole bound up in one specification, price £2. 2s., returnable on receipt of a bona fide tender): Section A—Boilers and accessories; Section B—Steam and exhaust pipes, etc.; Section C—Steam dynamos and accessories; Section D—Switchboards, etc.; Section E—The mains; Section F—Arc lamps and posts, etc.; Section G—Transformers; Section H—Secondary batteries; Section I—Apparatus and tools; Section J—Testing instruments and apparatus. Tenderers are at liberty to tender for either section, but not for part of a section. Ground plans of plant and specifications, with terms and conditions of tender and contract, may be obtained at the offices of the Council, Morecambe-street, Morecambe. Tenders, sealed and marked "Tender for Electric Lighting," must be addressed to Mr. Wm. Tilly, clerk to the Council, District Council Offices, Morecambe street, Morecambe, and be delivered by March 11.

Ashton-under-Lyne.—The Corporation are prepared to receive tenders for the supply and erection complete of the following apparatus and plant: Refuse destructors; multitubular and Lancashire boilers; economiser, tanks, pumps, steam-pipes, etc.; continuous current steam dynamos, motor-generator, balancing transformer, switchboard, cables, street-boxes, etc.; arc lamps and columns, accumulators, overhead crane, station wiring, meters. Tenders may be sent in for any section or for the whole of the sections, but not for part of a section only. Plans of the district can be seen and copy of the general conditions, specification, and form of tender can be obtained on deposit of £5. 5s., which will be returned on receipt of a bona fide tender, at the Borough Comptroller's Office, Town Hall, Ashton-under-Lyne, or at the offices of the consulting engineers, Messrs. Fawcus and Clirehugh, Temple chambers, Brazennose-street, Manchester. Sealed tenders, which must be on the prescribed form, endorsed "Tender for Electric Lighting," to be delivered to Mr. John Neal, borough comptroller, Town Hall, Ashton-under-Lyne, not later than 12 o'clock noon on March 15.

RESULTS OF TENDERS.

Blackpool.—The Town Council have accepted the tender o the International Electric Company for arc lamps for lighting the electricity works.

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Brighton.—The Town Council have resolved to accept a tender by Messrs. Willans and Robinson, Limited, to supply and erect at the electricity generating station two 750 h.p. engines, coupled to dynamos of the Electric Construction Corporation's make, for the sum of £9,576.

Dover.—The Town Council have received the following estimates for the equipment of the tramways:

R. W. Blackwell	£13,000	1	5
Brush Electrical Engineering Company	13,679	5	0
Siemens Bros.	12 432	8	0
Dick, Kerr, and Co. (accepted)	8,040	0	0
Westinghouse Electric Company	11,718	5	0

BUSINESS NOTES.

Lancaster.—The Town Council have decided to do away with meter rents to consumers of town's electricity.

Santiago.—The Chilian Congress has authorised the construction of an electric railway from Santiago to San Bernardo.

Dover.—The Town Council have passed the electric lighting estimates for 1897, amounting to £1,186. Last year the amount was £1,374.

Atteroliffe.—A quantity of electrical machinery was damaged in the fire which occurred last week at Hadfield's steam foundry in Newhale road.

Personal.—The salary of Mr. J. E. Edgcome, the borough electrical engineer of Kingston-on-Thames, has been raised from £200 to £300 a year.

Bristol.—The Sanitary Committee have decided to extend the electric lighting in the public streets. It is estimated that 200 lamps will be required

Chester.—The question of improving the lighting of Frodsham-street and Brook-street has been adjourned until the Electric Light Committee can take the matter in hand.

Coventry Electric Tramways Bill.—In the House of Commons on Monday, on the motion of Dr. Farquharson, the Coventry Electric Tramways Bill was read a second time.

Bradford.—The Gas and Electricity Supply Committee have agreed to recommend the Council to carry out an extension of the electric light mains, the cost being estimated at about £3,000.

Kingston-on-Thames.—Application has been sent in to the Local Government Board for a further loan of £20,000 for electric lighting, and the necessary plans have been ordered to be prepared.

Sheffield.—An anonymous writer in the *Sheffield Daily Telegra h* urges that the city should take over the electric light and power company and appoint an up-to-date and civil electric engineer to take charge of the department.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended February 21 amounted to £1,320, as compared with £1,059 in the corresponding week of the previous year, being an increase of £261.

Bristol Tramways and Carriage Company, Limited.—The traffic returns for the week ended February 19 were £2,088. 7s. 11d., compared with £1,748. 8s. 8d. for the corresponding period of last year, being an increase of £339. 19s. 3d.

City and South London Railway.—The returns for the week ended February 21 were £1,044, compared with £968 for the corresponding period of last year, being an increase of £76 The total receipts for the half-year 1897 were £8,717, compared with £7,914 last year, being an increase of £803.

Chelsea Electricity Supply Company, Limited.—The report for 1896 shows a net profit of £9,164. A dividend is recommended of 5 per cent. on the ordinary shares, £2,000 is placed to renewals fund, and £1,527 carried forward. A sum of £14,818, balance of premiums on shares, is carried to reserve, making the total reserve £15,866.

London Lighting Extensions.—The London County Council Committee have sanctioned extensions of mains proposed by the following undertakers: the Vestry of St. Pancras, the County of London and Brush Provincial Electric Lighting Company, the London Electric Supply Corporation, and the Notting Hill Electric Lighting Company.

Llandudno.—At the adjourned meeting of the District Council Mr. T. T. Marks gave notice to move at the next monthly meeting that Mr. A. H. Preece, who has already been engaged to carry out a scheme of electric lighting combined with a refuse destructor, be directed to include in the scheme an electric tramway system, so that the profits, if any, will be devoted to the rates.

Blackburn.—The users of the electric light have expressed some difficulty in understanding the rebate system of charging for the supply, and Mr. Giles, the borough electrical engineer, has sent to the local Press a full and careful definition of the system, and also giving the formulæ for calculating units to be consumed in a half-year before commencing to earn the cheaper units.

Torquay.—A limited company has been formed for the purpose of constructing an electric railway or tramway between Torquay and Paignton. The title of the company is the Western Counties Electric Railways and Tramways Company, Limited, and its object is to construct tramlines in various parts of the three Western Counties. It is proposed to adopt the overhead system.

South Indian Railway.—We believe it is in contemplation to supersede Pintsch's gas by electric light on this line. The former was sanctioned by Government, and is not altogether adopted yet. As far as tried it is not an unqualified success, and this has induced the South Indian Railway authorities to fit up one of their carriages with electric light apparatus for trial purposes.

Glasgow.—The Electric Lighting Committee are negotiating for the erection of new and much larger works at two or three different points, which will enable them at an early date to supply electric current to all quarters of the city. In order to increase the supply, pending the erection of these new works, storage batteries are to be put down at two points in the present electric lighting area.

Newcastle.—An enquiry has been held by the Earl of Jersey, Colonel Boughey, and Mr. Gerald Fitzgerald, members of the Light Railways Commission (Lord Jersey presiding), into the matter of an application by the British Electric Traction Company for an order under the Light Railways Act for the construction of tramway extensions affecting Longton, Newcastle, Burslem, Tunstall, Stoke, Silverdale, Chesterton, and Wolstanton.

Swansea.—Councillor Lindley has resigned his membership of the County Borough Council, assigning as his reason that the recent poll has not been satisfactory to his mind, and that he personally does not feel in its result the necessary authority for him to further assist in promoting the measure. Mr. Lindley was one of the principal advocates of the scheme, while the company with which he is connected signed a manifesto against it.

Edinburgh.—The Electric Lighting Committee of the Town Council have agreed to recommend that the charge for the light, as from May 15, should be 4d. per unit, a reduction of 1d.; that the charge for each public lamp should be £16 per annum, instead of £18; and that the charge for motor power should be 2½d. It was further resolved to recommend the establishment of a reserve fund for the undertaking, in terms of the electric lighting order.

A Chapter of Accidents.—In June last a man named Bidwell was walking along the road from Kingswood to Bristol, and presently he stopped and looked in a shop window. Just afterwards he was hurled violently through the same window. One of the tramcars had collided with a brewer's dray and threw the horse and shafts against the man and through the window. The man claimed damages against the tramway company, and the jury at the assizes last week awarded him £250.

Bromley.—The General Purposes Committee reported at the Urban District Council meeting that they had considered the letter received from Messrs. Todd, Dennes, and Lamb, submitting draft deed of the transfer of the Bromley Electric Lighting Order to a proposed local company, and recommended that such draft deed be referred to Mr. Willett with instructions to settle with counsel the general condition of transfer, and more particularly the terms on which the undertaking may be repurchased by the Council.

Huddersfield.—The revenue statement for 1896 shows a balance of income over expenditure of £434 9s. 1d. The engineer's report shows that in the consumption of electricity the units metered during January were 57,762, being an increase of 12,406 over the corresponding month of 1896, which is equal to 27 per cent. Extensions of mains are to be made in Manchester-street, John-street, Upperhead-row, Northgate, Buxton-road, and Ramsden-street, and a sub-station is to be constructed at the bottom of New North-road.

Paddington.—The Vestry have decided to inform the Metropolitan Electric Supply Company and the Board of Trade that no opposition would be offered to the placing of connecting boxes in the public footways of the parish, provided the company in question signed an agreement holding the Vestry harmless in respect of accidents which might be occasioned thereby, and that they would also defray the cost of any alterations that might be required by the Vestry to be made from time to time in such boxes, wires, or pipes connected therewith.

Larne.—Owing to the growing demand the electric lighting company have now completed important alterations at their works. The capacity of the plant now comprises two Mordey-Victoria alternators of 40,000 volts capacity each, giving current of an electrical pressure of 2,200 volts, and of a periodicity of 200 alternations per second. These machines have been manufactured by the British Electrical Engineering Company, Limited. Two engines have also been supplied by Messrs. Combe, Barbour, and Combe, of Belfast, developing 100 i.h.p. each.

The Carlisle Tramways.—At a meeting of the General Purposes Committee arrangements were made for the insertion of clauses in the tramways provisional order for the protection of the interests of the city. It was agreed that the Rickergate and Norfolk-road tramways be withdrawn; that interlacing tramways be put down in St. Nicholas and at the railway bridge in Port-road, for the convenience of the traffic and to meet objections which had been made on behalf of the Corporation. The Corporation agreed to give the tramways company 21 years before claiming a right to purchase the undertaking.

New Swindon.—The Electric Lighting Committee reported at the Urban District Council meeting that they had visited several towns where there was an electric light installation—viz., Bristol, Newport, London, Leicester, Derby, Stafford, Walsall, and Oxford—and gave it as their careful opinion that an electric light works could be erected at Swindon, and worked at a profit, for a capital of about £20,000, but suggested that in obtaining borrowing powers for a loan, a sum of not less than £25,000 be applied for. The question was discussed at great length, and even then had to be adjourned till the next meeting.

Commercial.—Messrs. G. Braulik, of Upper Thames-street and Old Swan-lane, E.C., write to inform us that they have passed

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through a most satisfactory year of business in 1896; the general turnover showing an increase of about 50 per cent. on the previous year. The sales of the Körting and Mathiesen arc lamps, too, have greatly increased, and over 30,000 are now in use. The sales of their "London" incandescent lamps (a speciality) have been more than doubled during the year; and the sale of electrical goods generally has so increased, and is still increasing, so much that additional premises have had to be taken at Old Swan-lane.

Moss Side.—At the meeting of the Urban District Council the minutes of the Highway Committee showed that a letter had been received from Mr. Nickson, superintendent of the electric light department of the Manchester Corporation, which stated that it was hoped that the Manchester Corporation would be in a position to lay the necessary mains in readiness for next winter. The Highway Committee were, however, unable to name a definite date for the requirement of the mains as the provisional order for the electric lighting of Moss Side was not made or confirmed and the powers would have to be transferred, and then certain notices would have to be made.

London Street Tramway (Canada).—Applications are invited for an issue of 350,000dol. of 5 per cent. gold debenture bonds for the Street Tramways Company of London, in the province of Ontario, Canada. The city is now seeking to establish a complete system of electric tramways, which is now being substituted for the old system of horse traction. In order to complete the work, capital is to be raised as a first mortgage on the undertaking and all its real and personal property. The tramway has been in operation for 15 years, and the last report of the directors of the company showed the net earnings for the year were 40,000dol., which affords a margin for interest on the proposed issue with a substantial dividend on the ordinary.

Douglas.—At the meeting of the Town Council there was considerable discussion with regard to the lighting of the town. The Sanitary Committee had passed a resolution that the Isle of Man Tramways and Electric Power Company be asked to tender for the provision of 50 electric lamps, and that the Douglas Gas Company be asked to tender for the provision of 120 double Welsbach incandescent lights. The Council was asked to approve this resolution, which, after some discussion, it did by 11 votes to 7. Mr. J. A. Brown, chairman of the Palace Company, attended and asked the Council to afford facilities to the electric supply company for laying a main for the further electric lighting of the palace. The Council promised to consider the matter.

Broadstairs.—The Ratepayers' Association convened a public meeting last week to ascertain the opinion of the town with respect to the proposed electric railway, and it proved beyond doubt the popularity of the scheme. The following resolution was carried with four dissentients: "That, in the opinion of this meeting, a new and improved system of communication throughout the Isle of Thanet is desirable, and it hereby expresses itself in favour of the scheme proposed by the Isle of Thanet Light Railways (Electric) Company subject to the insertion in the order of clauses protecting the public and other interests, and that a copy of this resolution be sent to the Light Railway Commissioners, the Urban District Council, and the promoters of the railway."

Nantwich.—A letter was read at the Urban District Council meeting from Messrs. Edmondsons, Limited, Westminster, asking whether the Council were prepared to sanction an application being made to the Board of Trade for a provisional order for the installation of the electric light. The letter concluded: "We understand that there is a demand for the electric light in your district, and we are prepared to form a small local company, provided we have the support of the Council to our application." The matter was referred for consideration to the Lighting Committee. Dr. Munro intimated that the Brine Baths Company felt so dissatisfied with the present system, and the cost, that they had quite made up their minds to introduce the electric light in the hotel.

The Newcastle Exhibition.—The Electrical and General Engineering Exhibition at Northumberland-road has had a very successful week. There have been crowds of visitors daily, and everybody has been greatly pleased with the varied and interesting collection of machinery and general trades exhibits, the illuminations and the fairy fountain, and the excellent music that has been provided. Owing to the haste with which the exhibition had been got ready, there was necessarily a good deal that was backward at the opening, but now everything is in order, and in the few days that have elapsed, Mr. Engel, the promoter of the exhibition, has been able to make several useful additions, and has others in contemplation. Last Saturday more than 7,000 people passed through the doors.

Jungfrau Railway.—We gave the awards of this scheme some time ago, and the main features of the premiated designs are to be published at a future date. The work on the first section of the line, which is an open cutting, has been begun, and it is expected that it will be finished to the Eiger Glacier in the early part of the present year. The cost of the line is estimated at £350,000, which is more than would be required if a more direct route were to be followed. The longer line has, however, been selected in order to include the most attractive outlook points, as well as to exclude the chances of competitive projects being undertaken. It is proposed to divide the capital of £350,000 into £150,000 in 7 per cent. shares and £200,000 in 4 per cent. debentures, the price of the trip being estimated at £1. 15s. per passenger.

Brighton.—At the meeting of the Board of Guardians, Councillor Dewe had given notice of motion, "That owing to the reduced scale of charges for electricity supplied by the Corporation, steps be taken to instal the electric light throughout the workhouse premises." He stated, however, that he had been informed that the lights were put out at eight o'clock, and, if that were so, it would render it almost absurd to carry out the motion, because the light would only be required for a very few hours, and the cost would be 5d. or 6d. per hour. Therefore, he proposed to withdraw his motion until he could see that electricity would be no more expensive than gas. Councillor Berry remarked that he would have preferred that the question should have been considered by the Stock Committee, but the subject then dropped.

The Telephone in Fife.—For several months the expediency of erecting an independent telephone system in Fife has been engrossing the attention of the members of the County Council. At a meeting of the Joint Telephone Committee at Cupar this week Mr. Budge, in criticising the most feasible tender for the erection of the system, said that the committee, if they sanctioned this expense—from £310 to £350 per annum—could not hold their face to the public and say that it was a right expenditure of the public money. After discussion it was resolved to continue the subsisting arrangement with the Post Office, asking at the same time that a special arrangement be granted the County Council, in terms of a letter from the Post Office, allowing nine stations for the rent of £71 8s. per annum for constabulary and county purposes.

Liverpool.—One evening last week, while the audience at the Theatre of Varieties were witnessing the "cinematograph," one of the electric wires fused and ignited the cloth concealing the instrument from view. At a meeting of the Lighting Committee the electrical engineer reported that up to January 31 the equivalent number of 16-c p. lights connected with the supply mains was for private lighting 49,491, and for Corporation lighting 3,958, making a total of 53,449, being an increase of 959 for the month. The value of the electric energy supplied during the month of January was to private consumers £6,503, and to the Corporation £234, making a total of £6,737, as against £5,401 for January, 1896. The value of work invoiced by the manufacturing and fitting department during January was £524, as compared with £468 for the month of January, 1896.

Carlisle.—The General Purposes Committee had a conference with Prof. Kennedy, their consulting engineer, last week, with reference to the proposed installation of electric light. A visit of inspection was made in the first place to the compulsory area defined in the Corporation's provisional order, and a number of streets in the neighbourhood for which it might be desirable also to provide. Prof. Kennedy took time to prepare his report. The site of the installation will probably be Brockbank's yard, and Prof. Kennedy indicated that very likely he might recommend that the light be extended down Botchergate as far as Tait-street, round by Portland and Chatsworth squares, and down Denton Holme, to supply the mills and works there. An effort will be made to have the installation carried out so that the light may be supplied to the citizens during next winter.

Brighton.—The Lighting Committee reported at the Town Council meeting that they had considered a letter from Councillor Fowler requesting that the position of the lamp in Hollingdean-road, near the railway arch, might be altered, and calling attention to his previous suggestion that arc lamps should be erected in Beaconsfield-road. The committee resolved that the portion of Mr. Fowler's letter which relates to the lighting of Hollingdean-road be referred to the borough surveyor to report upon, and that the consideration of the request that Beaconsfield-road may be lighted by arc lamps be deferred. On these proceedings coming up for discussion, Councillor Fowler spoke in support of the suggestion contained in his letter. Councillor Greenyer said arc lights were always "bobbing about," and he thought they would be better without them. Councillor Fowler said they would put up with the "bobbing about." The proceedings were confirmed.

Southampton.—The report of the electrical engineer was presented at the last meeting of the Town Council. It stated that the total number of units sold during December was 18,724, an increase of about 13 per cent. on that for December, 1895. The approximate total number of units sold during 1896 was 121,600, an increase of 21 per cent. on that for 1895. The Electric Lighting Committee reported that they had received letters from Messrs. G. T. Harper and Son in reference to their contract for the supply of coal to the electric light station, and the committee decided that the present contract be continued with Messrs. Harper, and that upon any increase in the price of coal the matter be left in the hands of the deputy chairman and town clerk. Alderman Bone proposed the adoption of this report, observing that the committee were increasing the numbers of their customers slowly but surely. Mr. Cawte seconded. The recommendations were adopted.

The Trunk Telephone Question in Scotland.—Mr. Asher, writing from Edinburgh to Mr. Martin, town clerk, Peterhead, says that after the distinct answer he got from Mr. Hanbury favouring the coast route, he cannot believe the information published in the *Aberdeen Journal* to be correct. He notices that Mr. Buchanan has taken the matter up, and he (Mr. Asher) on his return to London will enquire at the Postmaster-General on the subject. No reply has been received by Mr. Martin from Mr. Buchanan, who is probably waiting the result of the reconsideration by the Duke of Norfolk. On Saturday afternoon, Mr. M'Naughton, town clerk of Buckie, received the following telegram from Sir Wm. Wedderburn, M.P.: "House of Commons.—Relative to the trunk telephone between Aberdeen and Inverness, have enquired at postal authorities, and find question of connecting local telephone exchanges *en route* under consideration, with every desire to afford desired facilities.—WEDDERBURN."

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Blackpool.—At the Town Council meeting the minutes of the Electric Lighting and Tramways Committee were adopted. An agreement was arrived at between the Electric Free Wiring Syndicate, Limited, and the Corporation for the supply of wiring and fittings to consumers of electricity. It was also decided that in those cases where private plants are installed and where the Corporation's supply of electricity is used as a "stand-by" the following shall be the terms upon which the supply shall be given: for every unit of electricity which would be consumed in supplying the whole of the lamps and other electrical apparatus installed in any such premises during one hour, the sum of £9. 10s. per annum; and in addition, for every unit of electricity consumed as recorded by meter, the sum of 2d., the account for the same being due and payable quarterly. The resolution of the committee passed on August 13, 1896, providing for the minimum charge of current being 10s. per quarter, was rescinded.

Jandus Arc Lamp (Continental Patents) and Electric Company, Limited.—This Company has been registered, with a capital of £100,000 in £1 shares, to adopt and carry into effect an agreement to be made between John Brunswick Barton, William Jandus, and W. C. Johnson and the Company, and to carry on in the United Kingdom and elsewhere the business of a company for the manufacture, provision, and supply of the Jandus electric arc lamps, and other electric lamps and electrical apparatus, and as electricians, mechanical engineers, producers and suppliers of electricity for the purposes of light, sound, heat, motive power, communication, force or otherwise, makers, buyers, sellers, letters for hire, constructors, fitters-up, repairers and maintainers of and dealers in cables, insulators, globes, carbons, wires, lamps, accumulators, storage and other batteries, engines, machines, apparatus, and all things required for or capable of being used for or in connection with the generation, distribution, supply, storage, accumulation, and employment of electricity or electrical currents, or in connection with electric light, sound, heat, motive power, etc.

Govan.—At the meeting of the Combination Hospital Board the Town Clerk read a minute of the Improvement Committee, giving a detailed statement of the probable cost of introducing electric light into the institution. The estimate had been prepared by Mr. A. B. Allan, burgh surveyor. Bailie Marr, in moving the adoption of the minute, said that the adoption of the electric light meant a deal of expenditure. They had taken that item into consideration. It was certainly a big item, entailing a considerable amount of money. In fact, it would necessitate an annual outlay of £100 over that of gas. There was no question, however, but that it would be a great deal better in point of light, and would save so much painting and other cleaning which was required under the present lighting arrangements. There was no doubt but the electric light was very much dearer, but when the saving in painting, cleaning, etc., was taken into account, the extra cost would only be some £60 or £70. It was for the Board, however, to consider what should be done. He then moved the adoption of the minutes, which was agreed to. It was ultimately agreed to have the surveyor's estimate printed, and circulated among the members, and that the matter be allowed to lie on the table for a fortnight.

The City of Birmingham Tramways.—The method of traction to be adopted by the City of Birmingham Tramways Company was again the subject of discussion at a meeting of the Public Works Committee of the Corporation held this week. Plans of the best overhead and conduit systems of electric traction submitted by the company were considered, and eventually it was resolved to appoint a sub-committee, consisting of Alderman Cook, Alderman Hallam, Mr. Bisseker, and Mr. Lane, to visit certain English and Continental towns to inspect various forms of tramway traction, and report the result of their investigation to the committee. The sub-committee subsequently decided to visit London, Bristol, Blackpool, Paris, Brussels, Berlin, Budapest, and possibly Nantes. In the House of Commons on Monday the Bill came before Mr. Thomas, one of the examiners of the House of Commons, for proof of compliance with the standing orders relating to notices, etc. There was no opposition at this stage, but as all the formal proofs were not given the examiner decided that the standing orders had not been complied with. The matter will accordingly be considered by the Standing Orders Committee, who will decide whether or not the Bill may be allowed to proceed in the usual course.

King's Norton.—At the Rural District Council meeting, the Chairman, in moving the adoption of the report of the Parliamentary Committee as to the Tramways Bill before Parliament, said it would be within their recollection that the Birmingham City Tramways Company applied to the Board for a license to extend their lines on the King's Heath route from the present terminus to Alcester Lanes End, and on the Bristol-road route from the present terminus to High-street, Selly Oak. The matter was considered to be of vital importance to the residents, and a conference was therefore held between the Council and the various parish councils affected. After the matter had been fully considered, there was a unanimous decision not to give unconditional consent to the laying down of the new lines until something definite was before them as to the motive power that was proposed to be used. The company had threatened to drop the extensions altogether unless they were given a license straightaway, but he believed that the company would not find it to their interest to drop the extensions. Mr. T. R. Bayliss seconded the resolution, which was carried. The Chairman then said that further negotiations were in progress, and he had a letter before him on the subject, but it had not yet been considered by the Parliamentary Committee.

An Electrical Directory.—Messrs. H. Alabaster, Gatehouse, and Co., 22, Paternoster-row, E.C., have just issued the new edition of "The Universal Electrical Directory (J. A. Berly's) for 1897." This is the sixteenth year of publication, and each edition is an improvement on its predecessor. The book contains the names of the members of the electrical and kindred industries throughout the world. The British alphabetical section now comprises about 9,933 distinct names; the Continental section, 6,579; the American section, 4,472; and the Colonial section, 1,674; a total of 22,658, approximately 1,146 names of individuals and firms more than were contained in the book for 1896. For simplicity and facility of reference the book is divided into four groups—namely, British, Continental, American, and Colonial—which are again subdivided into alphabetical and classified sections (in the case of the British a geographical section has been added), making in all nine subdivisions. In addition to the new names incorporated in the present issue, much financial information is given, and the telegraphic addresses and local telephone numbers are given. The total of pages added to the work is 66 as compared with that of 1896, making in all about 1,020 pages entirely of directory matter. It is therefore the largest, as it is the oldest electrical directory in the world. The price is 6s.

Islington.—The following report from the Electric Lighting Committee was read at the Vestry meeting: "Your committee begs to report that it has considered a report of the electrical engineer expressing the opinion that it would be advantageous to the electric lighting undertaking if a small engine, alternator, and continuous-current dynamo were provided at the electricity works for the following purposes: (*a*) the continuous-current machine to act as an independent spare exciter to the large alternators in the event of an injury occurring to one of the existing exciters, thereby minimising the risk of interruption to the lighting. Such machine could, if required, be utilised for charging accumulators for motor-cars, or other purposes; (*b*) the alternator and continuous-current machine to be used in combination for supplying electricity to the public during the hours of daylight, when the demand is small, thus preventing undue wear and tear upon the valve gear of the larger engines consequent upon their running with a very small load. Your committee is of opinion that if the engineer's suggestion is adopted considerable economy will be effected, more particularly as it hopes to be able by the use of the suggested small plant to reduce the losses due to radiation, and it accordingly recommends that such engine, alternator, and dynamo be obtained at an estimated cost of £1,300, and that a loan be obtained to defray the cost."

Hammersmith.—The Electric Lighting Committee of the Vestry have reported with reference to the price for electric current fixed by the Vestry on November 11 last—viz., "Sixpence per unit for two hours per day of maximum demand, and fourpence per unit for each unit consumed in excess of such demand"—and recommended that in order to meet the requirements of persons using the light during long hours, both day and night, the Vestry do adopt an alternative system of charging—viz., a fixed charge of 1s. 3d. per 8-c.p. lamp per quarter, and 2½d. per unit for all current consumed. The charge for lamps to be calculated upon the maximum demand each quarter. The same committee also recommended that a staff for the generating station and outside work be appointed at an estimated cost of £25 per week. With regard to meters, they had received a report as to the various sizes required, and the committee recommended the Vestry to obtain about 20 from each of the following firms at an estimated cost of £480: British Thomson-Houston Company, Chamberlain and Hookham, and the Westinghouse Electric Company. They also further recommended the Vestry to subscribe £1. 1s. annually to the Municipal Electrical Association, in order to take part in its meetings and its proceedings. The committee further reported that having considered a request from 48 residents of Uxbridge-road, west of Percy-road, that the electric lighting of the main road may be continued to the boundary of the parish, they recommended that they be informed that under the electric lighting order the compulsory area is limited in Uxbridge road, westward, as far as Percy-road, and that the Vestry were unable to consider any extension of that area at present, but they contemplated in the course of time to extend the mains for both public and private lighting of the parish boundary. The report was agreed to.

Inaugural Dinner.—Mr. Walter Scott, who has just relinquished his position as engineer-in-charge of Messrs. Crompton and Co.'s London house-wiring department on that firm giving up this branch of their business, gave a dinner to some 70 of their London works staff at Queen's-gate Hall, South Kensington, on Saturday last, to inaugurate his commencing business on his own account. Mr. Scott presided, and was supported by Mr. Fox (manager, London works), Mr. Cousins, Mr. Masters, Mr. Acland, and other gentlemen. Advantage was taken of the gathering to present Mr. Scott with an illuminated address and handsome cruet, subscribed for by Messrs. Crompton's London works staff. Mr. Acland, in making the presentation, wished Mr. Scott success in his new undertaking, and said that he could not do better than read the address, which ran as follows: "To Walter Vernon Scott, Esq. Sir,—On your relinquishing your position as engineer at Messrs. Crompton and Co., Limited, electrical engineers, we, the undersigned employés at their London works, ask your acceptance of the accompanying token of our esteem. We desire to put on record the good feeling which has always existed between us, and we wish you every success in your new undertaking." Mr. Scott, in acknowledgment, desired to assure those present how highly he appreciated the gift, and trusted that this would not be the last occasion on which they would meet together. Mr. Fox also

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spoke in reply to the toast of his health, and said he was pleased to be present that evening, and to testify to the high esteem in which Mr. Scott was held by the firm, and by Mr. Crompton personally. He wished him prosperity in his new sphere, and from what he himself knew of Mr. Scott. he felt sure that he would achieve success. The dinner was followed by a smoking concert and lantern display. Song were creditably rendered by Messrs. F. Searle, S. Anning, Hodges, Seaward, Waters, Scott, and Adams.

Blackwall.—In their report on the lighting of Blackwall Tunnel the Bridges Committee of the London County Council state: "We have also invited prices from Messrs. Laing, Wharton, and Down, and the Edison and Swan United Electric Light Company for the supply of lamp-boxes. The prices quoted are £1. 6s. 6d. and 19s. 6d. each. We therefore recommend that the Council do accept the tender of the Edison and Swan United Electric Light Company for the supply of lamp boxes required in connection with the electric lighting of the Blackwall Tunnel at the price of 19s. 6d. each box. Prices have also been submitted for the supply of lamp-holders and globes by the Edison-Swan Company at 1s. 8d. each for lamp-holders and 1s. 10d. each for the lamps, and 3s. 6d. each for globes and holders. We recommend that the Council do accept the tender of the Edison and Swan United Electric Light Company for the supply of lamp-holders at 1s. 8d. each, lamps at 1s. 10d. each, and globes and holders for the lamps in the tunnel at 3s. 6d. each. With regard to the supply of the necessary bolts and nuts, Messrs. Nettlefold are prepared to supply the same at prices varying from 68s. 6d. to 103s. 6d. per gross. We recommend that the Council do accept the tender of Messrs. Nettlefold for supplying bolts and nuts, required in connection with the electric lighting of Blackwall Tunnel, at prices varying from 68s. 6d. to 103s. 6d. per gross We have to report that we have obtained prices from Messrs. Macfarlane for the lamps and lanterns to be fixed in the open approaches to the Blackwall Tunnel. The prices quoted by the firm are £6. 15s 6d. each for the 30 straight columns and lamps, and £20. 17s. 6d. each for four triple-armed lanterns. The cost will be defrayed out of the sum set aside for contingencies under the Blackwall Tunnel contract. We recommend that the Council do accept the tender of Messrs. Macfarlane for supplying the necessary lamps and lanterns in the open approaches to the Blackwall Tunnel at the prices named, £6. 15s. 6d. each for 30 straight columns and lamps, and £20 17s. 6d. each for four triple-armed lanterns."

Shoreditch.—The following was contained in the report of the Finance Committee of the London County Council, and adopted at the last meeting: "We have considered an application from the Vestry of Shoreditch for the advance of £24,800 for the purchase of machinery and plant for the equipment of the Vestry's electric lighting station. The Vestry have entered into four contracts for (*a*) six sets of engines and generators, transformer, high and low tension and arc lighting switchboards and instruments and public arc lamps and accessories for £14,879 ; (*b*) for pumps and exhaust mains, pipes, valves, storage tanks, etc., for £4,500 ; (*c*) for four motor-transformers with switches and accessories and motor-generator, for £2,900 ; and (*d*) for accumulator battery stands, etc., for £610, making £22,879, to which has been added the sum of £1,921 for extras, engineers' commission, and clerk of works' salary, making a total of £24,800. We have also considered a further application from the Vestry for the loan of £17,000 to defray the cost of purchasing cables, pipes, conduits, and accessories for distributing the electric current. The Vestry have entered into contracts for the sum of £15,705 for the supply of these articles, and with the usual allowance for extras, engineers' commission, and clerk of works' salary, the total amounts to £17,000, exclusive of the costs of the street work, which the Vestry propose to do by their own workmen. The Council's engineer has examined the prices and reports them to be reasonable. As the Vestry desire that the repayment of the loans may be spread over 42 years, it is requisite that the special conditions as to maintenance of the machinery and plant and against future borrowing in respect of these works should be imposed. We accordingly recommend : (*a*) That, subject to the Council hereafter giving its written consent under seal to the borrowing, and subject to all necessary consents and evidence being furnished to the satisfaction of the solicitor of the Council, the applications of the Vestry of Shoreditch for loans of £24,800 and £17 000 towards defraying the cost of purchasing the requisite machinery and plant for the equipment of the Vestry's electric lighting station and the necessary cables, pipes, conduits, and accessories for distributing the electric current, be granted, on condition that the loans be taken up at once, interest being charged thereon at the rate of £2. 17s. 6d. per cent. per annum, calculated quarterly, and with the principal being repaid by such equal half-yearly payments of principal and interest combined as will repay the amounts borrowed within a period of 42 years ; that it be referred to the solicitor to take the necessary measures for completing the loans, and that the amounts be advanced out of the consolidated loans fund. (*b*) That it be notified to the Vestry of Shoreditch that as they have elected to spread the whole of the initial cost of the electric light installation over 42 years, the Council will decline to give its sanction to the raising of any loan to replace plant and machinery which may be necessary during the currency of the loan, and will expect the Vestry to provide for all renewals required during that period out of a sinking fund to be provided for that purpose or from maintenance account."

Edinburgh.—The Town Council have decided that the charge for electric energy as from May 15 next should be 4d. per unit, the charge for each public lamp £16 per annum, and that the charge for motor power should be 2d. per unit. Mr. Mackenzie, convener of the Electric Lighting Committee, gave at the Town Council meeting the reasons which had induced the committee to advise the Council to take this step. He said that after the most successful first year's working of any electric lighting station ever started in this country, they began the current financial year with 452 customers, equivalent to 57,690 8-c.p. lamps. They were now within measurable distance of the end of the second year, and they were able to estimate pretty nearly that on May 15 next they should begin the third year's working with 830 customers, being equal to 100,000 8 c.p. lamps joined on. That continued progress was most satisfactory, and, as far as they could judge, was likely to continue for some time. The amount of light supplied during the current year showed an equally large increase, for while the number of Board of Trade units sold during 1895 96 amounted to 888,335, the number of units sold during the current year ending May 15 next would amount to nearly, if not quite, 1,700,000, an increase of over 90 per cent. In regard to the financial results, they were equally successful. They would not forget that the price was reduced as from May last from 6d. to 5d. per unit, continuing the large discounts as formerly. Meter rents were abolished, and public lighting was reduced from £20 to £18 per lamp per annum. The results were: Their income would be about £26,100, which was £2,250 above their estimate Their total expenses would be £19,250, which was, even with their much larger output, £950 less than their estimate, thus leaving the very handsome balance of £6,850 of income over expenditure for the year, instead of £3,650 as estimated in other words, £3,200 more. That was the result of the current year's working, which the Council might take as practically correct, though there were yet a few months of the year to run. He now came to the estimated results of the coming year—1897-98—beginning in May next. The engineers had gone into the matter most carefully and thoroughly, and from the marvellous accuracy and caution of Prof. Kennedy's forecast in the past they might depend upon his figures being equally reliable in this case. It was estimated that in the coming year the total output would not be less than 2,550,000 Board of Trade units, that being 45 per cent increase. It might be a good deal more—he thought himself it would be more like 60 or 80 per cent. of increase. The total costs for 2,550,000 units, including £16,135 as estimated by the Chamberlain for standing charges, the engineers put at £28 200. The total revenue they estimated at £32,120 counting the charge for private consumers at 4d. per unit with discounts counting the charge for public lighting at £16 per lamp—assuming that the number would be increased 80 or 90 lamps during the year. They thus contemplated a balance of income over expenditure for the year, after such a very large reduction in price, of £3,885, or say £4,000. It certainly would not be less ; more likely it would be £2,000 or £3,000 more. In regard to public lighting, as there was a feeling existing in the minds of some members of the Council that the public lighting was too highly charged, and that a proportionate reduction was not being made, he would like to point out the exact state of the case. Assuming that the Council sanctioned an increase of 90 lamps for the year, and taking the number sanctioned already at 500, they might expect an average of 545 burning during the whole year, and for this they asked £16 per lamp, or a total of £8,720. For the upkeep of these 545 lamps they should have to expend £692 in carbons, £1,635 in trimmers' wages ; repairs and maintenance, £200—a total of £2,527. That was an outlay for arc lamps only ; there was nothing of the kind for private consumers. That left them £6,193 for the current, sinking fund, interest, and management, The number of units required for the 545 lamps during the year was about 900,000. For that they got a little under 1¾d. per unit—£6,193 in all ; while for the private lighting they got an average of about 3½d. per unit, or, taking public and private lighting together, they got nearly 3d. per unit. That would show whether the electric lighting department was overcharging for street-lighting. He only wished to add that for what was nothing less than the extraordinary success of the electric lighting undertaking they were largely indebted first to their engineer-in-chief, Prof. Kennedy, who had shown himself what indeed he was acknowledged to be, one of the ablest and most reliable electrical engineers in the country. Second, to Mr. Monkhouse, who had left them, and to Mr. Newington, who had in a quiet, unostentatious manner done an enormous amount of difficult work during the last nine months. He was devoted to his work, and had been ably supported by the members of his staff. It should not be forgotten that the introduction of the higher voltage just in progress had been largely instrumental in enabling them to attain such successful results, and the consumers should bear in mind the fact, and not impede the completion of that desirable piece of work. They intended shortly to ask the Board of Trade for its official confirmation of their system as a high-voltage one. The Council have also decided to establish a reserve fund in terms of Section 52 of the electric lighting order, 1891, and have instructed the Electric Lighting Committee to report as to the sum to be voted this year to the fund.

PROVISIONAL PATENTS, 1897.

FEBRUARY 15.

4035. Improvements in the insulation of electrical conductors. Frederick Bathurst, 73, St. Stephen's-road, Upton Park, London.

4046. Improvements in electric batteries. Ernst Zappert, 11, Southampton-buildings Chancery-lane, London. (Theodor Bergmann, Germany.)

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3996. Improvements in telephone apparatus. William Edward Langdon, the Midland Railway, Derby.

4051. Improvements in underground conduits for electric wires. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Edward S. Perot, United States). (Complete specification.)

4064. Improvements in insulators. Robert Deléry, 77, Chancery-lane, London. (Complete specification.)

4088. An improvement in terminal connections of telegraph cables. Louis Maiche, 28, Southampton-buildings, Chancery-lane, London.

FEBRUARY 16.

4131. An improved system of electric traction. Clifford Douglas, 19, Bowling Green-street, Leicester.

4138. Improvements in and connected with electric furnaces. Francis Jarvis Patten, 70, Market-street, Manchester. (Complete specification.)

4183. Improvements in electric incandescent lamps. Charles Sumner Dolley, Russell Hawkins, Thomas Montgomery Lightfoot, and Howard Townsend Goodwin, 111, Hatton-garden, London. (Complete specification.)

4198. Improvements in and relating to electric motors and dynamo-electric mychines. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Elmer Ambrose Sperry, United States.) (Complete specification.)

4212. Improvements in or connected with alternating-current meters. Carl Raab, 6, Lord-street, Liverpool. (Complete specification.)

4228. Improvements in electricity meters. William Henry Johnson, 46, Lincoln's-inn-fields, London

FEBRUARY 17.

4242. Improvements in means for connecting or continuing electric circuits through electroliers, brackets for electric lamps and the like. Joseph Bernard Clarke, 22, Dudley-street, Wolverhampton.

4292. Improvements in apparatus to generate electric currents for medical and other purposes. Henry Nehmer and Ferdinand Nehmer, 27, Sekforde-street, Clerkenwell, London.

4308. Improvements in electric cables and in their manufacture. Willoughby Statham Smith and William Puddicombe Granville, 24, Southampton-buildings, Chancery-lane, London.

4330. **An improved incandescence electric lamp for advertising purposes.** Ignaz Paprian, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.

FEBRUARY 18.

4353. Improvements in electrical storage batteries or accumulators. Joseph Barton Scammell, 56, Leadenhall-street, London.

4375. Improvements in and relating to accumulators or storage batteries. Walter Rowbotham, 27, Vittoria-street, Birmingham.

4391. Improvements in electric heating devices. William Edwin Heys, 70, Market-street, Manchester. (Amand Désiré Chedville, France.)

4417. Improvements in electromotors and in apparatus for the electric propulsion of tramcars, railway locomotives, or trains and other vehicles. William Edward Ayrton and Arthur Hinton Allen, the Central Technical College, Exhibition-road, London.

4420. Improvements in or connected with electric batteries. John Laskey Dobell, 57, Chancery-lane, London.

4427. Improvements in and connected with telephones for domestic use. George Lee Anders, Julius Edward Wedekind, and Tinniswood Miller, 55, Chancery-lane, London. (Complete specification.)

4433. An improved system or arrangement for simultaneously telegraphing and telephoning on a single wire. William Phillips Thompson, 6, Lord-street, Liverpool. (The Actien Gesellschaft fiir Fernsprech-Patente, Germany.)

4434. Improvements in or relating to secondary batteries. Antoine Bonaventure Pescatore, 322, High Holborn, London.

4440. Improvements in or relating to transmission by telephone. Francis John Joseph Glynn, 111, Hatton-garden, London.

4442. Improvements in or connected with electric batteries. John Laskey Dobell, 57, Chancery-lane, London.

4461. Improvements in connection with brushes and their holders for dynamos. William Morris Mordey, 46, Lincoln's-inn-fields, London.

FEBRUARY 19.

4480. Twin armature dynamos and electric motors. Douglas Neale, 21, Rutland-square, Edinburgh.

4487. Improvements in and connected with electric arc lamps. Ernst Buchholtz and Peter Spies, 33, Chancery-lane, London.

4492. Improvements in the method of and apparatus for supplying current to electric cars. William Griffin, Commercial-street, Halifax.

4537. New or improved system of wiring for electric lighting and in means employed therefor. Reginald Francis Kirk Stubbs, 7, Southampton-buildings, Chancery-lane, London.

SPECIFICATIONS PUBLISHED.

1895.

19328. Electrolytical apparatus. Heathfield and Rawson.

19333. Electrical propulsion of vehicles. New and Mayne.

24578. Means and apparatus for connecting electrically-propelled vehicles on tram and railways to fixed conductors. Urquhart and Wynne.

1896.

2610. Construction of dynamo-electric machines and electro-motors. Rees.

3071. Dynamo-electric generator and motor collecting brushes. Dorman.

4404. Electric switches. Drake and Gorham.

6058. Moderating electric incandescent lamps and apparatus for that purpose. Bamberg.

6306. Electric motors. Greenwood.

6751. Carbons for electrical purposes. Thompson. (Lessing.)

7389. Telephone transmitters. Wilhelm and Tillman.

9960. Electric bell communication. Helman and Carroll.

13297. Electric furnaces. Regnoli, Lori, Pignotti, Pandaleoni, and Besso.

13485. Telephone switchboards. Anderson, Hutchison, and van Curen.

21930. Method of ensuing a quick break in electrical switches known as the "Knife" switch, "Chopper" switch, or "Hatchet" switch. Verity.

23127. Arc lamps. Lewis. (Post-dated October 21, 1896.)

25799. Construction of electrodes for accumulators. Schneider.

28609. Electric device for showing the relation of oxygen and nitrogen in mines and other places. Cohn.

28761. Electrical brakes for vehicles. Grosz.

29104. Winches and posts suitable for electric light lanterns Petersen.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	£	9-9½
Brush Company, Ordinary	£	½ ¾
—— Non. Cum., 6 per cent. Pref.	£	1½-1½
—— 4½ per cent. Debenture Stock	100	109-112
—— 4½ per cent. 2nd Debenture Stock	100	94-98
Callender's Cable Company, Debentures	100	104-109
Central London Railway, Ordinary	10	9½-10
——	6	5½-6
Charing Cross and Strand	5	9½-10
Chelsea Electricity Company	5	8½-9
—— 4½ per cent. Debentures	100	112-115
City of London, Ordinary	10	19-20
—— 6 per cent. Cumulative Pref.	10	17-18
—— 5 per cent. Debenture Stock	100	133-137
City and South London Railway, Consolidated Ordinary	100	59 61
—— 4 per cent. Debenture Stock	100	139-141
—— 5 per cent. Pref. Shares	10	15½-16
County of London and Brush Provincial Co., Ordinary	10	10½-10¾
—— 6 per cent. Cum. Pref.	10	14½-15
—— 4½ per cent. 2nd Debenture Stock	5	10¾-11¼
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	1½-2½
—— 5 per cent. Debentures	—	96 98
Edison and Swan United Ordinary	£	1½-2½
—— 5 per cent. Debentures	5	3-4
—— 4½ per cent. Debentures	100	105-110
Electric Construction, Limited	£	1½-1¾
—— 7 per cent. Cumulative Pref.	£	2½-3
Elmore's Copper Depositing	1	¾-1⅛
Elmore's Wire Company	£	⅞ ⅞
W. T. Henley's Telegraph Works, Ordinary	10	19½ 20½
—— 7 per cent. Preference	10	18½-19½
—— 4½ per cent. Debentures	100	109-114
House-to-House Company, Ordinary	5	5-5⅛
—— 7 per cent. Preference	5	8⅞-9½
India Rubber and Gutta Percha Works	10	21-22
—— 4½ per cent. Debentures	100	106-109
Kensington and Knightsbridge Ordinary	5	10-10¾
—— 6 per cent. Pref.	5	8-8½
London Electric Supply	5	1½-1⅝
Metropolitan Electric Supply	10	13½-14½
—— 4½ per cent. First Mortgage Debenture Stock	100	120-124
National Telephone, Ordinary	5	7⅛-7⅜
—— 6 per cent. Cum. First Pref.	10	17-19
—— 6 per cent. Cum. Second Pref.	10	17-19
—— 5 per cent. Non. Cum. Third Pref.	5	6⅛-6⅞
—— 3½ per cent. Deb. Stock	100	104-107
Notting Hill Company	10	11-12
Oriental, Limited, £1 shares	1	1½-2
—— £5 Shares	5	8½-9
—— £4½ shares	4½	7⅛-8
Oriental Telephone and Electric Company	1	11/16-13/16
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	103-105
St. James's and Pall Mall, Ordinary	5	13-14
—— 7 per cent. Pref.	5	9-10
Telegraph Construction and Maintenance	12	39-42
—— 5 per cent. Bonds	100	103-106
Waterloo and City Railway, Ordinary	8	10½-10¾
Westminster Electric Supply, Ordinary	5	12⅝-13⅛
Yorkshire House-to-House	5	7⅛-7⅜

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NOTES.

Society of Arts.—Mr. W. H. Preece is to take the chair at the reading of Mr. Bathurst's paper on "Prevention of Fires due to the Leakage of Electricity" at the Society of Arts on March 10. This is the paper which gained the Fothergill prize given by the society.

The Royal Society.—Among the papers down for reading at the Royal on Thursday was one by Prof. Lodge relating to "Experiments on the Absence of Mechanical Connection between Ether and Matter," and another by Prof. J. B. Haycraft on "Luminosity and Photometry." The rest were on geological subjects.

Northern Society of Electrical Engineers.—At the meeting at the Palatine Hotel, Manchester, on Monday next, at 8 p.m., a paper on "Methods of Charging for Electricity Supply" will be read by Mr. R. P. Wilson. Members desiring to take part in the discussion can have a copy of the paper on application to the secretary at 17, St. Ann's-square, Manchester.

Physical Society.—At the meeting of the Physical Society of London at 5 p.m. on Friday, March 12, 1897, at the rooms of the Chemical Society, Burlington House, the paper to be read is "A Mechanical Cause of Homogeneity of Structure and Symmetry Geometrically Investigated, with Special Application to Crystals and to Chemical Combination," by Mr. William Barlow.

Chemical Society.—The Pasteur memorial lecture will be delivered by Prof. Percy Frankland, Ph.D., F.R.S., at an extra meeting of the society on Thursday, March 25, at 8 p.m. The anniversary meeting will be held on Wednesday, March 31, at 3 o'clock in the afternoon, and the anniversary dinner will be at the Criterion Restaurant on the same evening at 7 p.m.

Perturbations from Electric Railways.—The *Engineer* has a note which says that the promoters of the City and West-end Railway Company, and of the Brompton and Piccadilly-circus Company, have agreed to insert a clause in their Bills undertaking to insulate their return along its whole length "to the satisfaction of the City and Guilds of London Institute." This is probably not so terrible an affair as it looks.

Endowment of Research.—It is stated that the leading learned and scientific societies have recently been approached through their presidents on the subject of starting a movement for the promotion of a memorial to commemorate the progress made in science during the reign of the Queen, and that a scheme has been agreed upon which has for its object the foundation of a research fund for the promotion of British science generally.

Mason College Engineering Society.—At a meeting of this society last week Mr. H. R. J. Burstall read a paper on "Underground Electric Mains." In his preliminary remarks, the author observed that from 25 to 50 per cent. of the cost of an electric installation was spent on the cables, a good average being about 40 per cent.; and went on to say that the system of mains most used was the armoured cable. As might be expected from the subject, an animated discussion ensued.

The Chamber of Commerce.—An address on "Metric Weights and Measures" was delivered last week before the members of the London Chamber of Commerce by Mr. J. Emerson Dowson, M.I.C.E. Among the speakers were Sir Samuel Montagu, M.P., and Sir Henry Roscoe. The discussion showed a strong feeling as to the desirability of the early passing into law of the Bill brought forward last year by the President of the Board of Trade legalising the use of metric weights and measures for purposes of trade.

The Force of a Pound.—It would appear that the fires of the mass-weight-force controversy are not even yet quite extinct. In fact, it may break out again at any moment, and the pages of *Nature* be illumined with the blaze of great names. Though Prof. Fitzgerald would prefer the "ert," it appears that the name of the "unit of inertia" is to be "the slug." This opens a truly delightful prospect in the way of novel nomenclature, and the temptation to pursue the subject a little further would be irresistible, if it were not for the unfortunate fact that as long as there is anyone left who remembers the "mho" it will not do for us electricians to throw stones at the mechanics men.

Three-Phase Motors.—It has been remarked by Kübler that almost all of the theories which have been offered for induction motors assume that the rotating field has a constant value and a constant angular velocity, neither of which in practice is the case; and, in fact, the periodic changes in the field are different from those required by theories based on the assumption that the magnetic field can be combined by the parallelogram of forces. (The method is strictly correct for the addition of sine curve changes.) For the above reasons and others, another method is proposed for calculating the current for three-phase motors in which the inclination of the coil is neglected.

The Argentine Telegraph Dispute.—The telegraph conflict in Buenos Ayres continues, and the offices of the River Plate Telegraph Company remain closed by order of the Government. The *Financial News* is responsible for the statement that the conflict will spread, and it appears that all the offices are now prohibited from sending messages for Brazil, from the north of the Atlantic, by the Chili route. This cuts off Brazil from direct communication with North America, Mexico, the Central American Republics, Chili, and Peru. Into the merits of the dispute we cannot go. But it shows what may happen when the interests of two South American States and the companies they particularly favour come in conflict.

The Electrolytic Action of Alternating Currents. Messrs. S. Sheldon and M. B. Waterman have been investigating the influence of current density, frequency, and temperature on the formation of lead sulphate in alternating-current electrolysis with lead electrodes. The results are plotted and published in the *Physical Review*. The current density curve at 142 ⁓ per second rises in a gentle curve to become a horizontal line at a density of 0·7 ampere per square centimetre. With a current density of 0·22 ampere per square centimetre the curve of lead dissolved rises rapidly to a maximum at 20 ⁓ per second, and then becomes a straight line, with an almost imperceptible slope downwards. The authors present no theory on the subject.

The "British" in Canada.—It is understood the British Association meeting at Toronto this summer will be unusually well attended in regard to the representative character of the gathering from a British scientific standpoint. Besides the American Association for the Advancement of Science, which meets at Detroit the week before the British, the four hundredth anniversary of the discovery of America by Cabot is to be commemorated by the National Historical Association of Canada, who have arranged to hold at Toronto during the summer an exhibition of records, mementoes, relics, documents, paintings, etc., illustrative of Cabot and his journey and of the period in which he lived; and the British Medical Association has resolved to visit

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Canada this year, and will meet at Montreal on August 24—that is, its proceedings, extending over the week, will immediately follow those of the British Association.

Calcium Carbide.—People proposing to keep a stock of calcium carbide for the generation of acetylene will do well to note that the Home Secretary has issued an Order in Council under the fourteenth section of the Petroleum Act, 1871, bringing carbide of calcium within the operation of that Act. Accordingly, from the date on which such order comes into force—viz., April 1, 1897—it will be unlawful to keep carbide of calcium except in virtue of a license, to be obtained from the local authority under the Petroleum Act. In France they have found a new use for the carbide. It is a medical one, so that even if it should turn out that there is anything in it (which seems unlikely) the demand for the carbide will not be heavily increased from that source.

Lighthouse Illumination.—It is known that we do not compare too well with France in the brilliancy of our lighthouse illumination. There are 760 lights on and around the coasts of the British Isles, against 510 in France; but the aggregate luminous power of the French lights is the greater. The total British seaboard is 3,800 nautical miles, while that of France is 1,692, so that the latter has an average of one light for about every three miles, against a light for each five miles in Great Britain. In oil and gas lights the British Isles have about one-third more mean power per light, but in electric lights France has 2·6 as much power as this country. This is perhaps due to the perfectly unfounded prejudice which has got possession of some people in this country that the electric light "does not penetrate" in foggy weather. It does not, but then neither does the oil; and whatever little advantage there is, is on the side of the whiter light.

Communication with Lightships.—It is understood that it will be some months before the Royal Commission on Electrical Communication with Lighthouses and Light-Vessels are able to enter upon the consideration of their final report. In May last an interim report was issued, in which, as was noted here, it was stated that the cables to light-vessels did not answer well, and it was added that experiments were being made with a system of communication by induction, which the commissioners hoped would solve the difficulty. This expectation has not been realised, and arrangements have had to be made for a series of further experiments in order to try alternative schemes. For these experiments fine weather, such as may be expected in the summer months, is necessary, and so the commissioners have decided to postpone the consideration of their final report for six months.

Physiological Electricity.—Mr. Victor Horsley has been lecturing at Toynbee Hall on "Electrical Currents in the Human Body." As we have a weekly note on the very full course of lectures which is being delivered by Dr. Waller at the Royal Institution, there is no need to go at length into the matters dealt with by Mr. Horsley at the East-end. He, however, remarked that in part his object was to put forward by means of a few simple experiments the actual truth concerning the existence of electricity in the living body, because, unfortunately, owing to ignorance, which was the source of all evil, the field of medical electricity had been selected by the fraudulent quack in order that he might the more easily plunder his victims. Although the subject had not yet been anything like mastered, still the vast amount of progress which had been made with regard to it during the last few years demonstrated to the full that the study of electricity in the human body will occupy an important part in medical science in years to come.

Earth-Air Currents.—The subject of the existence of vertical earth-air electric currents was dealt with at the last British Association meeting, but the evidence obtained has not been altogether satisfactory either way. The results of some preliminary investigation being confirmatory of Schmidt's conclusion from theory in favour of the existence of a current, and opposed to the experience of Prof. Rücker, who found no indication of one in an area in Great Britain, Dr. L. A. Bauer has carried out the test, taking as the closed curves parallels of latitude, and read a paper before the Philosophical Society of Washington. The results obtained lead to Dr. Bauer's conclusion that there are vertical electric currents which pass from the air into the earth and back again into the air, and between 60deg. N. and 60deg. S. the average current intensity per square kilometre is about one-tenth of an ampere. Prof. Rücker, it will be remembered, found no current. It is not of great practical importance anyway.

Royal Institution.—A general monthly meeting of the members of the Royal Institution was held on Monday afternoon, Sir James Crichton-Browne, M.D., F.R.S., treasurer and vice-president, presiding. The following were elected members: Mr. F. J. Beaumont, Major C. T. Blewitt, R.A., Mr. J. F. L. Brunner, Mr. James Cadett, Mr. J. C. Carter, Mr. John Cohen, Mrs. Thomas Collier, Mr. J. G. Craggs, Mr. T. Donaldson, Mr. Henry Edmunds, Mrs. Henry Edmunds, Mr. G. S. Elliot, Mr. W. A. Frost, F.R.C.S., Mr. W. T. Garnett, J.P., Mr. H. A. Harben, Dr. F. Hewitt, Mr. F. W. Hildyard, Mrs. George King, Mr. H. Leitner, the Rev. J. D. Parker, Mr. E. M. Preston, Mr. J. M. Richards, Colonel G. Sartorius, Mr. F. H. Schwann, Dr. W. R. Smith, Mr. H. A. Stern, Mr. C. J. Stewart, Mr. G. L. Stewart, Mrs. A. D. Waller, and Mrs. J. Lawson Walton. This evening's discourse is on "Vision." Lord Rayleigh's lectures begin to-morrow (Saturday), and next Friday's discourse is by Prof. Smithells on the source of light in flames.

Cable Interruptions.—The monthly list of the *Journal Télégraphique* gives the following interruptions on "international" lines for the last month up to February 25. Omitting, as usual, failures of more than a year's standing, communication was not restored on the 25th ult. on the African Transcontinental beyond Mazoe (failure, March 11); the Cartagena and Barranquilla line, in Columbia (from July 4); the St. Croix and Trinidad cable (November 29); the Amazon cable, beyond Obidos (December 7); the Hong Kong and Macao cable (January 5); the Grenada and Trinidad cable (February 3); the Pernambuco and Ceara cable (February 4); the Jamaica and Aspinwall cable (February 5). Omitting three short stoppages on Siamese lines, all repaired within a day or two, the others are the failure of the new German cable to Vigo, communication over which was interrupted from February 10 to February 16, and the repair of the Maranham and Ceara cable on February 4 after two months' interruption. The Santa Catarina and Larissa line is still returned as defective.

South Kensington.—It was an East Anglian master of foxhounds that suggested that the most appropriate way to perpetuate the memory of the Diamond Jubilee was to purchase and endow a wood in Suffolk for the breeding of foxes for ever. Among the many proposals, some of which are not more reasonable than this, it is to be hoped that Lord Playfair's suggestion that something might be done to complete the South Kensington Museum will not get overlooked. In comprehensiveness, and generally in value, the museum stands first of its kind in the world, and it has served as a model to many foreign capitals, especially to Berlin, Vienna, and New York. Yet it is so very badly

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housed that many of its treasures have to overflow into the galleries across the Exhibition-road. It is said that the reason why the museum still remains without a front is because the architects in their desire for beauty would propose such costly and unsuitable designs. But surely it cannot be impossible to find some mean between, say, the style of Queen Anne's-mansions and that of the Law Courts. Almost anything would do, for, as Mr. Charles Yriarte, who has added his voice to the volume of English opinion on the subject, says South Kensington is especially a museum for study, and for study a mere box is sufficient, if it is easy of access, and, above all, with space and light, and, lastly, from due respect for art, with decent surroundings, a fine entrance, and no unsafe neighbouring buildings. But there is really no reason why the completed museum should not make yet one more fine building to be seen in the "museum quarter."

Council or Company.—Some time ago the New York *Electrical Engineer* collected a great deal of information as to the conditions under which municipal electric light plants were operating in America, and came to the conclusion that the municipal works were a failure—"no real gain to the community was shown by the investment of public funds in commercial enterprises of this character." Our contemporary has now returned to the subject and is of the same opinion still, and more confirmed in it if possible. But it naturally occurs that the contrary experience of Great Britain needs explaining. So we have the following: "The American public has been told that there are many municipal plants run successfully in Europe; it it is so claimed, anyhow, and one of the reasons given is the superior virtue or morality of the authorities. This may be, though we doubt it." Then omitting a mere mistake: "In Europe there are a great many people of moderate means and abundant leisure to look after such plants for nothing save the local honour it confers on them. Here such a class hardly exists in this workaday republic. Everybody is busy, and will be until such a class is evolved to do for all our communities what the town councils have done in Old England or the selectmen in New. Even, then, there will be no gain of much account in running such enterprises, and we have still to be convinced that these plants in the Old World pay as they are alleged to do. We know they don't in China, the ideal country of governmental and municipal control." Some people take a deal of convincing. Statistics as to the amount of electric lighting carried out in the Chinese Empire by popularly elected municipal authorities are awaited with interest. It is safe to say that they will be novel to most of the electrical world.

A Canadian Carbide Plant.—In the *Canadian Engineer* there is a long description of the calcium carbide works erected at Merritton, Ontario, by Mr. T. L. Willson, which are now in regular and successful operation. For the establishment of these works, Mr. Willson acquired the power of three canal locks on the old Welland Canal, known as Nos. 10, 9, and 8, having each a fall of about 12½ft., and yielding a total of 1,650 h.p. Two pairs of 50in. turbines will be operated at each lock; one set of wheels is now in operation, another is being put in, and the third will be installed as soon as the work of the wheel-pits can be finished. The lowest of the three installations is on the site of an old lock put in the first Welland canal 68 years ago, and at this point, which is 1,200ft. away from the works, two pairs of 45in. wheels, at 120 revolutions per minute, will develop about 400 e.h.p. The wheels now in operation are connected to a flywheel 11ft. in diameter and running on a 7in. shaft. The flywheel has a pulley face of 31½in., and is belted to a General Electric Company 150-kilowatt 60-volt dynamo, having a stationary armature and revolving field. The current is carried on a cable of 21 00 wires, which works out something like 2½in. or 3in. diameter. The dynamo and transformer rooms are floored with cement, and the former structure is so planned that the retaining walls of the canal bank really form part of the walls of the dynamo-room. In this room is also placed the gasholder supplying the acetylene gas with which the office and works are illuminated. There are to be 10 furnaces when finished, but at present only two or three are going. Each furnace absorbs nearly 200 e.h.p., which produces in a day of 24 hours four pigs of carbide of 500lb. each. The dynamos run night and day.

Curve Plots.—What took place last week at the Institution of Electrical Engineers causes one to think as to the value of the sort of curve diagrams without some of which the columns of no technical paper would nowadays be considered complete. Mr. Wilson took certain figures relating to dynamos from price lists, plotted them into curves, and sent the curves to be engraved and printed. While that was being done the same curves were plotted over again by someone else from the same figures to form wall diagrams. When they came to be discussed, the first thing pointed out was a discrepancy between the two sets of curves. Moreover, Mr. Esson being determined to "spot" his own machines among the others, got the printed curves, and appears to have had the curves for his own machine plotted, naturally expecting to at once recognise it in the diagrams. He totally failed to do it, or, for the matter of that, any other maker's machine either. Yet they were there, or some of them. Now it must be remembered that these curves would be free from many of the usual errors, for the figures were obtained from printed lists, so that there could be no errors of observation or of instruments, and the possible errors of calculation are about included in a very simple division. The only possible conclusion appears to be that the curve formed by sweeping a line through a reasonable number of more or less roughly determined points is by no means either so certain or so characteristic as is usually assumed. Of course if sufficient trouble is used, the ordinates are taken close enough and the work checked when finished, any degree of accuracy can be obtained. But then the labour becomes more than the result is worth. It would be interesting to hear the drawing-office view of the subject.

The National Physical Laboratory.—Lord Lister has written to the *Times* a long letter controverting the views of that journal as to the establishment of a national physical laboratory. In reference to the contention that the laboratory will not be the same sort of thing as the Reichsanstalt, Lord Lister says "the aims and objects of the proposed institution are set forth in the memorandum in terms which are little more than a paraphrase of those used in official documents with respect to the Reichsanstalt." That the Reichsanstalt "does pure research in the same way as German colourmakers do it—by way of adjunct and finish to practical work"—is true, but it is not the whole truth, for the Reichsanstalt is divided into two departments, of which the first is the physical and the second the technical division. The principal work of the first of these is that exactly defined by the words in which were described one of the tasks which it is desired to undertake in the proposed laboratory—viz., "the systematic accurate determination of physical constants and of numerical data, which may be useful either for scientific or industrial purposes." The statement that the manufacturers of Germany supply the revenue of

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the Reichsanstalt in fees appears founded on a misapprehension, since Lord Lister says that this item in the budget of the Reichsanstalt is only £1,500. This is about one-tenth of the annual expenditure, and is considerably less than the sum annually earned in fees by the present Kew Observatory. Then there is the thermometer glass dispute, but that is such a perfect example of a side issue that it may be omitted. Indeed, for the matter of that, it seems to the writer much more to the point to consider what we want here rather than what they are doing over there in Germany. Unintelligent imitation never regained a lost place. But so much space was given last week to the *Times'* view of the matter that it is only common justice to give equal prominence to the other side.

The Institution.—At last week's meeting of the Institution of Electrical Engineers Mr. Hollins came down with a written "reply," which he read at a rate exceeding, if possible, that of the paper itself. That is very well when everyone has the printed matter before them, and can refer to it if necessary, but when it is not so a little more time to grasp each point would have been desirable. Subject to this it sounded an excellent reply, and Mr. Hollins appeared to make (metaphorically) mincemeat of his critics. He certainly displayed a most embarrassing knowledge of every invention, reasonable or absurd, which had ever been published on the subject dealt with in the paper. Then, as a change from the very long paper, we had the very little one—its author nearly described it as a mere note-paper. Mr. Wilson's term "mass factor" for the revolution-output is not a happy choice for several reasons. But, on the other hand, one could have wished he had presided at the christening of the currents. When Mr. Wilson remarked in the mildest manner that the alternating current might be called continuous if it never ceased to flow, there was something much more than a ripple of laughter to show the point was appreciated. But it is too late to hope to change now. There was a natural reluctance on the part of the engineers to tackle Mr. Wilson's curves until they had some sort of an idea whose machine a particular curve might represent. Prof. Silvanus Thompson threw himself into the breach. He is usually a model of lucidity, but being called upon without any preparation to discuss dynamo properties expressed in the most abstract manner, it was at times difficult to be sure that one had followed his meaning correctly. The rest of the discussion consisted mainly of variations on the remark that if the curves had indicated something else they would have been different. So in the end a subject which everyone expected to last another night at least was finished well within the usual time limit. The next meeting is on Thursday, March 11, 1897, when the paper will be "On Some Repairs to the South American Company's Cable off Cape Verde, 1893 and 1895," by Mr. H. Benest.

Animal Electricity.—In last week's note on Dr. Waller's lecture, the words "base" and "apex" in the middle of it (lines 20 and 21) should be transposed. This is not a consequence of the fact that the eminent lecturer himself in drawing a diagram of his connections started off with the heart the wrong way up or the dog's head on the wrong end (it comes to the same thing), for that was naturally at once corrected, but is simply an illustration of the (at present unproved) law of the conservation of error, whereby if one tries to be particularly careful in one place, some irritating blunder will creep in at another. Last Tuesday Dr. Waller began by showing Du Bois Reymond's experiment of 1855, but explained that though when conducted with the proper (and unusual) precautions it appeared to give a current in the right direction—*i.e.*, in the galvanometer from the inactive to the active sides of the body—it had been shown by experiments on animals that much the larger part of the result was due not to the muscle current but to skin effects. Hermann's experiment, by which the muscle current was demonstrated by electric stimulation, with an arrangement for cutting in or out the galvanometer at the proper moment, was described, and the lecturer then resumed the subject of the difference of potential of different points on the surface of the body corresponding with those taking place during contraction in the heart. The possibility of this being due to the flushing of the capillaries by the wave of blood (an important point) was eliminated by means of the time comparison afforded by the simultaneous record of a sphygmographic trace and that of the surface of the capillary electrometer. Dr. Waller then demonstrated by means of the lantern and capillary electrometer the surface variation of potential in the human subject due to the contraction of the heart, and exhibiting traces of it called attention to the fact that it (at any rate, in warm-blooded animals) corresponded only roughly to an interchange of higher and lower potential between the terminals to the apex and to the base, but really when examined minutely was found to follow closely the contraction of the ventricle, which was strictly not so much from base to apex as from the venous to the arterial end, so that at the end of the cycle there was a certain amount of recovery of the potential proper to activity at the base. The correspondence of this to what might be inferred from the evolutionary and the embryonic development of the heart was also alluded to.

High-Tension Lightning Arrester.—A lightning arrester, designed by Siemens and Halske for single-phase and other alternating currents with tensions from 2,000 volts, consists of two stout copper wires bent to curves and borne by porcelain insulators, so that the curved wires approach each other like a couple of flat "D's" placed back to back. The distance between the two wires can be regulated according to the tension in the circuit. The lower ends of the wires are threaded and held in a horizontal hole in the upper cap by two nuts. Each of the lower caps bears a clamp nut. One of these nuts is a screw connection with the circuit to be protected, on the other a screw connection with the earth connection. If, in consequence of a lightning stroke, an arc forms between the two bent copper wires the action of the ascending current of warm air and the repulsion of the currents in the wires carries it upwards, and as the wires separate more and more as they ascend the arc should become weaker and be broken. It is recommended that the device should be housed, to protect it from rain. There must be a free space above it of a least a metre (say, 40in.), as the arc (especially in large plants) may attain considerable magnitude. There must be no combustible materials in the neighbourhood. When the device is fixed in a building, and there is not proper room for it, the walls and ceiling may be covered with asbestos board. The distance required between the wires at their nearest point is 1mm. (0·039in.) for each 1,000 volts tension. The device may be installed in the open air without roof, but in this case one may expect, when it rains heavily, the formation of arcs between the wires, although usually they are soon broken. Where the device is installed in the open air, the minimum distance between the wires must be increased to at least 10mm.—say 0·4in. As this lightning arrester is free from self-induction, its operation would not be greatly hampered from installation in the open air if the lightning had to overcome self-induction in the circuit itself. Now long free circuits have always a fair amount of self-induction, and in such cases the arrester can be installed in the open air, but care must be taken that the arc flame does

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not strike the circuit. The arrester hence must be put at the side or above the line. If it comes near generators, motors, or transformers, then more self-induction must be introduced between these and the arrester. The device, it will be seen, is of German origin, but in America, where such things are wanted, the *Electrical World* apparently thinks much of it.

Government and the Telephones.—In the House of Commons on Tuesday Mr. Henniker Heaton asked the Secretary to the Treasury, as representing the Postmaster-General, whether his attention had been called to a letter of the late Postmaster-General, Mr. Arnold Morley, in which the writer officially laid down the right of the Post Office to take over the telephone system of this country without conditions in the year 1911, and whether, at an early date, he would be able to state (in order to avert misunderstanding and financial trouble) the policy of the Government on the question. Mr. Hanbury, in reply, said the letter referred to was probably one which was published on July 9, 1894, and which ran as follows: "On the termination of the license in December, 1911, the right of the National Telephone Company to carry on telephone exchange business will cease and determine. All they will have to sell will be their plant, and even this the Government will be under no obligation to buy." He (Mr. Hanbury) had nothing to add to that statement, and knew nothing of any claim of the company to receive ultimately full payment for all expenditure and investments made in extending their business. He hoped to be able at an early date to state the Government's policy on the general question, but might say at once that the Government had no intention of buying up the company's business, and would therefore give no notice to purchase, which it had the power to do, on or before June 30, 1897. But Mr. Henniker Heaton is not a man of one question and one answer even when it is divided into "firstly," "secondly," and so on up to "fifthly." He wanted to know more—namely, whether the Postmaster-General's attention had been called to the increasing dissatisfaction with the telephone service in London, its cost, and the errors and delays by which it is attended; whether the Post Office was making any efforts to supply the public with an independent State service, characterised by greater speed, accuracy, and economy; whether the Post Office authorities had and exercised any power of compelling the National Telephone Company to improve their service in the above respects; and whether he was prepared to grant licenses to companies which may be willing to afford a cheaper and better telephone service. Mr. Hanbury replied that the Postmaster-General had no reason to believe that there was increasing dissatisfaction with the telephone service in London (it is a pity that "increasing" was in the question at all). The Post Office had not attempted to establish a telephone exchange system in London. The power which the Department possessed was that of licensing fresh companies and of competing itself. The question of whether licenses should be given was one of policy, and the policy of the Government would be stated at an early date. Mr. Bartley enquired whether it was not the fact that the company kept applicants (for telephones to be erected, not applicants to send messages) sometimes waiting for months; but Mr. Hanbury said the Post Office had no information to that effect—which may mean anything. So we are going to be told something some day, but meanwhile are not much forwarder as to knowing what it is to be.

Prof. Zeeman's Discovery.—If a wisp of asbestos soaked with common salt is introduced into an oxyhydrogen flame placed between the poles of a powerful electro-magnet, on being examined by a good diffraction grating it is found that the characteristic D lines are widened out during the passage of the current. This result might be due to some influence upon the flame, but if a piece of sodium is volatilised in a porcelain tube closed at the ends by glass plates and a beam of light from an arc lamp is sent through, the reversed (black) lines are seen also to be broadened under the action of a very strong magnetic field. Suitable precautions are taken to minimise temperature alterations in the tube which could possibly affect the result. Hence a change in the period of vibration must be produced under the magnetic influence. Here is the natural end of this note, but a word or two of explanation may be desirable. It is now a commonplace that the actions which take place in electromagnetic induction and in the transmission of a light wave are of the same character. Now, if it is endeavoured to describe the action which takes place in a magnetic field, it is found that, whatever it is, it is completely represented by a rotation (or twist?) about an axis corresponding to the direction of the "line of force." Assume the direction of this is the same as the line up the centre of this page, and consider the motions in the sodium atom which give rise to the light vibrations of one of the D lines. These are in all directions, and the only thing we know about them is that they are all of exactly the same periodicity, but if the extreme case of the ellipse degrading into a straight line is included they are covered by more or less elliptical movements. Resolve these vertically and horizontally, and remember that the superposition of two harmonic vibrations in different directions is equivalent to a rotation and *vice versâ* (polyphase has at least ground that into every-one—even the people who say, What has the theory of light and vibration to do with our business?). It is then seen without much difficulty that while the components parallel to the line of force are not affected by the "rotation" about it, those taking place in a plane at right angles to it will give vibrations in the direction of the lines of the print, and their period will be slightly lengthened or shortened according as the atomic movement is in the sense corresponding or opposed to the rotation round the line of force. That is, the radiation will be shifted a very short distance down or up the spectrum, and the spectrum line will appear to be broadened. But there is still another effect. Obviously the light from the edges of such a broadened line is vibrating in the direction of the lines of print. It is therefore polarised in (as it is said) a plane containing the line of force and the direction of transmission. Prof. Zeeman, of Amsterdam, has recently been able to show that this is actually the case. If, instead of looking across the lines of force, we look along them (through a hole drilled through the core of the electromagnet) the theory is even simpler, though its optical demonstration (which we cannot touch on here) is more difficult. In this case the radiation which will be sent to the extreme edge of the spectrum line is that in which the vibration is a rotation round the axis of the line of force. That is to say, circularly polarised light forms the right or left fringe, and light plane-polarised in any direction is not affected. This has also been shown to be the case. It was just one of those things which looked much too small to be separated out, and its successful demonstration is due to Prof. Zeeman, of Amsterdam, who was led to it by experiments of Dr. Kerr, of Glasgow, and Prof. Quincke, of Heidelberg. It may lead to important contributions to our knowledge of the fundamental nature of electrical actions generally; but this note has already grown to unwieldy proportions, and must stop here.

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ELECTRIC LIGHTING BY WATER POWER AT FORT WILLIAM.

Fort William, a town in the county of Inverness, has a resident population of between 2,000 and 3,000 inhabitants. In the summer it is much frequented by tourists and others, who make it a centre for visiting the West Highlands, or for those who wish to climb Ben Nevis, the highest mountain in the United Kingdom. Since the opening of the West Highland Railway some two years ago, Fort William has awakened from an old-world village into a more modern town. The gas supply, which since its first start had always been unsatisfactory, was one of the first things that had to give way to a more up-to-date and better means of illumination. Last winter matters came to a crisis as regards the provision made for the public lighting and also the private supply, for the gas failed altogether. The Commissioners were obliged to resort to oil lamps, which were hung upon the existing gas standards, and the churches, shops, and private houses used paraffin lamps. Some time previous to this, Mr. R. Frederick Yorke, A.I.E.E., who had lighted up several large houses in the West Highlands with the electric light by means of water power, had gone into the matter of the electric lighting of the town; but owing to various difficulties at that time with regard to the water rights the scheme had to be abandoned. He, however, at the crisis mentioned, again came forward with another scheme, and as the proprietors of the water offered exceptional facilities, the necessary agreements were soon drawn up. A company, called the Fort William Electric Light Company, was then formed, and the work commenced.

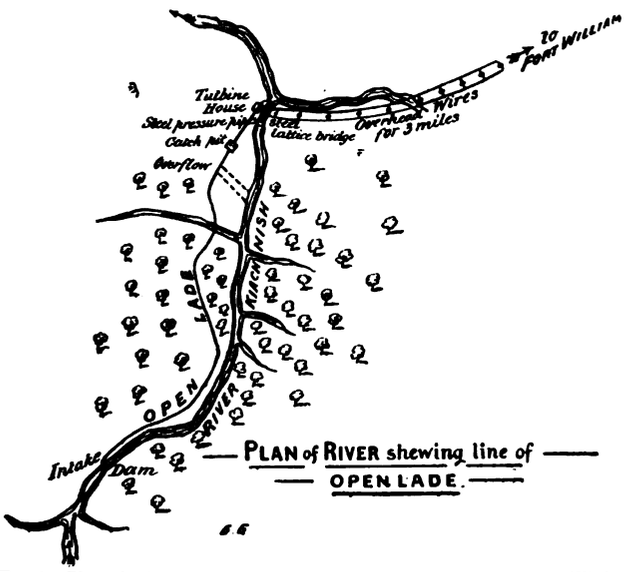

FIG. 1.—Plan of Water Power Supply to the Electricity Works at Fort William.

The water power used is obtained from the River Kiachnish, at a point some three miles from Fort William (Fig. 1). The river is a rapidly-running one, with a series of small falls, so in order to get the highest possible head of water for the turbines a dam was built at some distance up the river, and the water brought down in an open lade or mill race for a distance of some 1,400 yards. At the end of the lade there is a suitable catch-pit provided with an overflow. A steel pipe some 20in. in diameter is led from this point to the turbine-house, close to the river bank. The total available head of water on the turbines is some 120ft., of which 100ft. acts by pressure and the remaining 20ft. by suction. The water in the lade has a mean velocity of 3ft. per second, and the discharge of the lade about 900 cubic feet per minute. The two turbines, of the "Vortex" type, are of 60 h.p. each, and were constructed and erected by Messrs. Gilbert Gilkes and Co., of Kendal.

The two dynamos (Fig. 2) were supplied by Messrs. Laurence, Scott, and Co., of Norwich, being specially built to run with little attention. The armatures are wound with two distinct windings in separate slots on the core. The main winding is taken to a large commutator, where the voltage is 500 and the current 90 amperes. The second or smaller winding is taken to a small commutator at the other end of the armature, the voltage being 120 and the current 12 amperes. The lower-voltage current is used for exciting the field magnets and for lighting the turbine-house, and so avoids fine wire being used for the winding of the field-magnet coils and makes the possibility of a breakdown in the insulation improbable. The turbines and dynamos are direct-coupled and run at 600 revolutions per minute. The coupling used

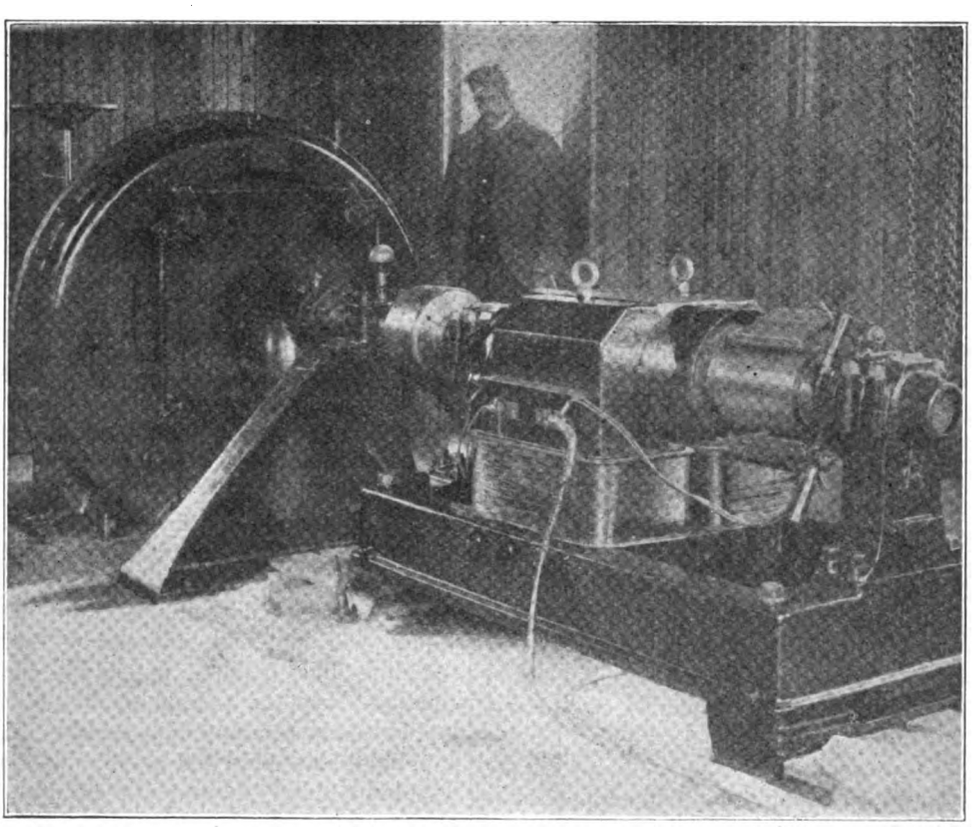

FIG. 2.—View of Dynamo Direct Coupled to a Turbine as used at Fort William.

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is a flexible one and prevents heating due to want of alignment in the machines. As the turbine-house is over three miles from the town, overhead wires are used. These consist of a stranded wire $^{19}/_{13}$ S.W.G., fixed to Langdon corrugated insulators on poles placed 60 yards apart.

At Fort William a substantial house is built containing the accumulator cells, switchboard-room, and stores, etc. The accumulator consists of a set of 164 cells of the E P.S. central-station type. The battery is charged in series, but for distribution the three-wire system is used, the centre wire of which goes to the middle of the battery, and is earthed. The switchboard, of enamelled slate, has two sets of 20-way regulating switches, with instruments showing the current going out to the different circuits. In order to balance the discharge, and so keep both sides of the battery the same, two-way switches are provided, so that the town incandescent lights can be switched on to either battery as desired.

The distribution is effected by both underground and overhead wires on the three-wire system, 150-volt lamps

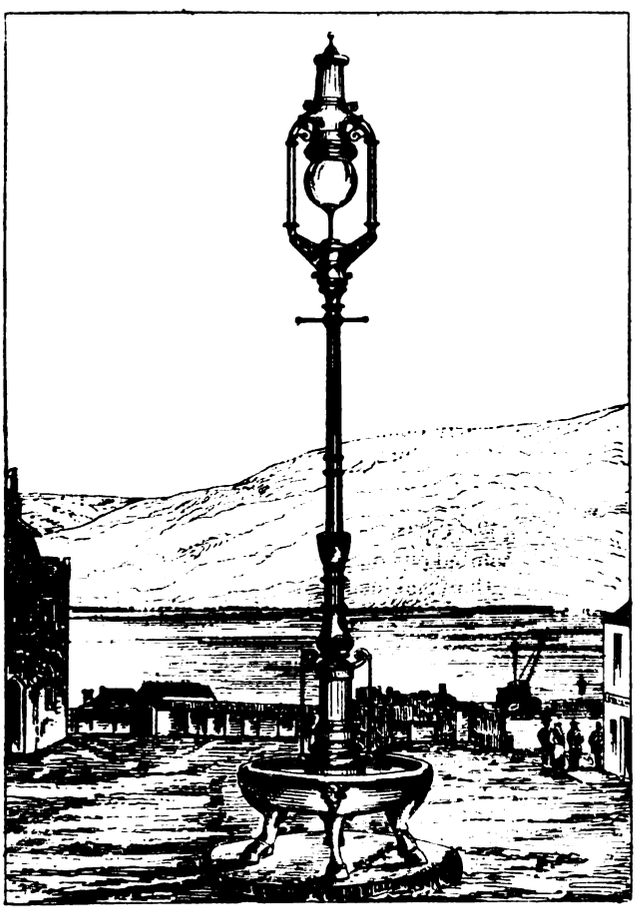

FIG. 3.—View of Lamp-post and Fountain at Fort William.

being used. The underground circuit is taken through the main street of the town, supplying churches, hotels, shops, etc., on the route. This cable (Messrs. Walter Glover and Co.'s) is insulated with diatrine, lead covered and double steel armoured. Connections with these cables are made at manholes placed at suitable distances apart. Alongside these cables a 4in. earthenware pipe is run, and opposite each consumer a special pipe is put with a cover and a side opening, so that connection is made in the manhole; the house main is drawn into this pipe and enters the consumer's premises by the pipe mentioned above, thus avoiding numerous joints in the main cables. The overhead wires are used for supplying the houses and villas situated at each end of the town. The meters used are supplied by Messrs. Laurence, Scott and Co., Norwich, and the system by which the consumers are charged is known as the "Norwich" system—*i.e.*, the price per unit is 9d. from one hour before sundown to 9 o'clock at night, and from that hour until an hour before sundown the following day the charge is 4½d. per unit, thus giving great encouragement to the use of the current during the period of light load.

The public lighting consists of six arc lamps in the principal street, three being of the ornamental overhung type, two—being presentation ones (Fig. 3)—fitted with drinking-troughs for horses at their base, and one with a fountain. The side streets and lanes in the burgh are lighted by incandescent lamps of 32 c.p. and 16 c.p., for which the old gas standards are utilised, with the addition of an ornamental top and globe. The number of lamps connected up to date amount to an equivalent of 3,000 8-c.p. lamps. The company commenced to supply the electric light on August 1 last year, the current being very rapidly taken up, consumers coming on as fast as they could be wired and connected; there being amongst them six hotels, three churches, the Belfort Hospital, court house, and also the prison, and all the principal shops and dwelling-houses. The water power has never given any trouble during the last severe winter, and the result of the working of the installation for the past six months has given great satisfaction, both as regards the public and the private lighting.

Mr. Yorke's aim is to render the working arrangements as simple and automatic as possible. In this he may claim to have succeeded, when it is stated that a crofter who had never seen anything of the kind was able, after a week's tuition, to take charge of the electric and water plant in the turbine-house. He is in communication by telephone with the engineer at Fort William, who instructs him when to start and stop running the machinery. Beyond this, all that is necessary is an occasional inspection to see that all is in working order. The whole of the work has been designed by Mr. R. Frederick Yorke, A.I.E.E., who also holds the appointment of managing director of the company. Mr. H. Wilson Bagot, A.I.E.E., has been Mr. Yorke's assistant, acting as resident engineer. Mr. Duncan McNiven, solicitor, is the secretary of the company.

Yorke's patent tubular system has been used throughout for wiring consumers' houses, permission being granted by the Board of Trade for its use, which involves the earthing of the middle wire at each house. The installation is interesting as being the first town in Scotland to be lighted by means of water power, and the success of Fort William should help to encourage other towns where water power is available to adopt electric lighting by this method.

THE MECHANICAL CONSTRUCTION OF ELECTRICAL MACHINERY.

BY F. M. WEYMOUTH.

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(Continued from page 231.)

THE DYNAMO.

Combination Bed-plates (*continued*).—We pointed out in our opening remarks that for the sake of stability, and especially on board ship in order to withstand the gyrostatic action of the rotating parts, a bed-plate should have a broad base, and the axis of the shaft should be as low as possible; all of which, indeed, is sufficiently obvious. It is thus to be noted that in practice dynamos adopted in direct-driven plant are almost invariably of some undertype pattern. An example to the contrary by Messrs. Goolden and Co. is illustrated on p. 525 of Prof. S. P. Thompson's "Dynamo-Electric Machinery," fourth edition. We have also observed as regards variety that a bed-plate may be common to both engine and dynamo: or else, an engine complete with separate base may be placed on a prolongation of the dynamo bed-plate; which latter arrangement seems to find most favour in practice. Of these, however, the former method may more immediately engage our first attention.

Now, to consider such a type of bed-plate, which, as before mentioned, shall also contain within itself all necessary rigidity, not heeding the degree of that quality that may be imparted by the foundations, we find that besides strength, and beyond the fact of having low bearings, its design must provide sufficient room for a flywheel (when this latter is not outside the bed-plate altogether, at the end of the engine away from the dynamo), and a clearance of from 4in. to 6in. on each side between the cast iron and the pole-pieces of the magnets. It may be necessary,

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furthermore, should the end winding of the armature not require the brushes to come at the sides of the commutator, with their contact points on either side in an approximately horizontal plain through the axis of the shaft, to find room for one set of brushes beneath the commutator. Consideration of such requirements, therefore, following more especially on the low axis of shaft, will lead us to a type of bed-plate such as is depicted in outline in the accompanying illustrations, whereof Fig. 77 is an elevation and Fig. 78 a plan.

Having regard now to these outlines, we note that there is a large well, A, besides two smaller ones, B and C. The two last are crank-pits for the engine, which may be assumed to be of some open type. A section through the first, on E F, is shown (Fig. 79) to a larger scale. Though the sections, *x y*, through the bed-plate sides are here purely hypothetical, some leading features are to be noted. Thus, a clearance of 5in. is allowed between the pole-piece and the cast iron, as shown by figured dimensions; and further, the same section also gives room for the flywheel, *f f*. Facings, *e e*, are provided, down to which are bolted the gunmetal brackets, of which one is shown lettered *g*. These last carry the magnets. The flywheel is shown dotted in the plan (Fig. 78), lettered *f*, and will be observed to be placed as close as feasible to the bearing, which will come at *b*. To allow for the extra weight due to the flywheel and armature, beside the pressure from the cranks, the bearing at *b* will be seen to have more length than is allowed the other bearings at *a*, *c*, or *d*. The facing extended to *q q* will represent the engine seating.

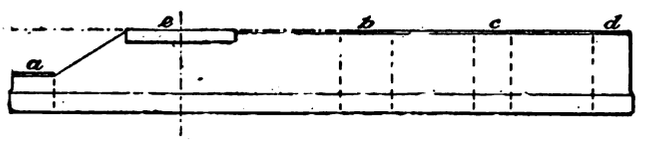

FIG. 77.

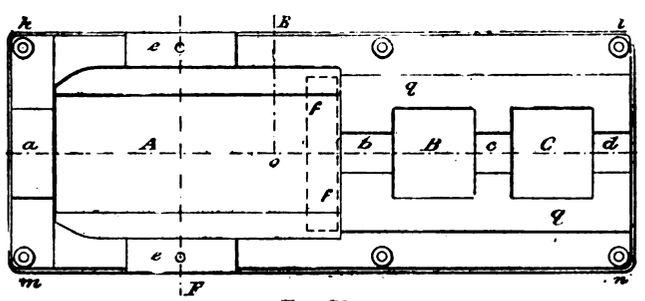

FIG. 78.

Now the bearings at *b*, *c*, *d*, appertaining to the engine, are embodied in the bed-plate, at least as regards their lower halves, and are permanent fixtures. But inasmuch as it may be necessary any time to dismount the armature, and it would then also be convenient to be able to do so without disturbing the magnets, for this purpose the end bearing at *a* must be made movable. Hence we find that the end of the bed-plate is here stepped down, as shown plainly at *a* in Fig. 77, and the bearing itself is more or less like a plummer block, and easily removed. The lowered end, *a*, of the bed-plate, however, also permits of the armature being withdrawn over it endways as required, and, in fact, must be made sufficiently low with this point in view. Being held, not with studs, but with bolts or tap-bolts, the bearing will come endways off the shaft, after removing the bolts, as with other bed-plates. In Fig. 79, it will be observed that beneath the commutator, as at *h*, there is plenty of room for the brush gear.

The actual strength of the bed-plate must now be considered. This, it is obvious at the outset, will depend not only on the thickness of the metal used—sometimes denominated the "scantlings"—but also on the general section adopted. It is important, for instance, viewing the subject not merely from a mechanical, but also from an economic point of view, to determine exactly what sections should be put in at *x* and *y* in Fig. 79.

In discussing a previous frame-shaped bed-plate (Fig. 62), we pointed out that if such were supported on two diagonally opposite corners deflection would probably occur, and the other two corners would sink. The same question may thus be raised in the present case; and it may be considered how far the imparting of such strength to a bed-plate would be justified as would allow it, carrying engine and dynamo complete, to rest on two diagonally opposite corners, as at *m*, *l* (Fig. 78), without undue deflection anywhere in the structure. In actual practice it would seem generally as though the consideration of such a question were superfluous, no doubt owing to the fact that

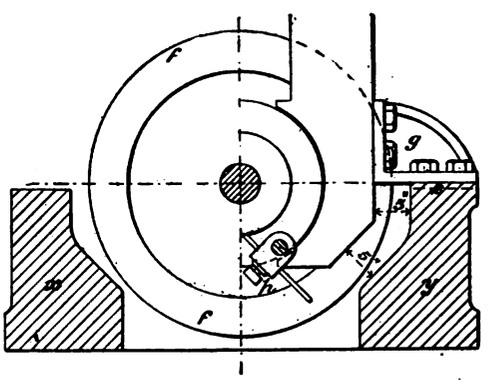

FIG. 79.

bed-plates are usually expected to be seated on properly-prepared foundations. A due and appropriate head, however, would not be given the subject as a whole unless such a case were at least assumed. It is easy to build weak: but how to build strong without waste of metal is a question that requires consideration. Circumstances, for instance, may be supposed wherein a combination plant would be expected to work quite satisfactorily when simply deposited on rough ground without any foundation whatever, the engine being connected to the boiler by a flexible steam-pipe.

On such a supposition, therefore, as the above, we find the problem clearly defined. It is plain, in fact, that under conditions of this nature, a bed-plate would be exposed to all sorts of strains that would not arise when fairly bedded on a substantial and level foundation such as might be afforded by a solid mass of concrete.

Now, we pointed out on one of our earlier pages that, in order to meet the combined torsional and bending strains, the best form for a bed-plate, theoretically, would be tubular. This not being very practicable, the nearest feasible approximation must then be sought. It will now be seen that this applies to the sections *x*, *y* (Fig. 79). For inspection of the plan (Fig. 78) will make it evident that in so far as the structure rests at *m* and *l*, rather than at *k* and *n*, a compound strain of both bending and torsion will be set up on the section *E o* which is the same as *x* (Fig. 79). Hence we find that theoretically, at least, while keeping the same necessary periphery to suit the flywheel and magnets, the section *x* should be shown tubular, with webs cast across at intervals for further stiffness. With the latter additions, in fact, it becomes cellular. To this the nearest approximation that is readily practicable is a channel section formed by omitting one side of the tube. The loss of strength due to this omission may be compensated by flanging the edges on the open side; while the webs will remain.

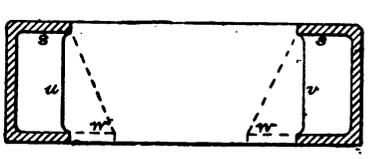

FIG. 80.

Figs. 80 to 82 herewith show three different ways of applying the channel sections (having webs, *u v*) to the general section on E F, though without immediately considering the flywheel and magnets. Now, it is evident that with the bed-plate supported at *m* and *l*, and the corners, *k* and *n*, tending to drop, the effect on the casting as a whole will be to expose it to a strain tending to twist it. Hence to meet this strain we find, as we have but just found in the case of the detail sections on E F, that the bed-plate as a whole must approximate a tubular form. This

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consideration therefore, following on our previous remarks, will lead us to view the arrangement of channels shown in Fig. 80 as the most appropriate among those represented, for these channels continued the whole length of the bed-plate, and joined across at intervals, as at *a*, *b*, *c*, and *d* (Fig. 78), produce the nearest feasible approximation to a tubular form for the casting as a whole, and the metal is thrown for the most part into the outer periphery of the general section (on E F), where it is thus used to its best theoretical and economic advantage.

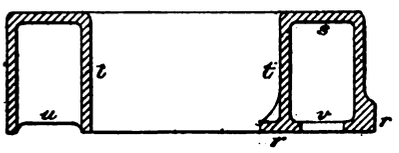

FIG. 81.

The combination shown (Fig. 81) would be good if there were any great horizontal strain acting between *m* and *k* (Fig. 78) across the end. But in the circumstances supposed, this would be the last strain to be apprehended after the plant was once in position. Should this point, however, be considered of moment, owing to the possibility for instance of blows being received on the corners in transport, or owing to rough handling, then the arrangement in Fig. 81 would have its advantages. For it is evident this combination would not be so easily deflected sideways as either of the other two. It has to be noted that this is the only arrangement of the channels that readily admits of flanges, or other thickening, being cast on the edges of the open sides, as at *r r*, though we shall illustrate later a section showing a slight attempt in this direction in a case where the channels are placed as in Fig. 80. As further compared with either Figs. 80 or 82, it is easy to make the total section of these added flanges, *r r*, equal to, or even more than equal to, the section of an upper flange or web, *s*. With flanges on the cross-webs also, as at *v* (Fig. 81), we get the nearest approximation to a complete cellular tube that is readily attainable in any of these combinations of channels. Due to the flanging, *r r*, and especially due to the addition of the extra walls, *t t*, the sides of the bed-plate under a vertical load will also become proportionately stronger than with the single vertical sides, as in Figs. 80 and 82. The walls, *t t*, being continued throughout the length of the bed-plate, this latter viewed as a whole will approximate the form of a tube having two of its opposite sides doubled. It will thus the better resist the twisting tendency above alluded to. We hence find that the combination shown (Fig. 81) with the flanges, *r r*, will be the strongest, though it will also be the heaviest, and the most expensive in view of the extra weight of metal.

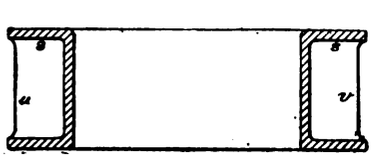

FIG. 82.

It has to be remarked here, however, that on comparing Fig. 80 with Fig. 79, though the flywheel and magnets limit the width of the top flange, *s*, of the channel section, this does not apply to the bottom flange. Hence it may be deemed quite sufficient as regards strengthening the dynamo end of the bed-plate against blows on the corners, or other strains across the end, simply to widen the bottom flange inwards, as shown dotted at *w w* (Fig. 80). This latter feature is, in fact, evident in a bed-plate we shall illustrate on a later page.

The combination shown (Fig. 82) is useful for light designs: for instance, on board ship, where the bottom flange may be bolted down to the deck frame, formed of angle iron or rolled channel, while the upper flange may be used for bolting down thereto the magnets. In such a case the dynamo end of the bed-plate is cast entirely in gunmetal, and is bolted to the engine bed-plate end to end. Thus shoes or brackets are not needed.

(To be continued.)

THE PRINCIPLES OF ALTERNATE-CURRENT WORKING.*

BY ALFRED HAY, B.Sc.(EDIN.), A.I.E.E.

(Continued from page 233.)

154. In order to reduce the magnetising current of induction motors, and render the magnetic leakage as small as possible, the air-gap of such motors is reduced to a mere mechanical clearance space. This is attained by embedding the field and armature windings in the iron instead of having them in the air-gap. The outside conductors of the field winding need not, of course, be embedded. The method frequently adopted in such cases will be understood by reference to Fig. 109, which shows part of the field and armature cores, separated by a narrow air-gap, and perforated with series of holes close to the gap; these holes receive the winding, which is divided into sections. Instead of round holes, rectangular ones (with the corners well rounded) are sometimes used; and not unfrequently the crown which separates the hole or channel from the gap is broken through with a saw-cut.

155. Reference has already been made (Art. 140) to the difficulties which occur in starting polyphase motors. The slip at starting being 100 per cent., we have very large E.M.F.'s induced in the short-circuited coils, and yet the torque of the motor may be comparatively small. In the case of motors of large size, it is found necessary to have

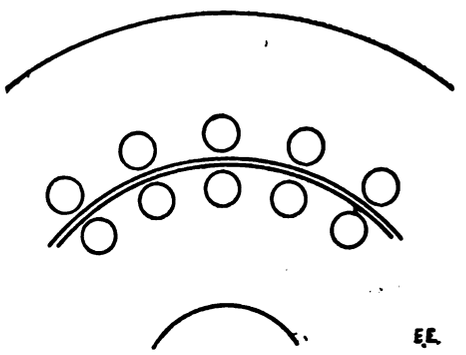

FIG. 109.

a special starting device in order to prevent the abnormally large currents which circulate in the field and armature coils from burning up the insulation. Small motors, may, however, be started without fear of any damage to the coils.

Of the various starting devices used, the most common arrangement is to have a simple resistance which may be inserted either into the field or the armature circuit. In the latter case not only is the current in the armature windings kept down, but the torque of the motor is increased at the same time (Art. 140). Special devices must, of course, be used for introducing the resistances into the armature coils at starting and then cutting them out. When the starting resistances are in the field circuit the arrangement is somewhat simpler, but it has the disadvantage of giving a weak starting torque.

156. Polyphase alternators will run as *synchronous* motors, and may be made self-starting, although they will not start against a heavy load. Let the field of such a polyphase generator be kept unexcited, and let its armature be supplied with polyphase currents. The result is to produce a rotating magnetic field which gives rise to induced currents in the pole-pieces; these currents resist the motion of the rotating field, so that the alternator field magnet tends to follow the motion of the rotating field. If free to move, the field magnet will thus be set in rotation, and run up to a speed which is but little below that of synchronism; the constant exciting current may then be switched on, and the machine will be pulled round into perfect synchronism, and maintained at the constant speed corresponding to it. If, however, the field magnet is stationary, then the armature will begin to rotate in the opposite direction, and synchronism will be reached when the speed of the rotating armature field in one direction equals that of the armature core in the opposite; it is evident that under these circumstances the field due to the poly-

* Based on a series of evening lectures delivered at the University College, Liverpool.

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phase currents will be a stationary one *in space*, although revolving relatively to the armature. As soon as synchronism is reached, of course the induced currents in the pole-pieces disappear, the field having become stationary.

This method of starting a synchronous polyphase motor is wasteful; it may be assisted by providing the pole-pieces with short-circuited copper coils. Another and more economical method is to use a small non-sychronous induction motor for running the large motor up to its speed of synchronism.

157. Attempts have been made to adapt rotary-field induction motors for working on ordinary single-phase alternate-current mains. Before this can be accomplished it is obvious that some method must be provided for producing two currents differing in phase from the single-phase alternating current supplied by the mains. One way of doing this is to arrange the two field windings of the induction motor so that their time-constants will be widely different, that of one winding being large, and of the other small. If the two windings are connected in parallel across the mains, as in Fig. 110, the currents will lag behind the E.M.F. of the mains by different amounts, the lag being considerable for the winding with a large time-constant, and small for the other. Since the two alternating fields which give rise to the rotating field must be equal in intensity, it follows that the ampere-turns in the two windings of the motor must be made equal. To secure this condition, and at the same time obtain the required difference of phase, one of the windings, W_1 (Fig. 110), consisting of a large number of turns, is connected directly across the mains; while the other, W_2, consisting of fewer turns (and hence having a much smaller

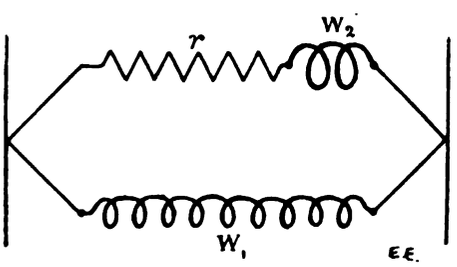

Fig. 110.

inductance), is joined in series with a non-inductive resistance, r, and across the mains. It is impossible by this method to produce a phase difference of $\frac{\pi}{2}$ (or 90deg.), since the angle of lag of each current behind the E.M.F. must have a value which is intermediate between 0 and $\frac{\pi}{2}$. But a phase difference of about $\frac{\pi}{4}$ (or 45deg.) may be obtained without difficulty. In accordance with the result deduced in Art. 143, the angle which the positive directions of the magnetic fields due to the two coils make with each other must be made equal to the supplement of the angle of phase difference. This is the arrangement adopted in the Langdon Davies motor.

158. Another class of alternate-current induction motor is that in which the armature rotates in a simple *alternating* field. To understand the operation of such a motor it will be necessary to refer to the curves of Fig. 95 (Art. 140). The full-line curve there given is the typical torque-speed curve of a rotary-field induction motor. It shows that as the *slip* increases the torque at first rapidly increases and then steadily diminishes. This effect has been fully explained in Arts. 138-140. The slip may be made to exceed 100 per cent. by rotating the armature in a direction opposed to that of the field. The torque (which will now resist the motion) will go on decreasing as the negative speed of the armature increases, and we obtain a curve such as the full-line curve shown in Fig. 111. Let us suppose that the direction of the rotating field is reversed; then instead of the full-line curve of Fig. 111, we obtain the dotted curve, which is merely the full-line curve replotted, the positive direction of the axis of *speed* being now from right to left instead of from left to right as in the first case, and the positive direction of the axis of *slip* from left to right instead of from right to left.

Let us next suppose that there are two rotating fields, of the same periodicity and intensity, one revolving right-handedly, the other left-handedly, acting on the armature at the same time. The torque due to the first field will then be represented by the full-line curve of Fig. 111, and that due to the other field by the dotted curve. For any given speed, positive or

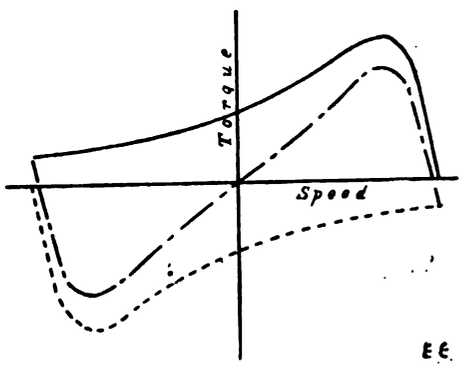

Fig. 111

negative, the resultant torque (shown chain-dotted in Fig. 111) on the motor armature is equal to the algebraical sum of the torques due to the two rotating fields. Now from the curves it is at once evident that the only speeds for which the torque vanishes are a zero speed, and one which is not far removed from the speed of synchronism. There will thus be no torque acting on the motor when it is standing still. As soon, however, as the motor is turned, either one way or the other, a resultant torque makes its appearance whose sign is the same as that of the speed; the motor will therefore gain speed, and run up to very nearly the speed of synchronism. If a load is applied to it, its speed will diminish, just as in the case of a simple rotary-field motor. And if the resisting torque due to the load is made greater than the maximum torque which the motor is capable of exerting, the armature will stop, and the torque entirely cease.

It is obvious that induction motors of this type are not self-starting, since no torque is produced by the alternating field on the armature when at rest. For starting them, an auxiliary winding must be provided on the field magnet, so arranged that the motor at starting may be temporarily transformed into a rotary-field motor. The requisite difference of phase between the currents in the two windings may be obtained by the method explained in Art. 157.

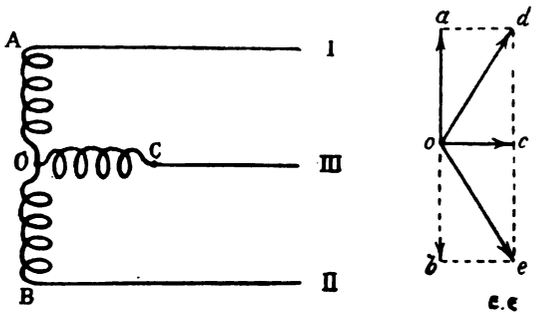

Fig. 112.

159. When dealing with polyphase systems, we regarded them as applicable only to power plants. But they are also applicable to lighting; in the latter case, however, difficulties present themselves when the circuits are unequally loaded, on account of the large variations which occur in the P.D.'s between the three mains. The regulation of the P.D.'s when the system is unbalanced must be carefully attended to, and this is the radical difficulty connected with combined power and lighting plants worked on a polyphase system. In some cases, this difficulty appears to have been successfully overcome.

160. In order to secure the advantages of the ordinary single-phase system for lighting along with those of a polyphase system for induction motors of the rotary-field

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type, Mr. C. P. Steinmetz has devised an arrangement known as the "monocyclic system," which has been used to some extent in America. The principle of this will be understood by reference to Fig. 112. A monocyclic generator is an ordinary alternator provided with a supplementary or "teaser" winding, so placed that the E.M.F.'s in the two windings are in quadrature with each other (Art. 149). In Fig. 112 A B represents the main winding; to the middle point of this, O, is connected one end of the auxiliary winding, O C, the other end of which, C, is in connection with an auxiliary main intended for supplying induction motors. In order to find the amplitudes and phase relations of the P.D.'s between the mains I., II., and III., we lay off a vector, *o a*,* to represent the P.D. between O and A due to the winding O A, and at right angles to this a vector *o c* to represent the P.D. between O and C due to O C; the resultant vector *o d* then represents the P.D. between the mains I. and III.; similarly, *o e* represents the P.D. between II. and III., while *b a* or *e d* gives the P.D. between I. and II. It is obvious that by properly adjusting the number of turns in the auxiliary winding O C, and hence the length of the vector *o c*, we can make the P.D.'s represented by *o d* and *o c* bear any desired relation to *e d* as regards amplitude and phase. The mains I. and II. would be used for lighting, while polyphase motors would be connected to I., II., and III. The system therefore combines the characteristics of ordinary single-phase working with the advantages of a polyphase system for induction motors.

(To be concluded.)

INSTITUTION OF ELECTRICAL ENGINEERS, Feb. 25.

Sir HENRY MANCE (president) in the chair.

We gave the ballot list last week. After formal business the first matter was Mr. Hollins's reply to the discussion on his paper on electric interlocking.

Mr. Hollins said that if in his paper he had failed to do full justice to any system, it should be put down to simple oversight on his part and not as implying any belief that the system was defective in any way. He might also say that he had discovered that some of his description of the system used on a portion of the Caledonian Railway would require correction. He regretted the mistake, and it had arisen from his taking the verbal description of the manufacturer. Taking the speakers in their proper order, he came first to Mr. Wyles. On the subject of the possible action of lightning, Mr. Wyles said that he had never heard of lightning releasing the Sykes apparatus. Possibly because on the South-Western it stood normally released, and the interval in which such an action was possible was a short one. He (Mr. Hollins) had had reliable information that on other lines cases had occurred, but that the signalman always knew what had happened, so that no mistake was caused. That showed that the lightning current was, as he had stated it, positive. He thought, at any rate, that the evidence was sufficient to justify the experimental reversal of the coils. Of course, in saying that, he had not forgotten the possibility of an induction current from a neighbouring wire. He (Mr. Hollins) never laid claim to his paper being the first on block signalling and electric interlocking; but as a matter of fact the papers of 20 years ago mentioned by Mr. Langdon gave very little information on electric interlocking. He might also say, in answer to a question of Colonel Addison's, that the results given in the paper were obtained under normal conditions of working. No special result was tried for in view of the paper, and, as a matter of fact, they had obtained even better results since the figures were taken, although there had been almost continuous wet weather. He might also remark that the exceedingly few failures they had had on their 400 rail contacts were all on the side of safety. It was part of working of the system that each part should be regularly inspected and the parts oiled and attended to at intervals of not less than 10 days. The work was thoroughly systematised, and he might say that a better and more loyal staff for carrying it out no man could have or wish for. In this connection a special word should be given to Mr. Saich, the son of his (Mr. Hollins's) predecessor. As to treadles in general, if people thought they were going to put down a treadle or anything else of the kind and leave it unexamined, they would be disappointed if they expected it to go on working all right indefinitely, and he thought they deserved to be. He was quite certain that the Sykes and the Siemens and the Spagnoletti contacts were good ones, but they would all require attention. In the nature of things it must be so with any mechanism. If for no other reason, there must be nuts and bolts about it and its attachment; and every railway man knew how the nuts kept working loose on the fish-plates and required to be attended to. The vibration of heavy engines and trains must affect any apparatus so adjusted and fixed, and if it was not looked to from time to time it was not giving the thing a fair chance. He (Mr. Hollins) laid no claim to the invention of the friction clutch. It was invented in New York many years ago. All he could possibly claim was the adaptation of it. His friend Mr. Spagnoletti had made some comparisons between his own system and the one described at length in the paper. He would say little about that, but when Mr. Spagnoletti went on to complain that he (Mr. Hollins) had given an undue prominence to one system in comparison with others, including Mr. Spagnoletti's own, he could only say that he had described in full the system which he knew most about. But in reference to the charge of giving a meagre and in part inaccurate description of Mr. Spagnoletti's instruments, he would ask whether Mr. Spagnoletti had forgotten that he had been asked for the loan of instruments or drawings, or for a written description, so as to ensure accuracy? When, in reply to that, he asked him (Mr. Hollins) to deal with his system from a verbal description, how could he reasonably complain of the space allotted to it, or a possible mistake occurring on a point of detail? As for electrical rail contacts, they were devised many years previous to 1873. As for the Metropolitan—not the District—he had been unable to trace anything like all the trains Mr. Spagnoletti had spoken of, though he had been on the watch for them ever since the figures had been given. Moreover, as to the "disadvantages of tunnel working," should it not rather have been the advantages of being in tunnel? Of course, he knew that there was the darkness which made inspection and adjustment not quite so easy, but there were the great advantages of practically permanent temperature and the absence of frost, snow, and rain. He (Mr. Hollins) had four contacts in tunnels, and they had worked very well. In fact, he had had about one failure in 12 months from then. He had never expressed an opinion as to whether the lock should be fixed on the lever, but only stated that as a matter of fact it had been. It was not the case that in his system the locking must necessarily be over the lever, and in some instances it was not. He would strongly urge that the signalman should not work by the lock indication, but by the block indication, leaving the lock to act as a check only. The lock indications were really merely to show whether the lever could be used. As to Mr. Goodenough's communication, there had probably been some misunderstanding, for all the conditions he had laid down as essential had been complied with. Mr. Shoolbred's, and, to some extent, Major-General Webber's, suggestion that the work of the older inventors might be consulted had been followed, and he thought with advantage. Mr. R. W. Weekes had caused some amusement by remarking that nothing had been done to stop the engine. It might be news to Mr. Weekes, but he could tell him that something had been proposed in that direction. One of the propositions went so far as to provide that, when two engines got on to one section, an alarm should sound on both engines and steam should be shut off in the following engine. He (Mr. Hollins) had compiled abridgments of many electrical patents relating to matters connected with the subject, and might, perhaps, bring some of these results before the members some day. What he had learned from these patents had been such as should induce a spirit of modesty among the successful designers of the present day. One point remained—namely, that Mr. Hollins considered that too much stress had been laid by some of the speakers on not altering the present block instruments when electric interlocking was added to the existing block working. There would be practically no saving in the cost, and the assumed difficulty of a change of system had not been found to exist in fact. On the Great Eastern suburban system they had changed from Tyer to Sykes without the slightest hitch. Of course, it was done carefully. With a single-needle system they could not have possibly got the work done, the number of necessary movements in such a system being so much greater. In one case by the change they effected a saving of something like 33,000 movements per day.

The Chairman said the thanks of the Institution had already been given to Mr. Hollins for his paper, which was one that wanted studying line by line. He, however, thought he might express his thanks to Mr. Hollins for his not less able and interesting reply to the discussion on the paper.

Mr. Ernest Wilson then read his paper on

THE RELATIVE SIZE, WEIGHT, AND PRICE OF DYNAMO-ELECTRIC MACHINES.

BY ERNEST WILSON, MEMBER.

PART I.—SIZE OF MACHINE.

In the design of dynamo-electric machines the rate at which work is done on or by a machine at a given speed of rotation is, amongst other things, an important consideration. The output of a generator of electricity is stated, in the case of steady currents, when the potential difference in volts at the terminals of the machine, the current in amperes supplied by the machine to the external circuit and the revolutions per minute of the machine are given. This also holds with alternate currents on non-inductive loads. The quantity

$$\frac{\text{Volts} \times \text{amperes}}{\text{Revolutions per minute}},$$

which is here called the "mass factor," bespeaks, with certain limitations, the size or mass of the machine. The limitations, to be treated fully, are somewhat complex; for instance, the

* All the vectors here referred to are supposed as usual to denote rotating vectors whose projections on the vertical axis give the corresponding values of the P.D.'s.

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potential difference at the terminals of a generator, for a given speed of rotation, can be varied by varying the conductors

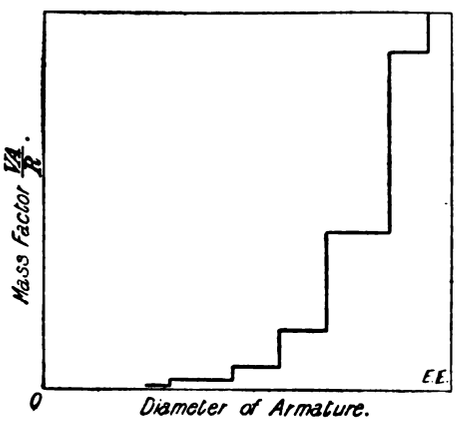

FIG. 1.

on the armature, or, again, by keeping the number of conductors constant and varying the field. In the former, the percentage increase or decrease of insulation material has to be considered when dealing with wide limits, and the consequent variation of current density in the conductors if the same output is required, involving the important question of compliance with given temperature specifications; in the latter, the weight of iron in the field magnets can be varied, but since the bed-plate, bearing brackets, armature, etc., form a large proportion of the total weight of the machine, the consequent variation in this total weight is smaller. Then, again, the ultimate temperature of the armature on load is a function of the speed; armature reaction and efficiency variation with speed have to be considered, and so on. There is, however, no doubt but that this mass factor can be of considerable use to the designer of dynamo-electric machines; for instance, when dealing with a given type of machine, such as the two-pole with drum armature, so largely used at the present time for central-station work, a salient feature of such a machine is the diameter of the armature. Another feature is the breadth of the magnets parallel with the armature shaft. Let a curve be drawn in which the ordinates are the mass factors, and the abscissæ the diameters of the armatures, according to any good practice. The curve in Fig. 1 illustrates this relation. For each diameter a series of values of $\frac{V \times A}{R}$ are given, each corresponding to a series of breadths of magnet limb for a given thickness, or a series of thicknesses of magnet limb for a given breadth, or breadth and thickness may each be varied simultaneously. Such a curve for a given type is of use to the designer, and is the outcome of actual experience in the best proportions for a given output. An important feature of this curve is that the diameter at each successive increase covers a greater range of variation in the mass factor—that is to say, the diameter tends towards a maximum. It is, of course, clear that the practice of one firm may produce a different curve to the practice of another in the design of the same type of machine, and each firm may turn out equally good machines. The quantities involved may be

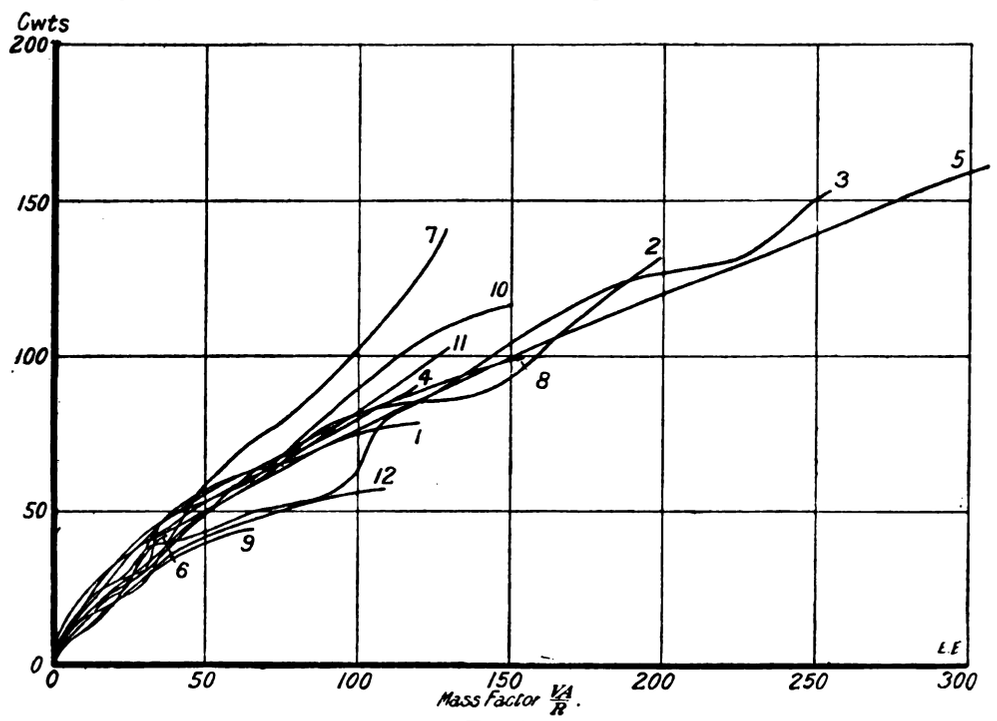

FIG. 2.

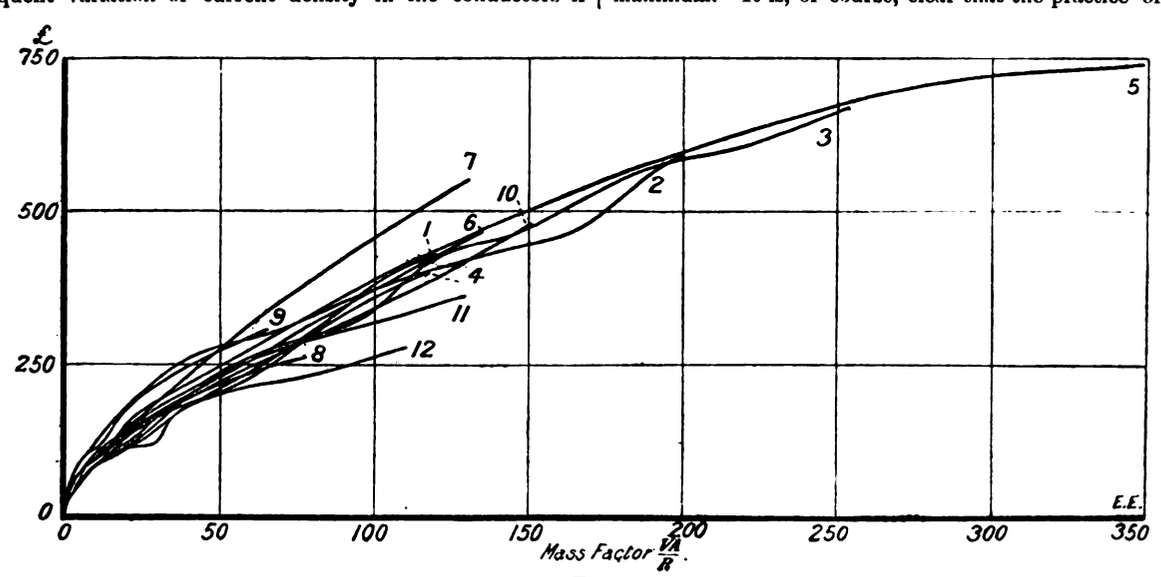

FIG. 3.

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TABLE I.

1.—Two-Pole Drum Armature. 100 Volts.

KW.	Revolutions per minute recommended.	V A / R	Net weight.	Price f.o.r.
			Cwts.	£
1	1,500	0 67	4	33
3	1,120	2·7	6½	42
4	1,020	3·9	9	55
5	1,090	4·6	13	66
7·5	980	7·6	16	74
9	800	11·2	20	92
12	800	15	24	105
22	850	25·9	30	130
30	830	36	46	170
40	690	58	60	230
40	520	77	66	295
50	540	93	72	365
60	500	120	78	430

2.—Two-Pole Drum Armature. 100 Volts.

KW.	Revolutions per minute. Maximum quoted.	V A / R	Approximate weight.	Price delivery to carrier.
			Cwts.	£
23	765	30	40	230
29	735	39	45	260
40	705	57	57½	280
54	720	75	65	315
54	655	82	72¼	335
54	580	93	79½	360
75	575	130	85	420
75	515	146	90¼	440
75	460	163	104	460
100	505	198	132	590

3.—Two-Pole Drum Armature. 110 Volts.

KW.	Revolutions per minute. Maximum quoted.	V A / R	Weight of complete machine	Price delivery in London.
			Cwts.	£
8·2	1,000	8·2	12	90
11	1,000	11	14	110
13·7	1,000	13·7	17	120
16·5	900	18·3	22	130
22	900	24·4	25	160
24·2	800	30·2	37	180
33·5	800	41·9	40	210
40	750	53·5	44	250
51	600	85·2	53	300
60	600	100	62	340
62·7	600	104	72	360
70	600	117	84	420
75	520	144	100	460
92	520	178	120	550
115	520	222	130	610
132	520	254	153	670

4.—Two-Pole Drum Armature. 105 Volts.

KW.	Revolutions per minute. Maximum quoted.	V A / R	Approximate net weight.	Price f.o.r.
			Cwts.	£
1·6	1,250	1·3	3·5	30
3·1	1,250	2·5	5·7	38
4·2	1,150	3·6	7·5	48
5·2	1,000	5·2	10·5	58
8·4	1,100	7·6	14·5	72
10·5	1,000	10·5	18·5	88
12·6	950	13·3	21·5	100
15·8	1,100	14·3	22	110
15·8	900	17·5	26	125
21	830	25·3	35	146
26·3	740	35·5	45	175
31·5	630	50	55	205
47·3	580	81·5	70	312
63	530	119	90	400

5.—Two-Pole Drum or Gramme Armature. 50 to 250 Volts.

KW.	Approximate revolutions per minute.	V A / R	Net weight.	Price f.o.r.
			Cwts.	£
11	1,200	9·2	22½	110
18	1,035	17·4	29½	140
30	845	35·5	41	205
50	730	68·5	60½	300
78	650	120	85¾	430
115	585	197	119	580
165	535	308	160½	720
214	490	437	220	845
270	460	587	298	990

6.—Two-Pole. 110 Volts.

KW.	Revolutions per minute.	V A / R	Approximate net weight.	Price f.o.r.
			Cwts.	£
4·9	1,200	4·1	8½	60
7·1	1,200	6	11½	75
10	1,200	8·3	14	90
14	1,100	12·7	16½	115
18	1,000	18	19¼	135
22	900	24	26	155
28	850	33	40	180
37	775	48	36	225
50	650	77	—	312
75	550	136	—	470

7.—Two-Pole. 100 Volts.

KW.	Revolutions per minute.	V A / R	Net weight.	Price delivery to carrier
			Cwts.	£
1·2	1,600	0·75	2	36
2·5	1,550	1·6	3	48
4	1,400	2·9	5¾	60
6 6	1,325	5	7½	75
10	1,200	8·3	9½	87
13	1,050	12·4	12¾	100
18	900	20	20	145
24	900	27	24	170
33	900	37	37¾	220
40	800	50	57¼	275
50	700	71	75	360
62	480	129	142	550

8.—Two-Pole Gramme Armature 65 to 150 Volts.

KW.	Approximate revolutions per minute.	V A / R	Net weight.	Price, packed, f.o.r. London.
			Cwts.	£
7·5	880	8·5	14·6	88
9	830	10·8	17·2	95
12	780	15·4	20·9	110
15	720	21	25	125
18	670	27	29	156
24	630	38	40	180
30	550	54	53	223
39	500	78	69	260
50	460	109	85	—
61	400	152	98	—

9.—Four-Pole. 65 to 110 Volts.

KW.	Approximate revolutions per minute.	V A / R	Net weight.	Price f.o.r.
			Cwts.	£
3	1,500	2	2·4	55
7	1,300	5 4	7	88
12	1,200	10	11·3	121
18	1,100	16·4	18	159
25	700	36	33	236
36	550	65	44	297

10.—Two Pole. 65 to 220 Volts.

KW.	Revolutions per minute. Maximum quoted.	V A / R	Net weight.	Price.
			Cwts.	£
5 8	1,300	4·5	12·9	60
11·6	1,100	10·5	16·7	95
16·3	900	18·1	29	130
22·5	800	28	41·2	162
33·1	600	55	55·5	230
56·7	500	113	100	375
75	500	150	116	475

11.—Two Pole Drum Armature. 100 to 200 Volts.

KW.	Approximate revolutions per minute.	V A / R	Net weight.	Price f.o.r.
			Cwts.	£
3	1,500	2	5½	40
6	1,300	4·6	7½	60
12	1,100	10·9	14	93
18	950	19	22	123
26	900	28·9	30	159
36	850	42	42	199
50	750	67	60	252
65	680	96	81	307
80	620	129	104	363

12.—Four Pole Drum Armature.

KW.	Revolutions per minute.	V A / R	Net weight.	Price f.o.b. London.
			Cwts.	£ s.
4½	1,050	4·3	6 7	63 12
9	850	10·6	15	91 19
17	700	24·3	23·5	126 0
25	675	37	35	177 16
40	600	66·7	48·2	220 1
60	550	109	56	271 17

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varied through fairly wide limits. The salient features of other types of machines, whether for steady or alternate currents, might be treated in the same manner.

Part II.—Weight and Price.

The object of this part of the paper is to investigate the way in which the weight and price of dynamo-electric machines, as constructed by different firms, vary with the variation of the mass factor. The figures in Tables I. and II. refer to English manufacturers, and were recently (October, 1896) sent to the author (except in one instance—No. 3, Table I.). They therefore represent latest practice. The data contained in Table I., from which the curves in Figs. 2 and 3 have been plotted, refer to steady-current dynamos complete for belt driving. In most cases the mass factor has been deduced from machines giving about 100 volts, and the headings in Table I. give the curve number in Figs. 2 and 3, and the type of machine to which the

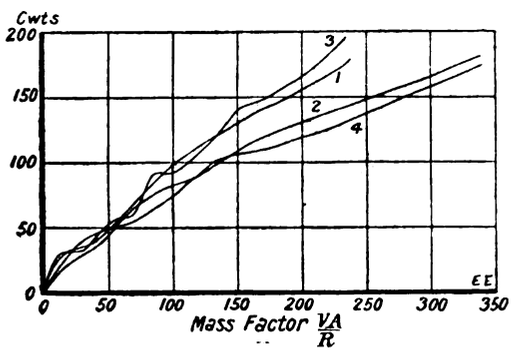

Fig. 4.

figures refer. With regard to the weight of the dynamo, it must be remembered that the power it supplies at a given number of revolutions per minute can be varied considerably without affecting the net weight. Due notice must be taken of efficiency, and the compliance of the machine with given temperature specifications. Broadly speaking, the curves in Fig. 2 show that the weight increases initially somewhat rapidly as the mass factor increases, and then develops into a fairly straight line. With regard to price, the initial increase is more marked. Now that the curves are drawn one naturally compares them with one another, and it is interesting to note how, both in regard to weight and price, the different firms in the manufacture of two-pole machines have come to work, with one or two exceptions, nearly on the same lines. In the comparison of the curves with one another one should take due notice of efficiency, and the compliance of the machine with given temperature specifications. The weight and price of the multipolar machines, No. 12, are lower than any quoted for a mass factor of 110. It is well known that multipolar dynamos are lighter and cheaper than the ordinary two-pole machine for large sizes, but there is not sufficient data at the author's disposal to fix definitely the point where this becomes important.

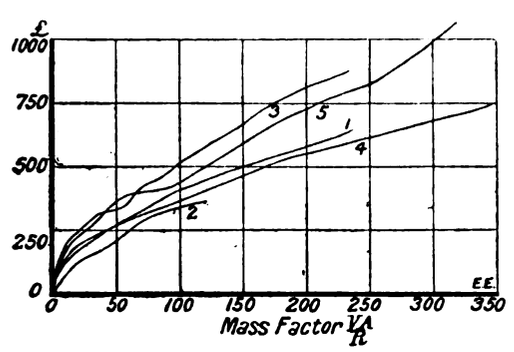

Fig. 5.

In the case of alternate-current dynamos the mass factor is equally useful for comparison of weight and price. Since in a given machine the frequency and volts at the terminals on open circuit are each proportional to the revolutions per minute, it follows that the mass factor is independent of frequency if we assume equal armature reactions. We must not forget that the product of volts and amperes is only permissible when the current is in phase with the potential, as on non-inductive loads such as glow lamps. In the transmission of power to motors, for instance, the current may or may not be in phase with the potential. In the latter case the current must be increased for the transmission of the same power. Then, again, there is the loss in the pole-pieces, which may or may not exist in a given machine. For a given speed of rotation, if we vary the frequency, we must vary the number of poles; but this requires an inverse variation in the field to give the same volts for the same armature. This might have an effect upon both weight and price, but of course the choice of frequency is dependent upon other external considerations. The curves in Figs. 4 and 5 have been plotted from the data contained in Table II., and refer to single-phase machines without exciters, complete for belt driving. An inspection of the curves shows again that the initial rise is greater in the case of price than in weight. The difference between the costs by the different makers is more marked than in the case of steady-current machines.

Taking the whole of the curves collectedly with regard to weight, the steady-current machines and alternators are about

TABLE II.

1.—Up to 5,000 Volts, any Frequency.

KW.	Revolutions per minute (approximate).	VA/R	Net weight (approximate).	Price f.o.r.
			Cwts.	£
5	1,500	3·3	12	75
15	1,000	15	25	150
30	750	40	40	240
50	550	91	90	380
75	500	150	130	500
100	420	238	180	650

2.—1,150 to 2,300 Volts, Frequency 125.

KW.	Revolutions per minute.	VA/R	Net weight.	Price f.o.b. London.
			Cwts.	£
30	1,500	20	22	125
60	1,500	40	35	173
90	1,250	72	70	293
120	1,070	112	84	350
300	682	440	198	973

3.—1,000 to 1,050 and 2,000 to 2,100 Volts, Frequency 100.

KW.	Revolutions per minute.	VA/R	Net weight.*	Price f.o.r.
			Cwts.	£
12·5	1,200	10·4	28	200
25	857	29·2	37	285
30	857	35	38	310
37·5	666	56·3	56	340
45	666	67·6	57	420
50	600	83·3	90	450
60	600	100	92	540
75	500	150	141	660
80	500	160	144	705
100	428	234	196	880
250	300	833	378	1,870

4.—2,100 Volts, Frequency 83·5.

KW.	Revolutions per minute.	VA/R	Net weight.	Price f.o r.
			Cwts.	£
15	835	18	28	185
25	716	35	44	230
40	626	64	52	295
65	556	117	88	390
100	500	200	118	550
150	417	360	185	750
200	358	559	235	980

5.—1,000 to 1,050 and 2,000 to 2,500 Volts, Frequency 75.

KW.	Revolutions per minute.	VA/R	Price in London.
12·5	1,125	11·1	£180
20	750	26·7	250
30	643	46·7	350
50	560	89·3	410
80	500	160	630
114	450	253	825
120	375	320	1,080

* These weights have been deduced by the author from gross weights by deducting 20 per cent. from the first three, 10 per cent. from the next seven, and 6 per cent. from the last.

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equal up to a mass factor of 100 or 120; beyond this, the alternators would seem to be somewhat heavier. In regard to price, the alternators would seem to be dearer all through.

It is almost unnecessary to add that the mass factor can be used in connection with motors as well as generators.

I wish to thank Messrs. Woodfield, Tomkins, and Strutt, demonstrators in the Siemens Laboratory, King's College, London, for the help they have given me in the preparation of this paper. I have also to thank Mr. C. J. Evans for checking the figures and curves.

Discussion.

Mr. Mordey was called upon by the **Chairman** to open the discussion, but said that he was not prepared to say anything on the subject at such short notice.

Mr. W. B. Esson called attention to a discrepancy between the large curve diagrams on the wall and the reproductions of them at the end of the paper. Which were they to go by?

Mr. Wilson said he would prefer that the curves printed with the paper should be taken as the basis of discussion.

Prof. Silvanus Thompson considered that the Institution was indebted to Mr. Wilson for a useful contribution to their knowledge of dynamo machinery. The information they all desired was usually that which it was impossible to get, and, therefore, if it was not what they most wanted, yet they should be grateful to Mr. Wilson for the information he had been able to extract from the manufacturers. It was doubtful if the quantity called in the paper the mass factor—*i.e.*, output/revolutions—was really the best basis of comparison. The proper basis of comparison should be the peripheral velocity, because the E.M F. depended upon the linear velocity with which the field was cut, and not or only indirectly upon the simple angular velocity. It resulted in different kinds of machines with different capabilities in the matter of speed being classed together. Using the information they had, if in Fig. 1 [The curve, $y = V A/R$, x=diameter of armature] they multiplied both ordinate and abscissa by the number of revolutions per minute, only the scale of the curve was changed, the angular velocity cancelled out, and the general form of the curve expressed the fact that the output increased in proportion to the square of the linear velocity. In large dynamos a better use per pound was being made of the iron and copper if they were so constructed that they could be run at a higher peripheral velocity than small ones, but not otherwise. There was one point to which he thought progress was tending. Some years ago they had two papers from Mr. Sayers, the whole point of which was that it was possible to make a dynamo of less weight and cost if it was designed so as to get rid of the demagnetising effect of the armature or arrange so as to compensate for it. In spite of the larger amount of work in winding, he believed that in the Sayers armature the saving indicated enabled the machine to be produced at a lower price than where there was no compensation. If it were possible to find a reasonable way in which the armature could magnetise its own field magnets without a field winding in shunt or series at all, there would be a great saving. Prof. Thompson then added that about 14 years ago it had been laid down in a paper that motors should be of different design to dynamos, that motors should have small field magnets and large armatures, the whole object being to reduce weight of the motor to a minimum. That was an example of the danger of seeking one end only, for that idea seriously impeded the progress of motors Little had been said by Mr. Wilson about efficiency. Some firms might work to Admiralty rules as to temperature, etc., and others to much less rigorous conditions, which would make a great difference to the comparative weights of copper used. Information on the subject of arc lighting machines which had always the same amount of heating in the armature would be interesting. He (Prof. Thompson) did not understand why Mr. Wilson called a continuous current "steady," as though implying that the other was an unsteady sort of affair.

Mr. W. A. Ravenshaw saw the influence of the drawing office in the shape of some of the curves. Moreover, some firms considered not so much prime cost as the prices of another firm. Thirdly, some machines were made in sets, so that the armature size did not increase regularly, but by leaps, different sizes of machine having the same length of armature. That would give the wavy curves. With Gramme armature machines the loss from the cross field causing eddy currents became appreciable on sizes over 30 kilowatts. Cast iron or steel might be used for bed-plates, giving again another difference in weight. Discounts differed, so that the price curve did not represent the true price.

Mr. E. K. Scott, in reference to this, said he knew a case where 20 per cent. and 2½ per cent. was given, and 2½ per cent. more for cash. Other firms gave 15 per cent., but the curves represented list prices, not the net selling price.

Mr. Geipel suggested that it would be better to call the "mass factor" what it really was—namely, watts per revolution—as they did in the Brush Company's designing department. It would be more useful to give the price of the machine per watt.

Mr. Sam Mavor said that Sayers winding had proved successful in use, the extra work being more than recouped in machines above six, eight, or nine kilowatts. The most valuable curve would be not on a basis of list price, or even net price, but prime cost.

Mr. W. B. Esson had endeavoured to get his own machine identified among the curves, but had failed. Nor had he been enabled to find those of any other makers. Where Mr. Wilson got his figures from was a mystery to him. Mr. Esson referred also to the difference the temperature specification made.

Mr. Wilson, replying, said the curves on the wall were not identical with the ones in the paper, but were replotted from the same figures. In reference to Prof. Thompson, if there were no diameters of armatures in the lists, he could not bring them in. He took the thing from the point of view of the practical engineer: given the output and speed in revolutions, what is the machine I want? He had confined himself to two-pole machines and to alternators, because in those he had a large amount of data compared with those obtainable for other machines. As for "steady" current, it might be said that the alternating current was continuous so long as it kept flowing. The "steady current"—well it was steady, and he thought the term better than continuous. He was pleased to hear that the Sayers machine gave good results. He knew the price of a machine depended upon the demand and the buyer, as well as mechanical considerations. He could only give them what he knew. The same thing applied to temperature, which was not in the price-list. He was much surprised that Mr. Esson had been unable to identify any of the machines from the curves. There was no doubt that alternators came out dearer than direct-current machines, and that was without the exciters, which, of course, would add still more to the weight and expense. He would be glad of information on multiphase work, and believed that the three-phase machine would come out lighter and cheaper than the direct current.

The **Chairman** said many firms used a similar factor to the "mass factor." One he knew called it the "output" factor. In the course of business manufacturers tried to level down their prices to a competing machine. There were also the questions of efficient commutation and non-sparking, and so on, all of which affected the price.

FORTHCOMING EVENTS.

The following are some of the announcements for forthcoming week:

To-day (Friday). — Institution of Civil Engineers' students' meeting (Expansion Bearings for Girders, Messrs. Baynham and Dobree).—Royal Institution (Mr. Shelford Bidwell on "Some Curiosities of Vision"), 9 p.m.—And at Paris, Civil Engineers of France meeting.

To morrow (Saturday).—Royal Institution, 3 p.m. (The Right Hon. Lord Rayleigh on "Electricity and Electrical Vibrations" Lecture I).—Conversazione of the Junior Engineers, Westminster Palace Hotel, 7.30 p.m.—General Electric Company's dinner.

Monday, March 8.—County of London and Brush Provincial Company's meeting (Winchester House), 2 p.m.—And at Manchester, the Northern Society of Electrical Engineers (Mr. Wilson on Methods of Charging).

Tuesday, March 9.—Royal Institution (Dr. Waller on Animal Electricity), 3 p.m.—Institution of Civil Engineers (discussion of the papers on the main drainage of London, and paper to be read, time permitting, on "The Mond Gas-Producer Plant and its Application," by Mr. H. A. Humphrey).

Wednesday, March 10.—Society of Arts ("The Prevention of Fires Due to the Leakage of Electricity," by Mr. Frederick Bathurst), 8 p.m. Mr. W. H. Preece, C.B., F.R.S., will preside.—Crystal Palace Wednesday lecture (Electrical Discoveries and Inventions during the Queen's Reign, by Prof. Silvanus Thompson, D.Sc., F.R.S.), 8 p.m.

Thursday, March 11.—Institution of Electrical Engineers (at the Civil Engineers, Great George-street, Cable Repairs off Cape Verde, by Mr. Benest), 8 p.m.—Royal Institution (Prof. Gardner on Early Greek Monuments)—Society of Arts, Indian Section ("Prevention of Famine in India," by Sir Charles Alfred Elliott, K C.S.I., secretary to the Famine Commission of 1878, and late Lieutenant-Governor of Bengal; Lord George Hamilton, Secretary of State for India, will preside), 4.30 p.m.

Friday, March 12.—Physical Society (Mr. Barlow on Structure in Crystals and Molecules), 5 p.m.—Royal Institution (Prof. Arthur Smithells on the Source of Light in Flames), 9 p.m.—Civil Engineers' students' meeting ("The Inverness Section of the Inverness and Aviemore Railway," by Mr. H. F. Brand; Mr. J C Hawkshaw will preside), 8 p.m.—Junior Engineers (Mr. Beckton on the Protection of Buildings from Fire), Westminster Palace Hotel, at 8 p.m.

Saturday, March 13.—Royal Institution, Lord Rayleigh's second lecture, 3 p.m.—Also, at West Hartlepool, North-East Coast Engineers' meeting ("The Machine Cutting of Accurate Bevel and Worm Gears," by Mr. J. H. Gibson), 6 p.m.

Mance's "Methods."—Our staid and scientific contemporary *Nature* has been perpetrating a joke. Alluding to what happens when the President of the Institution of Electrical Engineers takes the chair, it is remarked that whereas it used to be Mance's Methods of finding faults, that has now given place to Mance's methods of finding merits in the papers read before him.

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THE

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TO CORRESPONDENTS.

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All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C Anonymous communications will not be noticed.*

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LITIGATION—WASTED TIME AND MONEY.

We are, of course, unable to comment upon the case of the "meters" which is now being tried in the law courts, but arising out of that and similar cases comes the question of legal procedure. Again and again during the progress of this case, as, indeed, in many others, we have heard the remark, "what a waste of time," and less often, but far from infrequently, the remark, "what a waste of money." Really, at first sight, when you come to see half a dozen Fellows of the Royal Society, the *crême de la crême* of the scientific world, dawdling about a law court for a week or two in order to combat one another's evidence, it does seem that there is a waste of energy, talent, time, and money, but upon further consideration it will be very difficult to suggest a much better system than the present. Some time ago we had occasion to discuss this question, and then made a suggestion which commended itself to many of our legal friends, so that to recur to the idea of a scientific man to act in these cases with the judge need not again be considered. We are afraid there is no help for this huge waste, and the reasons are not far to seek. In the first place, assume that every judge who tried a scientific case was of the calibre of Lord Rayleigh, possessed of his knowledge, experience, and attainments, we doubt if that would shorten the case very much. The judge is practically compelled to hear *all* the evidence, and neither side will make an admission telling against them till the evidence compels them so to do. It may be said that a judge has power to stop the case when he is convinced. That is so; but each judge has learned by long experience that he is never sure of having heard all the points till the last word is spoken. A tale often told of a judge anxious to expedite matters may be told again. It has nothing to do with a scientific case, but with a case of burglary and a slow, methodic, conscientious policeman. To the tale: A man was being tried for burglary. The evidence was pretty strong against him, but he had a counsel who was not slow to seize any chance in his favour. Well, our slow, methodical policeman was giving evidence, and came on to state the details of measurements of the *two* boot-marks the burglar left behind him on the soft ground. Almost before the details could be heard, counsel cried to his client: "Show the judge and the jury your left leg"; and up came, to the astonishment of the audience, a wooden leg. The judge jumped to the conclusion this settled the case in the man's favour, and asked the jury; they thought so, too, and said, "Not guilty." All the time the poor policeman had been trying to get in a word, but it came too late—the man was free. The explanation the policeman was going to give, but did not, was to the effect, so peculiar were the measurements, that probably one set must have been caused by a man with a wooden leg who had fastened on a boot to this leg to throw the police off the right scent. We cannot vouch for the truth of this tale. It was told us by an eminent legal gentleman as one well known, and was given to us in proof that a judge, whatever his capacity or intelligence, was perforce ready to

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patiently listen to all the evidence put before him. How, then, will any change of system prevent litigants fighting strenuously for every point they think will tell in their favour, and every counsel so cross-examining as to try and break down the points made by his opponents? When it is becoming evident that a minor point will have no influence on the case one way or the other, a few words from the judge to the effect "but that is not material, is it?" generally causes counsel to drop the matter or to summarise the point he is relying upon, which may, of course, have been too much hidden in the war of words. Suggestions have been made that many cases involving mechanical appliances and scientific principle would better be settled by arbitration before a man of science. The opposing parties would argue every point just the same. The one side would hold that its scientific interpretation was the correct one; the other side would urge that finality had not yet been reached in scientific matters, that the other side was not infallible, and, in fact, that its interpretation was the only true one. Then the beaten side would not give in. They would try to upset the arbitrator's decision in the law courts. This is human nature. It is, of course, very easy for a man who hates the precincts of a law court, and feels the waste of the hours he is spending there, to ejaculate an anathema against this waste, but when he comes seriously to consider what other course he would pursue to obtain a just decision between man and man, the difficulties are not so easily surmounted. The looker-on not directly interested in either party involved in a case sees most of the mistakes made on either side—mistakes that unavoidably lengthen the case; but, again, mistakes cannot be avoided. Certainly arbitration would not get rid of them. Thus we are fain to acknowledge an *impasse*. The wasted time and money seems awful, but how to avoid it is the difficulty. Who can solve the problem?

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

THE JANDUS ARC LAMP.

SIR,—In a short article on the "Jandus Arc Lamp" in your issue of February 26, 1897, you state that the makers of the lamp have been unable to supply you with information as to the relative efficiency between the ordinary and enclosed type of arc lamp respectively. You then refer to me as claiming that as between lamps taking the same power there is "a slight excess of illumination from the enclosed arc."

It might readily be inferred from your article that my measurements apply to the Jandus lamp, which is not the case. As the Electric Arc Light Company, U.S.A., who own basic patents on the enclosed arc in Great Britain, will soon have their new high-efficiency lamps on the market here, I trust that the public will in no way connect my name with any other than the original American enclosed arc lamp—the "Pioneer."—Yours, etc.,

L. B. MARKS, M.M.E.,
Chief electrician to the Electric Arc Light Company, U.S.A.
Savoy Hotel, March 3, 1897.

[The writer of the notice of the Jandus arc lamp in our last issue had no intention of suggesting that Mr. Marks's experimental results were obtained from that lamp, but merely took the opportunity of making the remark that information was obtainable from American sources with regard to enclosed arcs that is not obtainable here. Indeed, the American and French papers have lately had a good deal to say with regard to the enclosed arc lamp and Mr. Marks's researches thereon. Mr. Marks informs us that in the more recent forms of this lamp as developed by him for the Electric Arc Light Company, the double globe is avoided—a recess at the top of the lamp serving all purposes. We hope next week to find space to discuss the question more fully.—ED. *E. E.*]

THE LOCAL DISTRIBUTION OF ELECTRICAL POWER IN WORKSHOPS.

SIR,—Being very much interested, as you no doubt are aware, in above subject, we read with pleasure the opening sentences in Mr. E. K. Scott's articles on above subject, but we were very much surprised to find we were familiar with the wording of several paragraphs, and on looking further into the matter we find that the paper read 12 months ago by our Mr. Daniel Adamson before the Manchester Association of Engineers had evidently been of great assistance to your writer. We give below in parallel columns one extract from each in support of this statement:

Extract of paper by E. K. SCOTT *in* ELECTRICAL ENGINEER *of January 1, 1897.*	*Extract from paper by* Mr. DANIEL ADAMSON, *of Hyde.*
Even then, however, electricity has not done with it, because with the three high rolls used at these works the elevating tables on either side of the rolls, although they are raised and lowered by hydraulic power, are traversed across from one set of rolls to the next by means of motors, and the live rolls on these tables are also driven by motors. The whole of the operations are controlled by men stationed at switches wherever it has been convenient to place them; very few, if any men, coming near the red-hot masses of metal.	Even then, however, electricity has not done with it, because with the three high rolls used at these works the elevating tables on either side of the rolls, although they are raised and lowered by hydraulic power, are traversed across from one set of rolls to the next by means of motors, and the live rolls on same are driven also by motors. The whole of these operations are controlled by men stationed at switches wherever it has been found convenient to place them; and it is a very curious sight to see these masses of red-hot steel handled by the machinery, acting apparently on its own volition, because of course there are no men near the actual place of operation.

There are other traces of similarity in the articles, but the above is the most noticeable instance, and we write to ask whether you do not think some acknowledgment should have been made.

We think it as well to correct one point that occurs on p. 50 of your issue for January 8, as Mr. Scott does not appear to have read our paper carefully. We refer to his table "No. 2.—List of Powers"; this is not from any article by Mr. Flather in *Engineering Magazine*, but from Mr. Flather's book on "Dynamometers," and was quoted in an article in the *Engineering Magazine*, on page given, by Mr. George Richmond, and this is the reference given in the paper by Mr. Daniel Adamson.—Yours, etc.,

JOSEPH ADAMSON AND CO.
Hyde, Cheshire, February 25, 1897.

[Mr. Scott has given a fairly complete bibliography at the end of his papers, where Mr. Daniel Adamson's paper is duly acknowledged and credited.—ED. *E. E.*]

SHEFFIELD.

REPORT ON TRAMWAY TRACTION.

(Continued from page 270.)

REMSCHEID.—Population, 48,000.

In Remscheid the deputation were received by Captain von Hagen, the managing director of the company, who conveyed them over the whole of the lines in a special car, and gave valuable information and statistics relating to the tramways. Remscheid is a very hilly town with many narrow streets, and as there is a great similarity in this respect to the conditions under which the tramways will

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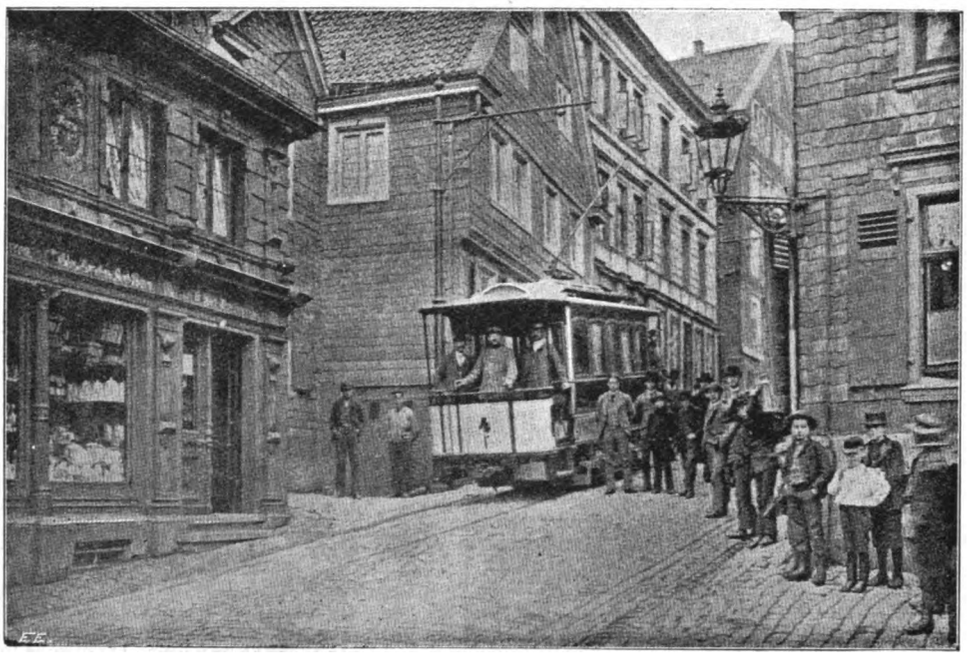
have to be worked in Sheffield, the results here deserve to be specially noted. The width of the narrowest street through which the tramways run is about 16½ft. The steepest gradient is 1 in 9·5 for a length of about 80 yards, but there are many other places where the gradients, though not quite so steep, are much longer. The curves, too, are in many cases sharp, one having a radius of about 59ft. The three photos which accompany this report illustrate the class of streets and gradients. Generally the paving is of granite on concrete. In some of the suburbs, for the sake of cheapness, macadam is used. with one row of setts on each side of the rails, but this is considered very unsatisfactory, and the director considers the whole width between the rails and a margin outside should be paved. The rails weigh about 68lb. to the yard. The length of the tramways is about 6¼ miles. The gauge is one metre—*i.e.*, about 3ft. 3in. The tramways are in the hands of a company with a capital of about £42,000. About two-fifths of the amount is subscribed by the Municipality, who, however, take no part in the management. The present tramways are electric overhead on the Thomson-Houston system, and have been in use about 3½ years. The terms of the concession generally are as follows: Length—For 75 years, at the end of which period the tramways pass into the hands of the Municipality free. Municipality takes a percentage of the receipts. The lines are all single, but the deputation were informed double lines would be preferred, and will probably be constructed in a few years' time. It was stated that the present lines would need reconstructing at the end of 10 years from when they were laid, and repairs have already been necessary, so, apparently, the construction at first was not very substantial. It will be noticed that the rails are very light for electric traction. It was stated the cost of overhead construction for a single line amounted to nearly as much as that for a double line. As in most of the other cities visited, the current is conveyed by means of overhead wires supported principally by poles fixed on one side of the street. The company would prefer rosettes on account of cheapness, but there is a difficulty in obtaining permission to fix them. The overhead apparatus is also utilised in connection with the electric lighting of the streets and for transmission of the power to works *en route*. The height of the wires is about 16ft. from the ground. The cost per mile run is said to be about 4d., and the receipts about 5½d. The horse-power at the station is 750, and



Remscheid Tramways—View showing Car on a gradient of 1 in 9·5 in Narrow Street.

Remscheid Tramways—Another View of Car on a gradient of 1 in 9 5.

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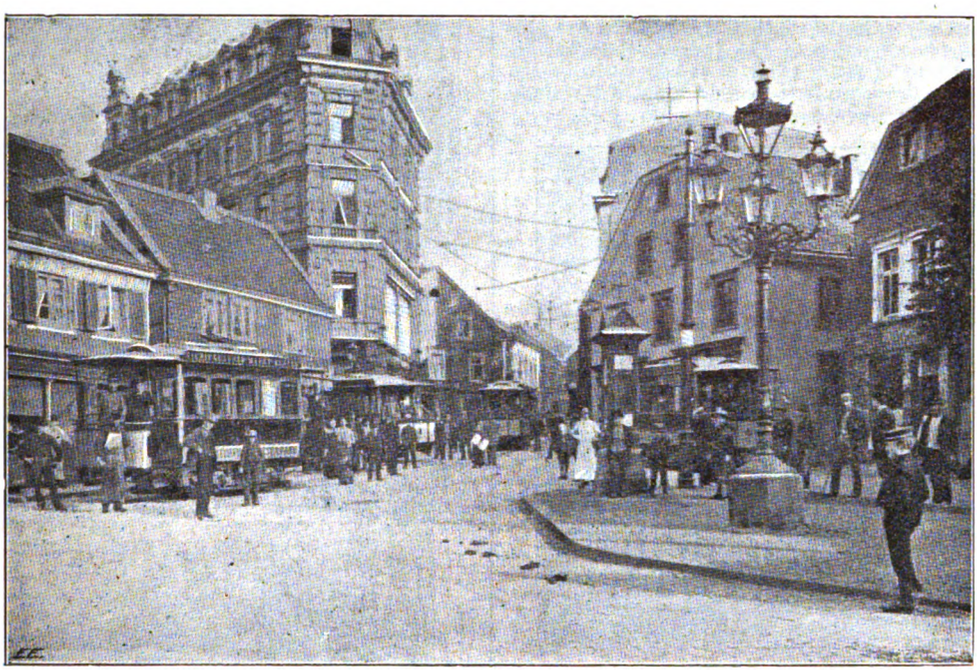
there are three dynamos, each capable of producing 200 amperes. In a short time four more machines, each of 175 h.p., will be ready for work, and one will be held in reserve. The voltage is 500, and the current is direct. The station is also provided with accumulators (in parallel with the dynamos), which operate alone when the load is very light, principally in the night and early morning, and enable the station to be worked with more economy than would otherwise be the case. In addition to running the tramways the power station supplies electricity to about 50 works; generally about 2 h.p. to each. The small cars without outside seats, which seem to be generally preferred on the Continent, are used here. They carry 18 passengers inside and 12 on the platforms — altogether, 30 passengers. There are 13 cars, each supplied with two motors of 20 h.p. The weight per car is about 5½ tons empty, and the cost about £750. Each car is fitted with two independent brakes in addition to an electric brake, and the action of these is very powerful. On the steepest incline a car can be pulled up in its own length, and, if necessary, backed. The lighting is electric, the power being supplied from the overhead wires. Scrapers are attached to the cars, when necessary, to remove dirt and snow from the rails. No luggage is carried on the cars. The fares are 1d. and 2d., and tickets are used. Stopping places are provided about a furlong apart. This system is said to be very popular, and is becoming universal in Germany. The deputation were informed that during last year the traffic was once interrupted for three hours by a snowstorm. During the first six months the electric lines were open a child was killed, but now an ingenious reversible fender is used, which, it is expected, will prevent the recurrence of such an accident. The speed (maximum) is between nine and ten miles an hour, which, however, could be greatly exceeded if thought desirable. The service is every 10 minutes. The drivers receive about 18s. 6d. per week, but, in addition, they get one-tenth of a penny per kilometre run and a free uniform, so that really their wages are equal to from £1. 2s. 6d. to £1. 5s. per week. The electric tramways are regarded as a great success; in fact, the deputation were told no other system would answer in Remscheid. The dividend paid is 3 per cent., which, it is expected, will be increased. During 1895 the increase in receipts was not commensurate with the increase in traffic, and this is stated to be due to the extreme severity of the weather in the early part of the year, when all the available power had to be utilised, and on this account the fares were increased, or rather the distance traversed for a certain fare was reduced. The running is very smooth, and there is little noise—what there is being of a humming nature. The poles do not seem to be objected to, and people very soon get used to them. It is desirable to call attention to the following special features of the Remscheid tramways: (*a*) the success with which the difficulties of heavy gradients, narrow streets, and quick curves have been overcome; (*b*) the new system of accumulators provided at the power station; (*c*) the supply of electricity from the power station to works in the town, by which means the surplus current can be used and some income gained.



Remscheid Tramways—View showing the Overhead Wires in the Market Place and Narrow Streets adjoining.

PROF. FLEMING ON THE ENDOWMENT OF RESEARCH.

Prof. J. A. Fleming on Wednesday night delivered a lecture at Carpenters' Hall on "The Work of the Electric Current." Lord Reay presided.

The lecture was of an elementary character, and our readers would hardly thank us for a summarised *résumé* of the progress of electrical science, beginning with the discovery of the voltaic pile and ending with the Niagara power-house. Prof. Fleming did all that could possibly be done with such a subject in the course of 60 minutes. At the conclusion of his lecture, however, he referred to another matter. All the results he had brought to the notice of his audience could not, he said, have been brought about without the previous discoveries, which were the result of scientific work undertaken with no other object than the pursuit of truth. Before an Atlantic cable could be worked or a City of London electrically lighted there was necessary a long investigation in matters of pure science. That was a fact now recognised by many, and much attention was being given to the subject. It was not, however, merely a question of spending money—that was the least difficulty. How to get the right men and set them to work was what was less obvious. It was by no means obvious that what was being done was the best thing. It was a most important matter to press upon our English manufacturers the importance of scientific research. It was not easy to get an English manufacturer to believe that a German firm of similar standing to his own would be employing 10 or 20 men engaged in scientific research upon matters allied to the firm's business, or the necessity of purely scientific research as a starting point. It was essential to move onward if we were not to be left behind, and besides technical education and the teaching and diffusion of what was already known, there was the still more urgent matter of the progress of science and the discovery of fresh facts. It was for that reason that he had called their attention to some of the results which had followed investigations made in the spirit of pure research, which was the investigation of the truth—and the whole truth—and the unravelling of the forces and laws which explained the mysteries of the world in which we lived.

Lord Reay also spoke, expressing a hope that the scheme for a national physical laboratory would be carried out.

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LEGAL INTELLIGENCE.

CHAMBERLAIN AND HOOKHAM v. JOHNSON AND PHILLIPS.

In the Queen's Bench Division of the High Court of Justice, before Mr. Justice Wills, the above case was commenced on Thursday of last week. This is an action to restrain the defendants from manufacturing and selling the Perry meter, which is claimed to infringe a patent granted to Mr. George Hookham in 1887.

Mr. Moulton, Q.C., Mr. A. J. Walton, and Mr. J. H. Gray appeared for the plaintiffs, and Mr. Bousfield. Q.C., M.P., Mr. J. C. Graham, and Mr. C. E. Jenkins for the defendants.

Mr. Moulton, Q.C., in opening the case, gave a carefully prepared *résumé* of the duties required from electricity meters both for registering current and energy supplied. He reviewed briefly the development of the electrical industry, and the need that arose in the eighties for a meter to measure the electricity supplied. He went on to describe the essential elements of a good meter. The model (Fig. 1) shows clearly the similarity of the braking effort between a magnetic brake generating eddy currents in a copper disc and fluid friction. The vessel under the disc contains mercury, which can be withdrawn by lowering the other vessel to the right, which is connected to the first by an indiarubber tube. The magnet can be withdrawn from the disc, so that the two brakes can be directly compared. The weight acting on the revolving axis was varied to show that the braking effort was proportionate to the speed. The model was neatly arranged and accurately adjusted, so that Mr. Moulton was able to give a practical demonstration to the judge. He next proceeded to show the type of meter (Figs. 2 and 3) made by Mr. Hookham in 1887, and described in the patent which it is claimed

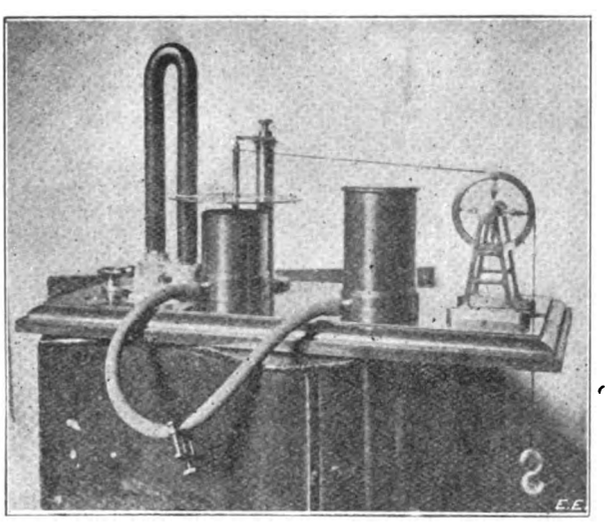

FIG. 1.—Model of Fluid Friction and Magnetic Brakes.

the defendants have infringed. In this there is a disc armature revolving between the two poles of a powerful electromagnet. The spindle of the armature is supported on two friction wheels, the ends of the spindle being sharp cones, and resting in vertical slots. The current is led into the armature by means of a double commutator dipping in two contact troughs filled with mercury. One segment on the first commutator is diametrically opposite to the same contact on the other commutator. The twisting of the conductors by which this is done can be seen in Fig. 2. The body of the armature contains a copper disc, which acts as a brake disc. After describing this meter Mr. Moulton went on to lay down the distinguishing elements in a good motor-meter as follows:

1. A motor, the armature being of any known type—*i.e.*, drum, ring, or disc, or of the simple disc or cylinder type.
2. A constant power field in which the armature revolves.
3. A disc or cylinder of metal, preferably of copper, rotating with the armature.
4. A powerful and constant magnetic field formed by pole-pieces a short distance apart, between which the disc or cylinder revolves so as to form a powerful magnetic brake.
5. Fluid contacts giving nearly frictionless admission to the currents.
6. A registering apparatus.

A variant to the above lay in the use of the armature or disc to act as the brake also. Mr. Moulton then said that certain of these elements were well known before Mr. Hookham's patent, but that the combination of these elements so as to give a practical meter formed the subject of the invention. He submitted that the defendants had particularly infringed the first and sixth claims in Mr. Hookham's specification.

Mr. George Hookham then went into the witness-box, and stated, in reply to questions put by **Mr. Moulton**, that he was the inventor of the meter in question, and that prior to 1887 he had given much attention to the subject of electricity meters. In 1887 excepting the Edison deposition meter, there was no practical meter on the market. He considered the discovery of a correct brake—*i.e.*, a brake following a correct law—the basis of a good meter. The next difficulty was that of static friction. He took two steps to obviate this difficulty: first, to make the friction as small as possible, and then to reduce its relative effect by exaggerating the electric forces. He diminished the static friction by using

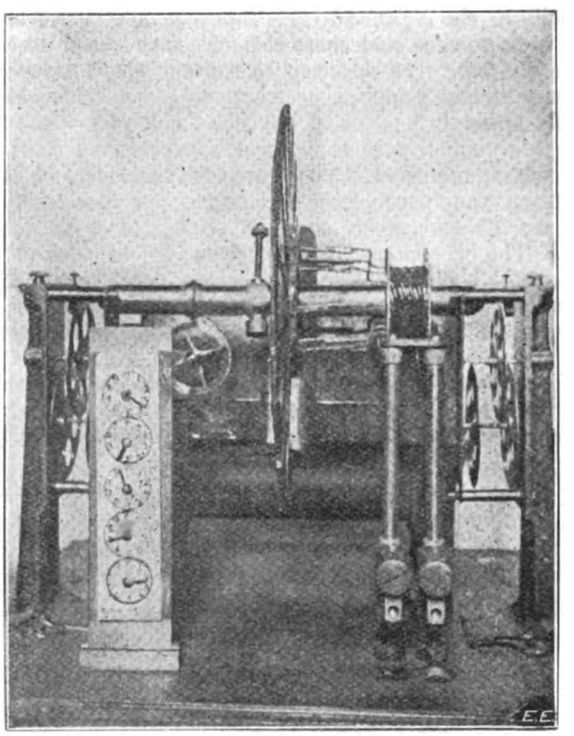

FIG. 2.—Hookham Meter, 1887 Type.

friction wheels and fluid contacts. He increased the electrical forces by using powerful magnets with poles brought near together, giving also powerful braking forces. He preferred to use permanent magnets, and his method of design gave both strength and permanence to the magnets. In most cases this gave sufficient power to act as an effectual brake, but he sometimes went further

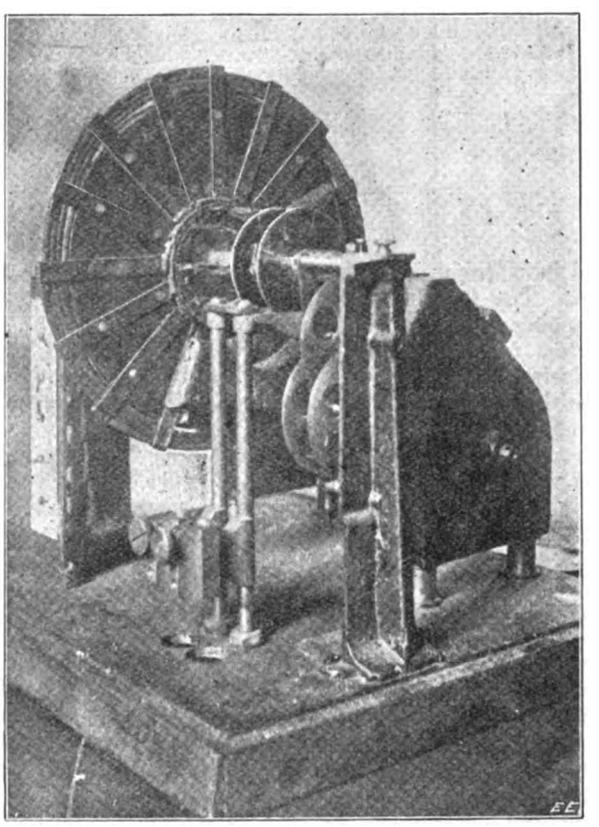

FIG. 3.—Hookham Meter, 1887 Type.

and grooved the pole-pieces to increase the Foucault currents and to make the brake more efficient. With these means he was able to get an effective meter in which the magnetic forces are dominant. His idea in design was to make all other work done by the motor negligible compared with that done against eddy currents. The speed of rotation of the armature is then directly

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proportional to the armature current. The electric brake might be formed by the armature itself. After detailing the various types of motors he could use in his meter, Mr. Hookham described the directions given in his patent for the construction of his practical motor. He said about 130 of the first type (Figs. 2 and 3) were sold, and about 1,000 of the next type. He then pointed out the similarity between the essentials in Prof. Perry's meter, as made by Messrs Johnson and Phillips, and in his own meter.

Cross-examined by **Mr. Bousfield, Q C.**, Mr. Hookham said he did not consider that the Ferranti and Hopkinson meters in 1887 were practicable. His firm manufactured the Hopkinson meter, and sold about 20 in the years 1883 to 1886 inclusive. He did not

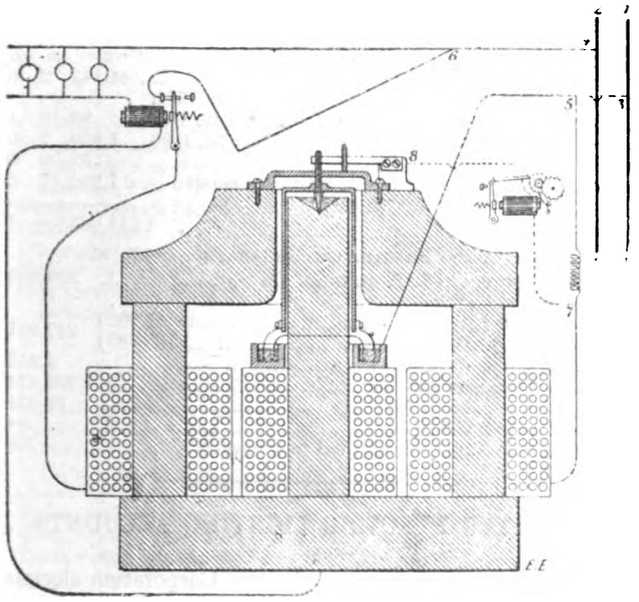

FIG. 4.—Section of the Edison Meter, 1883, showing the Motor Part and Mercury Contact.

consider small sales due to want of demand of electric meters, or to the stringent Board of Trade regulations then in force. Except in externals, he considered the Perry meter the same as his own. He could not say how many of the 130 meters (Figs. 2 and 3) had grooved pole-pieces. He grooved those for larger outputs only. He said he was ignorant of the Ayrton and Perry 1882 patent, and did not obtain information from it when designing his meter. He considered that the patentees showed no appreciation whatever of the relation between forces. His practical directions for making the magnetic and electric forces large and

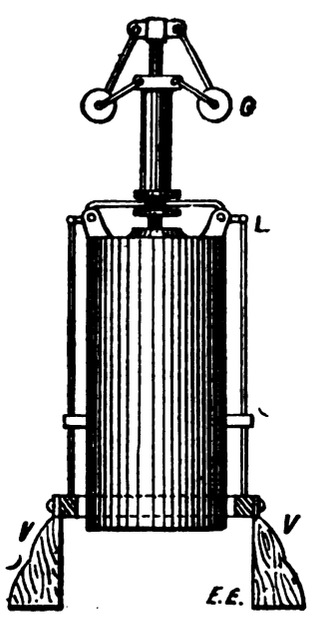

FIG. 5.—Edison's Fluid Brake, 1883, showing variable Dip Vanes.

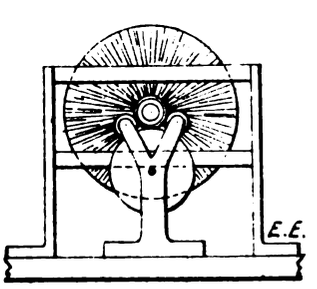

FIG. 6.—Gray's Frictionless Bearings, 1882.

the static friction small were embodied in Prof. Perry's meter. On severe examination, the witness would not admit that his procedure in gaining these results were obvious deductions from common knowledge. In his form of commutator of the 1887 type there was a small amount of sparking which oxidised the mercury and introduced trouble. His was a current meter, not an energy meter. The witness was then shown a model of the Edison meter patented in 1883. This model (which we illustrate in Fig. 4) consists of a cylindrical armature of copper of the same type as that used by Prof. Perry, having pole-pieces both inside and outside the cylinder. The contacts are made in mercury, and a fluid friction brake (shown in Fig. 5) is used. The governor, G, varies the area of brake in contact with the mercury, in order to give resistance proportionate to the speed. Mr. Hookham said that the only difference between the Edison meter and his own lay in the fact that a different brake was used and that the magnet did not appear to be saturated. The counsel then read extracts from Munro's and Gray's specifications, dated 1882, in which Barlow wheels were described as "current" meters. Munro says: "As a means of measurement of the electric current employed in lighting and for motive purposes I employ an adaptation of the device known as Barlow's wheel. In this a horseshoe magnet encloses a disc of copper mounted on an axle, and when a current passes from the axle by the wheel to a pool of mercury, into which the edge of disc dips, the disc rotates. This rotation is proportional to the strength of the current, and by fitting a suitable counter to the axle of the disc I can register the number of turns, and so graduate my indicator to show amperes." The witness did not consider the apparatus would give a practical meter. The counsel then referred to Gray's specification. The witness said that two Arago discs were used as brakes, but that one larger disc would have been a more scientific arrangement. The friction wheel bearings described by Gray (Fig. 6) were similar in principle to his bearings, but he used a groove to keep his axis on the top of the wheel, whereas Gray used two small rollers. His arrangement was better and cheaper. He did not consider that Ayrton and Perry's 1882 specification gave sufficient instructions to enable an electrical engineer to make a practical meter. He admitted that Elihu Thomson had made a motor meter, and had acknowledged the patent; but Elihu Thomson was distinctly an expert. He acknowledged that the braking effort on a Barlow wheel would be doubled by using two magnets, and trebled by using three magnets. Although this was the equivalent of Prof. Perry's arrangement, he did not think that it was the way the result had been arrived at.

Re-examined by **Mr. Moulton**, the witness said that Edison's meter would not set up eddy currents in the copper cylinder. Edison's brake was not in his opinion a practical one; neither was Gray's meter a practical one. Gray's frictionless supports had been used before in the Atwood machine. The Elihu Thomson meter shown had a starting device to overcome initial friction.

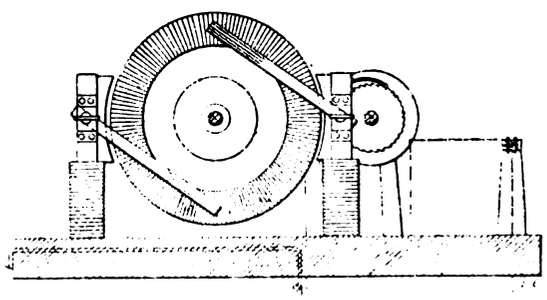

FIG. 7.—Gray's Meter with Solid Brushes, 1882. Mercury Co tacts are also described.

In reply to **Mr. Bousfield**, Mr. Hookham said that it was essential that a meter should start with small current. The common devices for reducing the initial friction in motors were not sufficient for motors used in meters. Special means had to be adopted such as would not occur in ordinary electrical engineering.

In reply to **Mr. Moulton**, the witness said that he did not think that in 1887 permanent magnets would be used by engineers wishing to make an accurate meter. A constant field was needed, and the way to get permanency and constancy was not generally known.

Mr. James Swinburne, examined by **Mr. Moulton**, said he did not consider that Ayrton and Perry's 1882 specification gave sufficient instructions to enable a practical meter to be made. The proportions given by Hookham were practically those required to give permanent magnets. Neither Munro's nor Gray's specification gave information enabling workable meters to be made. In Prof. Perry's meter, permanent magnets were used as described in the Hookham patent, as are also a motor and a brake. In his opinion, the Perry meter was constructed substantially in accordance with the plaintiff's specification.

Cross-examined by **Mr. Bousfield**, Mr. Swinburne said that in 1892 he read a paper at the Institution of Civil Engineers in which he expressed the views "that Profs. Ayrton and Perry had invented nearly all the types of motor meters now in use," that "nine years ago they laid down the principles involved in their construction with perfect clearness." The following practical directions were in his opinion required to be taken from Hookham's specification in order to make a practical meter on the principle described by Ayrton and Perry: first, a constant field for a brake; secondly, electrical connections with as little friction as possible; thirdly, the broad principle of making the electrical forces enormous compared with the frictional forces; fourthly, the meter must have range. The last point was not expressed, but anyone following the directions given would get a meter with a wide range. The grooving of the poles was not an essential, but was an advantage.

(To be continued.)

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HANLEY ELECTRIC LIGHTING ACCOUNTS.

The accounts of the last year's working of the Hanley Corporation electric light station have just been issued. The loans sanctioned under the provisional order amounted to £46,110, the whole of which has been borrowed at 3 per cent., and of which £1,270. 6s. 11d. has been repaid.

REVENUE ACCOUNT, YEAR ENDING DEC. 31, 1896.

Dr.				£ s. d.
A.—To Generation of Electricity.				
Coal, including carriage, etc.	£755	3	3	
Oil, waste, water, and stores	198	5	8	
Wages	572	13	1	
Repairs and maintenance as follows: buildings, £15. 18s. 5d.; engines, boilers, £240. 15s. 9d.; dynamos, transformers, etc., £46. 18s. 11d.; other machinery, instruments, and tools, £17. 8s. 9d.	321	1	10	
				1,847 3 10
B.—To Distribution of Electricity.				
Wages to linesmen, etc.	13	9	8	
Maintenance of mains	27	5	6	
Maintenance and renewals of meters, switches, fuses, and other apparatus on consumers' premises	133	11	3	
Maintenance of apparatus at distributing stations	34	4	5	
				208 10 10
C.—To Public Lamps.				
Attending and repairs	155	16	7	
Renewals of lamps	18	9	0	
				174 5 7
E.—To Rents, Rates, and Taxes.				
Rates and taxes	155	12	6	
				155 12 6
F.—To Management Expenses.				
Salaries, engineers' department	315	18	4	
Stationery and printing	22	12	5	
General establishment charges	24	19	10	
				363 10 7
H.—To Special Charges.				
Insurances, etc.	25	11	9	
				25 11 9
Total expenditure				2,774 15 1
Amount carried to net revenue account				1,790 17 11
				£4,565 13 0

Cr.				£ s. d.
Balance from last account, less bad debts written off				5 17 2
Sale of current per meter at 5d. (less discount) per Board of Trade unit.	3,851	19	0	
Public lighting	510	0	0	
				4,361 19 0
Rental of meters and other apparatus on consumers' premises	106	3	6	
Sale and repairs of lamps	61	11	0	
Sale and repairs of other apparatus	30	2	4	
				197 16 10
				£4,565 13 0

NET REVENUE ACCOUNT, YEAR ENDING DEC. 31, 1896.

Dr.	£ s. d.
Interest on mortgage debt	1,322 5 6
Interest on overdraft for extensions	361 14 3
Amount transferred to sinking fund	682 8 1
	£2,366 7 10

Cr.	£ s. d.
Balance from last account	102 15 0
Balance brought from revenue account	1,790 17 11
Interest on money at deposit	391 19 3
Balance carried to general district rate account	80 15 8
	£2,366 7 10

CAPITAL ACCOUNT FOR YEAR ENDING DEC. 31, 1896.

Dr.	Expenditure up to Dec. 31, 1895. £ s. d.	Expended during year. £ s. d.
Lands	500 0 0	—
Buildings	6,056 7 4	1,601 2 6
Machinery	10,547 15 9	4,580 4 7
Mains, including cost of laying	9,857 13 1	4 487 15 1
Transformers, motors, etc.	2,691 13 7	305 15 8
Meters	929 4 4	329 16 6
Electric instruments, etc.	234 1 7	82 4 1
General stores, lamps, etc.	674 16 5	273 4 4
Street-lighting, lamps and posts	870 18 0	120 9 8
	£32,362 10 1	£11,780 12 5
Total expenditure		£44,143 2 6
Balance of capital account		1,966 17 6
		£46,110 0 0

Cr.	Receipts up to Dec. 31, 1895. £ s. d.	Received during year. £ s. d.
Amount raised by loans	22,110 0 0	24,000 0 0
Total receipts		£46,110 0 0

GENERAL BALANCE SHEET.

Dr. Liabilities.	£ s. d.
Capital account—amount received	46,110 0 0
Sundry creditors	154 6 4
Sinking fund account—balance at credit thereof, £1,270. 6s. 11d.; less amount provided by general district rate, £80. 15s. 8d.	1,189 11 3
Balance	609 8 6
	£48,063 6 1

Cr. Assets.	£ s. d.
Capital account—amount expended for works	44,143 2 6
Stores on hand at Dec. 31, 1896—coal, £19. 1s. 3d; oil, waste, etc., £27. 13s. 10d.; general, £43. 15s	90 10 1
Sundry debtors for current supplied to Dec. 31, 1896	1,830 7 0
Other debtors	32 9 0
Cash with treasurer—balance of loan unexpended	1,966 17 6
	£48,063 6 1

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units		320,905
Quantity sold—		
Public lamps	51,992	247,881
Private consumers by meter	195,889	
Quantity used on works		4,443
Total quantity accounted for		252,474
Quantity not accounted for		68,431
Number of public lamps		44
Total maximum supply demanded in kilowatts		325

WORCESTER ELECTRIC LIGHTING ACCOUNTS.

The following is an abstract of the Corporation electric lighting accounts for the year ending December 31, 1896, together with a report by the city electrical engineer:

Dr. CAPITAL ACCOUNT.	£ s. d.
Lands, including law charges incidental to acquisition	5,182 8 8
Buildings	20,763 14 1
Machinery—mains (including the cost of laying the mains and services), transformers, motors, etc.	32,166 5 2
Meters	1,479 5 6
Electrical instruments, etc.	264 3 1
General stores (cable mains, lamps)	215 19 0
Preliminary expenses	506 5 8
Advertising, printing, and sundries	140 2 11
	60,718 4 1
Balance	1,820 5 5
	£62,538 9 6

Cr.	£ s. d.
Stock issued	59,877 0 0
Premiums thereon	1,870 18 0
Service lines	162 8 3
Sale of boilers and other effects at Powick	116 0 7
Interest allowed by treasurer	5 17 0
General district fund, preliminary expenses	506 5 8
	£62,538 9 6

REVENUE ACCOUNT.

Dr. To Generation of Electricity.	£ s. d.
Coal	886 15 1
Oil, waste, and engine-room stores	123 8 7
Wages at generating station	953 12 8
Repairs to buildings, plant, and machinery	108 18 11
To Distribution of Electricity.	
Wages of linesmen, fitters, and labourers	48 9 0
Repairs, maintenance, and renewal of mains	17 18 9
Repairs to transformer	2 18 0
Repairs, maintenance of apparatus at distributing station	3 15 0
Attending and maintaining public lamps	214 4 1
To Rents, Rates, and Taxes.	
Rents	34 17 0
Rates and taxes	47 9 0
To Management Expenses.	
Salaries, engineer's department	343 8 6
Stationery and printing	58 11 4
General establishment charges	27 15 3
To Law and Parliamentary Charges.	
Law charges	264 10 4
To Special Charges.	
Insurances	18 12 3
	3,155 3 9
Balance carried to net revenue account	1,602 9 10
	£4,757 13 7

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Cr.	£	s.	d.
Sale of current, per meter at 1d., 1½d., 2d., 3d., and 5d. per Board of Trade unit, £4,043. 5s. 9d.; less discounts, £275. 14s. 11d.	3,767	10	10
Public lighting	712	6	8
Rental of meters and other apparatus on consumers' premises	197	10	9
Lamps	0	14	6
Rent of watermill at Powick	50	0	0
Rent of cottages	29	10	10
	£4,757	13	7

GENERAL BALANCE-SHEET.

Dr. Liabilities.	£	s.	d.
Capital account—amount received	62,538	9	6
Sundry creditors	1,115	1	10
Sinking fund account	2,457	5	10
	£66,110	17	2

Cr. Assets.	£	s	d.
Capital account—amount expended for works	60,718	4	1
Stores on hand December 31, 1896: coal, £64 3s. 9d.; oils, waste, and engine-room stores, £40. 3s. 1d.; carbons, £45. 11s. 6d.	149	18	4
Sundry debtors for current supplied to Dec. 31, 1896	1,533	14	5
Public lamps	278	1	8
Other debtors	75	1	8
Cash with treasurer	1,739	9	2
Net revenue account—balance, being deficiency on revenue account	1,616	7	10
	£66,110	17	2

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units		424,221
Quantity sold—		
Public lamps	42,565	333,644
Private consumers by meters	291,079	
Quantity used in works		5 635
Total quantity accounted for		339,279
Quantity not accounted for		84,942
Total maximum supply demanded (kilowatts)		658·74

ABSTRACT OF MR. E. T. RUTHVEN-MURRAY'S REPORT ON THE ELECTRICITY DEPARTMENT'S WORK IN 1896.

I have the honour to present to you the following report on the results of the department's second year of work upon sundry recommendations with regard to the future procedure, and also upon the extensions to the works necessitated by the growth of the business. During the past year most of the additions and alterations to the plant and machinery necessary to put it into thorough order have been completed, practically the only matter remaining requiring alteration being the turbines, which we have ascertained do not come up to the specified requirements as regards efficiency. It is most desirable, in view of the fact that every pound of water has at times its definite value to us, that these be put in order forthwith, or that they be replaced by others which fulfil the requirements of the specification. The plant has been maintained in thorough order out of revenue during the past year, and the supply has been continued with regularity to our consumers' complete satisfaction. Our costs show a marked improvement over those of last year—indeed, our figures are, I think, likely to rank among the half-dozen lowest reached in high-tension stations. Exclusive of interest and sinking fund, our works costs are 1·488d. per unit sold, a decrease of over ¾d. on last year's figures, and our total costs are 2·269d., a decrease of nearly ¾d. per unit sold. Of the total costs figure no less than ·190 of a penny per unit sold was incurred in legal expenses in connection with the weir. The condensing plant put down last year has been a source of great assistance, and the lower contract price for coal also helped.

Extensions.—Owing to the demand having increased some 50 per cent. during the past year, the number of 8-c.p. lamps wired having increased from 14,605 to 21,958 and the number of consumers from 181 to 241, it becomes necessary to add to the plant at the electricity works. We have indeed been running at considerable risk for some months, as, by reason of the many floods which have occurred, we have repeatedly run without any spare plant. Strictly speaking, the capacity of our works is only 375 kilowatts, for although there are four alternators of 125 kilowatts each, one of them can only be driven by water power, and when this fails is rendered useless. It therefore happens that always for a portion of the year the capital expended on this plant must be unremunerative. I propose to improve matters by putting down a high-speed engine capable of driving the alternator at half-load. Not only will this small engine run the alternator as a day-load plant, but it will take the small excess load, for which we now have no alternative but to run the large engines. The combined plant can also be run—that is to say, the turbines can be augmented by the steam-engine, or *vice versâ*—to obtain the full output from the dynamo which by water power we have never been able yet to get. As a steam unit, since the dynamo will only work up to half-load, the combined efficiency will not be very high, but I think this inefficiency will be more than counterbalanced by the extra efficiency obtained when both steam and water are used together, and after all the arrangement will be incomparably more economical than any at present open to us when there is very little or no water power available. The cost of the scheme will be much less than would be that of putting down a special day and light load plant, together with all the separate switch-gear connected with it, and by my proposal at a small cost we are able to increase the effective capacity of the works by 75 kilowatts and to reduce the idle capital spent on No. 5 plant by nearly 50 per cent. The other addition to the generating plant which I consider necessary is a 500-h.p. engine and direct coupled 300-kilowatt alternator. This plant would be placed in the vacant space just inside the engine-room on the right-hand side on entering. With such a unit it would in all probability be possible to take the whole of next winter's load with this single steam-engine alternator running, instead of three smaller ones working at something under full load, and thus less economically, the remainder of the load being taken by water power. Switch-gear will be required for the new Brooks main, already ordered, and also for the new alternator. Now that additions are necessary, I most strongly recommend that the existing switchboard be replaced by new switch-gear of the best possible design. Our present switchboard is, for reasons I have explained to your committee, unsatisfactory, and for this reason I advise its removal while the other extensions are in progress. I recommend that the new switch-gear be erected on the wall a little farther down the engine room, and that it be operated from a platform some 7ft. above the engine-room floor level. The apparatus would occupy but one fifth of the space taken up by the present switchboard, so that it could be controlled by one man. From the elevation of the platform, the whole of the plant will be seen, which under existing circumstances is impossible. Two new boilers will be required, each boiler rated at 250 h.p. I recommend that they be of the same type and make as those at the works, but that they be fitted with superheaters. The pair of boilers would be built in one battery. The existing steam-mains over the boilers will be too small, and will require in some cases to be substituted by larger ones. At the same time better provision for the prevention of breakdown should be made. The estimated cost of these extensions is £8,834. Manufacturers are now very busy, and no time should be lost in placing contracts, so that the plant required may be ready for the coming winter's load.

Summarised, my recommendations are as follows: (1) that the charge for current be altered from 5d. per unit with various discounts to 6d. per unit for the first hour's daily average use, and 2½d. per unit for all consumed in excess of this amount; (2) that motors and cooking apparatus, wired on a separate circuit, which do not use the supply for an average of 365 hours per annum, be charged at the above rates instead of the present ones; (3) that all discounts be discontinued; (4) that meter rents be abolished to all consumers using their demand for an average of 365 hours per annum; (5) that one 8-c.p. or one 16-c.p. incandescent lamp be given free to each consumer for every 50 units of electricity paid for, and larger lamps for proportional consumptions; (6) that the charge for current supplied to the waterworks motors be 1d. per unit; (7) that the proposals for free wiring have consideration given to them; (8) that the extensions set forth in this report be carried out as soon as possible.

COMPANIES' MEETINGS AND REPORTS.

W. T. HENLEY'S TELEGRAPH WORKS COMPANY, LIMITED.

The eighteenth ordinary general meeting of this Company was held on Friday last at the offices, St. Martin's-lane, E.C., Mr. Sydney Gedge, M.P., presiding.

The **Chairman**, in moving the adoption of the report, stated that there was a great deal of difference in the position of the Company now, when they were holding their meeting in February, and the time, not many years ago, when they put off their meeting month by month—and in one year until December—in the hope that they might be able to communicate some good news to the shareholders. He congratulated them on the marked improvement which had taken place in the position and prospects of their undertaking. Mr. Sutton (the managing director) had just returned from abroad. He found everywhere a great deal of competition. Mr. Gedge then referred to the figures of the report, a summary of which was given last week. They had transferred £7,500 to the reserve fund, compared with £5,000 last year, and the dividend now proposed would make the distribution 10 per cent. for 1896, free of income tax, compared with 8 per cent. in the previous year, 6 per cent. for 1894, and 5 per cent. for each of the three preceding years. The amount carried forward was £14,294, compared with £13,367 a year ago. Their profits had not been earned by any one big contract, but by a number of small ones. The attention of people generally was being directed to the necessity of having more cables to our Colonies. Two of the more recent cables they laid were those between Halifax and Bermuda and between Florida and Bahamas. The former was laid in 1890 and the latter in the spring of 1892, and it had not been necessary yet to spend a penny on either of them for repairs. He hoped that before long the Government would see the great advantage of giving such subsidies that there should be telegraphic communications from Great Britain to every part of her Majesty's dominions without the cables touching any foreign coast. Before long they would have to ask the shareholders to increase the capital, his own view being that the ordinary capital should be raised from £100,000 to £150,000. The additional capital, however, must be raised only when it was wanted, and when it would earn dividend.

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The **Hon. Randolph Stewart** seconded the resolution, which was carried unanimously.

Mr. Sutton said that with increased work more plant and buildings were needed. With regard to German competition, Henley's could successfully compete with Germany or any of her foreign rivals. Their stock this year amounted to £78,000, against last year's £42,000, or nearly double.

A bonus of £500 was voted to the directors above the ordinary fee.

Major-General G. Hutchinson, C.B., C.S.I., and the Hon. R. Stewart were re-elected directors, and Messrs. Ball, Baker, Deed, Cornish, and Co. were re-elected auditors.

KENSINGTON AND KNIGHTSBRIDGE ELECTRIC LIGHTING COMPANY, LIMITED.

The general meeting of this Company was held on the 25th inst. at 1, Great George-street, Mr. Granville R. Ryder presiding.

The **Chairman** stated that not only had there been a considerable increase in their business, but the ratio of increase was much larger than it had ever been before. The number of buildings lighted by the Company was more by 216 than in 1895, while the lamps, calculated on the usual basis of 8 c.p., had increased by 25,175, as against an increase of 14,102 in the preceding year. Their total number of lamps at December 31 last was 119,955. In view of these very encouraging figures, the directors had pleasure in recommending a dividend of 7 per cent. as compared with 6 per cent. for 1895. This dividend, he could assure them, was payable without in any way straining the Company's resources. Notwithstanding the fact that during 1896 their rates and insurance together increased by about £1,200, and that for maintenance of buildings, etc., they paid £2,570, and also wrote off on sales of old and obsolete plant nearly £3,000, they were enabled to place a further sum of £2,345 to the renewal account, raising it to £12,336, and to write off capital expenditure to the extent of £2,000. About £10,000 extra capital was raised during the period under review, the money being expended principally in extending their mains and in erecting the Knightsbridge station. The amount of electricity sold during 1896 was 1,514,729 units, which produced in receipts £34,371. During 1895 the sale of electricity was 1,228,734 units, and the receipts £28,090. The cost of manufacturing the electricity, coal, oil, and sundries was last year £6,916, and in 1895 £6,068. Therefore, for an additional cost of £847, they had gained in receipts not less than £6,281, a fact which showed to what a large extent the cost of electricity per unit might be reduced by a large output. He concluded by moving the adoption of the report and the dividend therein recommended.

Sir Frederick Bramwell seconded the motion, which was agreed to.

In answer to a question by **Sir Arthur Clay**, the **Chairman** said that as yet there was not much demand for current for cooking purposes.

Sir F. Bramwell, Bart., F.R.S., and Mr. R. W. Wallace, Q.C., were re-elected directors, and Messrs. Lovelock, Whiffen, and Dickinson were re-elected auditors.

CHELSEA ELECTRICITY SUPPLY COMPANY, LIMITED.

The annual ordinary general meeting of this Company was held at 19, Cadogan-gardens, S.W., on Wednesday, Mr. J. Irving Courtenay presiding.

The **Chairman**, in moving the adoption of the report, stated that it was not proposed to pay a larger dividend than the previous 5 per cent., although the profits would admit of it. They had during the year had an addition to the circuits of 23,106 lamps, that being three times as large as the average increase for the past three years. The number of lamps added in 1895 was 10,068, and in 1894 the number added was 6,621. The total number of lamps connected to the end of the year was 80,460. More plant, buildings, etc., being required for this increase, considerable capital expenditure had been necessary. The first portion of the Alpha-place station had been built, and this part would be equipped with 1,500 h.p. The extension was now being proceeded with, and when the whole was completed the Alpha-place station and the Cheyne-walk station would together be able to supply about 5,000 h.p., or 200,000 lamps fixed. An arrangement had been concluded with the London Electricity Company by which they took a certain amount of current for the daylight load only. A new sub-station had been built at Pond-place to supply the Fulham-road district. In building this station ample provision had been made for future extensions of plant. Ten large motor-dynamo transformers of a new variable ratio type, made by the Electric Construction Company, of Wolverhampton, each capable of supplying over 2,000 lamps at one time, has been delivered during the year, and were doing good work. The storage batteries were, as usual, of the E.P.S. type. A considerable extension in mains had been made in the Fulham-road and in the King's road, where many large shops were supplied. Mains had been laid in 6,500 yards of streets. These mains consisted chiefly of Callender-Webber casing, containing a number of ways or ducts, into which Callender cable was drawn. The total length of these ways laid down during 1896 was 13 miles, and over 16 miles of cables had during 1896 been drawn into these, and others already laid down. The expenditure was, however, incurred gradually, and the capital expenditure both per lamp fixed and per unit sold was less than previously. To meet this expenditure the nominal share capital had been increased in 1896, and 12,000 ordinary shares issued in May and fully subscribed. These were entitled, for 1896, to 2½ per cent. dividend per annum on the instalments paid up, and in 1897 they would rank with the ordinary shares previously issued. The net revenue, after paying interest on debenture stock, amounting to £2,700, was £9,164. 7s. 4d., out of which a dividend of 6 per cent. per annum on the preference share capital, and 5 per cent. on the old issue of ordinary shares, was recommended, carrying forward a balance to next year of £1,526. 17s. 4d. The cost of producing the current had been slightly decreased. Last year was the first year throughout the whole of which the Board of Trade unit had been supplied at 6d. The rates have been largely increased, the Company having to pay £670 more than in 1895. Despite this, £2,000 had been added to the renewals fund.

Major-General Webber seconded the adoption of the report, which was carried unanimously.

The retiring directors, Mr. J. Irving Courtenay and Major-General C. E. Webber, C.B., were re-elected. The auditors, Messrs. Cooper Bros., were also re-elected.

TELEGRAPH CONSTRUCTION AND MAINTENANCE COMPANY, LIMITED.

The ordinary general meeting of this Company was held on Tuesday at the offices of the Company, Sir Robert Herbert presiding.

The **Chairman**, in moving the adoption of the report, referred with great regret to the death of their late chairman, Admiral Sir George Richards, and Mr. G. W. Campbell, their late colleague on the Board, both of whom had for many years rendered valuable services to the Company. The accounts for the past year showed a net profit of £88,300, after charging the interest on the debentures. That was a very good profit. They were, however, handicapped by the very small amount brought forward—£18,869—from the previous year. The amount carried forward on the present occasion was £39,940, which was the smallest sum, with the exception of last year—£18,869—that they had been able to place to reserve for the last five or six years. So far, they had entered upon the current year under better conditions than those which they approached in 1896. The business of the Company had been good, and showed some improvement over last year. Both the factories had been fairly active, and the steamships had been laying or repairing submarine cables under contracts and also on charter. The factories and machinery, which were frequently undergoing improvement, were at the present time in a higher state of efficiency than they had ever been before. Formerly they enjoyed a monopoly of business with America, but with increasing competition that had all changed. As an example of this he mentioned that France had embarked upon great works, and were now determined to do for themselves that which years ago they accomplished with British assistance. To the net profit must be added £18,869 brought forward, making a total of £170,170. From this amount was deducted the interim dividend of 5 per cent., amounting to £22,410, leaving £84,760 to be dealt with. Of this sum the directors proposed to distribute a dividend of £1. 4s. per share, absorbing £44,820, being at the rate of 10 per cent., and making, with the amount already paid, a total dividend for the year of £1. 16s. per share, or 15 per cent., leaving £39,940 to be carried forward. The Chairman concluded by moving the adoption of the report and the payment of a dividend of £1. 4s. per share, in addition to the interim dividend of 12s., making 15 per cent. for the year.

Admiral Sir Anthony H. Hoskins seconded the resolution.

In reply to **Mr. Croft**, the **Chairman** said that the directors thought it better on the whole not to give in the report any detailed information of the work done by the Company. Such information as might fairly be given they would rather give informally and privately to any shareholder who required it. The motion was carried unanimously.

Mr. Colin F. Campbell had been elected to fill one of the vacancies on the Board, and his appointment was confirmed, as was also the re-election of Admiral Sir A. Hoskins.

SCARBOROUGH ELECTRIC SUPPLY COMPANY.

The annual meeting of this Company was held at Scarborough last Thursday, Mr. G. Alderson-Smith presiding.

The **Chairman**, in moving the adoption of the report, said that this year they had already had applications for 555 additional lights. With the increased demands it would be necessary to have an additional engine, and that with the addition of mains and cables would cause a capital expenditure of a little over £3,000.

Mr. J. Bell Simpson seconded the motion, and after discussion it was adopted.

A dividend of 4½ per cent. was declared.

Mr. G. Alderson-Smith, Mr. G. L. Beeforth, and the Hon. C. A. Parsons (retiring directors) were re-elected, as was also the auditor, Mr. C. E. Bradley.

TRAMWAYS UNION COMPANY, LIMITED.

The annual general meeting of the shareholders of this Company, Limited, was held on Tuesday at Winchester House, E.C., Mr. E. M. Underdown, Q.C. (the chairman of the Company), presiding.

The **Chairman**, in moving the adoption of the report, said they were still in a state of transition with regard to the change from horse to electric traction on some of their lines. The profit for the year, including the amount brought forward, was £11,732.

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Interim dividends had already been paid, and further distributions were now recommended of 2s. 6d. per share on the fully-paid-up shares and 6d. on those on which only £1 was paid, making a total for the year of 5 per cent. in each instance. Their traffic receipts showed an increase for the year of £8,786 over those of 1895, and this of itself was satisfactory, but the expenditure was £7,573 more. As to the adoption of electric traction generally on their lines, the policy they were pursuing was to wait until they were assured that they could do better with it than under the present system. Meanwhile, in view of any possible change, they were restricting their outlay on cars as much as possible.

Mr. G. Richardson seconded the adoption of the report, which was carried.

COUNTY OF LONDON AND BRUSH PROVINCIAL ELECTRIC LIGHTING COMPANY, LIMITED.

Directors: The Right Hon. Lord Rathmore (chairman), J. B. Braithwaite, jun. (deputy-chairman), Emile Garcke, Frederick W. Reynolds, Aymor H. Sanderson, Francis E. Savory, R. Percy Sellon, B. H. Van Tromp. Engineer and manager: A. J. Lawson, M.I.E.E. Secretary: H. B. Renwick.

Report of the directors, with abstract of accounts, to be presented to the shareholders at the third ordinary general meeting of the Company to be held at Winchester House, Old Broad-street, London, E.C., at 2 p.m. on Monday, March 8, 1897:

The capital expended during the year at St. Luke and Clerkenwell and at Wandsworth amounted to £159,954 2s. 6d., making the total expenditure on the two London stations up to December 31 last £272,723. 6s. 3d. This expenditure has been met by the balance of instalments falling due on the first issue of 10,000 6 per cent. preference shares at par, and by a further issue of 10,000 6 per cent. preference shares at 20 per cent. premium, for which subscriptions amounting to over £400,000 were received. The premium thus obtained has been applied as follows: reduction of general preliminary expenses, £12,169. 12s. 11d.; writing off preliminary expenses in connection with St. Luke and Clerkenwell, £2,000; writing off preliminary expenses in connection with Wandsworth, £1,500; writing off costs in connection with applications for provisional orders, £830. 7s. 1d.; carried to reserve, £3,500. The balance to credit of revenue account for the past year, after payment of proportion of rents, rates, taxes, and general establishment charges, amounts to £5,904. 11s. 7d., to which is to be added £1,208. 19s. 1d., being the balance remaining from last account after payment of the final dividend for 1895, making a total of £7,113. 10s. 8d. available for distribution. Out of this sum an interim dividend for the half-year ended June 30 last, at the rate of 6 per cent. per annum on the preference shares has been paid, and the directors recommend that a further dividend to December 31, 1896, at the same rate, upon the preference capital be declared. This will leave a balance of £525. 12s. 9d. to be carried forward to next year's account. In the St. Luke and Clerkenwell districts the work on sub-stations and mains within the compulsory area was completed during the year, and additional mains have been laid down in other streets. Up to December 31 applications representing 14,429 8-c.p. lamps have been received, and of these the equivalent of 14,179 lamps had been connected. Delivery of machinery into the station was commenced in October last; its erection is now far advanced, and by midsummer plant capable of supplying 60,000 8-c.p. lamps will be in working order. A considerable number of applications have been received for the supply of current for motive power; it is therefore proposed to lay down separate mains and continuous-current machinery to meet the demand. The Wandsworth station buildings are now completed for the reception of machinery; part of the plant has been installed, and the supply of current has been commenced. Applications for the equivalent of 3,509 8-c.p. lamps had been received prior to December 31 last. The provisional order (St. Olave) granted to the Company by the Board of Trade in 1895 was confirmed in the last session of Parliament. A provisional order for Camberwell, the largest parish in London, adjoining the parish of St. George-the-Martyr, for which the Company also holds an order, was granted last year by the Board of Trade, and confirmed by Parliament. Our Wandsworth station will be capable of supplying all these districts for some time to come. The Company has applied to the Board of Trade for provisional orders for other London districts, and has received the consents of several of the local authorities concerned. Within the past year there has been a considerable increase in the consumption of current from the Bournemouth and District electric supply station, while a material saving in the cost of production has been effected. Further improvements in both these respects may confidently be expected in the present year. On December 31 last the equivalent of 23,267 8-c.p. lamps were connected to the mains. During the year just ended the applications received by the Dover Electricity Supply Company, Limited, had reached the equivalent of 7,808 8-c.p. lamps, of which 7,518 were then connected, and the current sold, including that for public lighting, amounted to 154,200 Board of Trade units. The best hotels and many of the principal shops throughout the town are being supplied, and a further considerable increase in lamp connections will take place during the present year. A contract for the supply of power to the Corporation for tramways has been entered into between the Dover Corporation and the Company. As regard the Richmond (Surrey) Electric Light and Power Company, Limited, in the year under review the connections at Richmond amounted to the equivalent of 7,125 8-c.p. lamps. As a result of the increased demand for current and of reductions effected in the cost of generation, the gross profit for 1896 amounts to £1,162. 17s. 10d., as against £230. 2s. 1d. in 1895. It is intended to further extend the area of supply in Richmond during the present year. Mr. William Charles Braithwaite, having joined the Oxfordshire banking firm of Messrs. Gillett and Co., and finding himself too much occupied to attend the meetings of the Company's Board in London, the directors have, with much regret, to announce that he has resigned his seat on the Board. The retiring directors are Mr. Emile Garcke and Mr. Francis E. Savory, who are eligible for re-election. The auditor, Mr. R. H. Marsh, also retires, and is eligible for re-election.

BALANCE-SHEET, DEC. 31, 1896.

Dr. Liabilities.				£	s.	d.
Capital authorised				800,000	0	0
Capital issued—						
22,475 ordinary shares of £10 fully paid				224,750	0	0
20,000 preference shares of £10	£200,000	0	0			
Less calls not due—						
January 1, 1897 £20,000 0 0						
March 1, 1897 30,000 0 0						
	50,000	0	0			
	150,000	0	0			
Add calls paid in advance	11,770	0	0			
				161,770	0	0
				386,520	0	0
Loans against security				53,650	0	0
Reserve, as per report				3,500	0	0
Sundry creditors	30,493	8	7			
Bills payable	4,000	0	0			
				34,493	8	7
Net revenue account—						
Balance forward from last account	2,658	19	1			
Profit for the year	5,904	11	7			
	8,563	10	8			
Less final dividend on 10,000 6 per cent. preference shares (first issue) for half-year ended December 31, 1895; and interim dividend on 20,000 6 per cent. preference shares (first and second issues) for half-year ended June 30, 1896, from due dates of instalments, less income tax	4,171	4	7			
Balance available for distribution, as per report				4,392	6	1
				£482,555	14	8

Cr. Assets.	£	s.	d.
Capital appropriated to the County of London (North) electric lighting order	155,596	12	6
Capital appropriated to the Wandsworth electric lighting order	117,126	13	9
Lands, buildings, etc.	10,311	1	8
Preliminary expenses, £23,579. 6s. 6d.; less amount written off this year as per report, £12,169. 12s. 11d.	11,409	13	7
Investments in and advances to associated electricity supply companies—viz., shares at cost, £68,857. 8s.; mortgages, debentures, and bills, £103,573. 15s. 4d.	172,431	3	4
Provisional orders secured at cost	1,532	2	1
Pending applications for provisional orders at cost, £1,775. 0s. 5d.; less amount written off as per report, £830. 7s. 1d.	944	13	4
Head office furniture, books, and instruments, £1,356. 14s. 8d.; less amount written off, £64. 6s. 10d.	1,292	7	10
Sundry debtors, £7,589. 17s. 4d.; bills receivable, £1,030. 11s.	8,620	8	4
Cash at bankers and in hand	3,290	18	3
	£482,555	14	8

REVENUE ACCOUNT, TWELVE MONTHS ENDING DEC. 31, 1896.

Dr.	£	s.	d.
Proportion of directors' remuneration, salaries, and wages, rents, rates and taxes, and insurance	1,560	17	11
Printing, stationery, and postage	204	12	2
Sundry charges and travelling expenses	634	13	3
Auditors' fees	116	10	0
Depreciation of office furniture	64	6	10
Balance carried to net revenue account	5,904	11	7
	£8,485	11	9

Cr.	£	s.	d.
Gross profits derived from interest on investments, rents, discounts, and administration of associated companies	5,538	8	11
Commissions	537	0	0
Transfer fees	46	12	6
Profits on investments realised	1,218	5	5
Balance from revenue account	1,145	4	11
	£8,485	11	9

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NOTTING HILL ELECTRIC LIGHTING COMPANY.

The tenth annual meeting of this Company was held at the offices, Bulmer-place, Notting Hill, on Tuesday, Prof. W. Crookes, F.R.S., chairman of the Board, presiding.

The **Chairman**, in moving the adoption of the report and accounts (which we have already published), alluded in sympathetic terms to the premature death of Mr. Sidney Waters, to whom, he said, the Company owed so much of its present prosperity. Turning to the accounts, he thought they must in every way be considered satisfactory. The whole of their share capital had been issued. Last year they had £11,380 of preference shares unissued, but during the year these were considerably over-applied for by shareholders, and the whole of the issue was allotted at a premium of £2 per £10 share. Owing to the great increase of their area, they had to provide capital to lay down more mains and to build more engines and machinery, as and when the demand for current increased. As all their share capital was now issued they had two options before them. One was to create more share capital and the other to make use of their powers to borrow not more than 50 per cent. of their capital. As regarded their loan capital, they could easily borrow money on terms which would cost less than the dividend the shares would bear, as they would observe on £98,800 spent they had earned net £4,736, or about 5 per cent.; and as very much of their money was sunk in buildings, land, extra heavy mains, and other things which would not require increase as the output increased, all fresh money they spent yielded considerably over 6 per cent. That being the case, it followed that if they could secure money at 4 per cent. there was at least 2 per cent. profit on all such loan money spent for the benefit of the shareholders. But they could do even better than that. If they issued debentures or debenture stock to pay 4 per cent., and undertook not to redeem at par before the end of their 42 years—retaining the power to pay off at 105 after 10 years—they could not only place the debentures, but obtain a premium besides, for their reserve. They had had bids at 106 per cent. for all they required at present; but if any shareholder would like to participate, his application on these terms would have preference. During the ensuing year they would push forward their heavy work as fast as they could, and by the end of the year they expected to have filled up their compulsory area—he meant, of course, their new area—with all necessary mains. This, with the increase of expenditure on machinery, would absorb £10,000 of debenture money. After that he did not foresee any great expenditure. The Bill confirming their new provisional order gave the Company authority to supply electricity over about a square mile of the northern part of the parish of Kensington, adjoining their original area of supply, and also enabled them to extend their mains down Holland Park-avenue (late Uxbridge-road), and thence throughout Addison-road to Kensington-road, connecting at that point with the mains previously laid. They were thus enabled to give a full supply of light to consumers at the most distant point of their area. The directors proposed a dividend of 6 per cent. on the ordinary preference shares (which had already been paid) and 4 per cent. on the ordinary shares.

Mr. A. Howden seconded the motion, and it was agreed to.

Mr. Howden and Mr. J. T. Jervis were re-elected to the Board of directors, and the meeting then terminated.

DUDLEY AND STOURBRIDGE TRAMWAYS COMPANY.

The annual meeting of the Dudley and Stourbridge Steam Tramways Company was held at the Grand Hotel, Birmingham, on Tuesday. Mr. G. Bagott (chairman) presided, and the other directors present were Messrs. C. A. Edge and T. P. Harris.

The **Chairman**, in moving the adoption of the report, said they considered it somewhat satisfactory. The traffic receipts had increased from £7,303 to £8,212, and the expenses were £5,738, against £5,816. The mileage had increased from 112,490 to 118,368, and had been run at a less cost. He compared the different items in the balance-sheet with those in that of last year, and said that the most gratifying part of the present report was that the profit had risen from £1,550 to £2,822. They had not relaid any of the lines this year; if they had done so the profits would have been diminished by about £300. After they had paid a dividend of 2½ per cent. they proposed to carry £1,349 to depreciation fund, as against £966 last year. This was about £400 more than last year, but they would probably have to expend this additional amount in necessary work on the lines during the next 12 months. The depreciation fund would stand at £2,883, as against £2,458 last year. During the year they had made nearly 11,000 journeys, and they had only lost eight—a remarkably piece of tramway work. The shareholders should bear in mind that they had laid 4½ miles of new tramway, and there yet remained one mile more to relay. When that was done they might reasonably expect an extra sum of money for some years to come to be added towards dividend.

Mr. U. A. N. Smith seconded the motion.

Mr. H. G. Walker asked if anything had been done with regard to the property being purchased by a new company. He thought the shareholders ought to be taken into confidence in this matter.

Mr. E. Rowlands (solicitor), at the request of the chairman, explained that certain negotiations were proceeding between the Company and the British Electric Traction Company with a view to the purchase by the latter of the Dudley and Stourbridge Company. He was prepared to give the figure privately to any shareholder, but he questioned the wisdom of a public announcement Whatever proceedings were ultimately taken, the shareholders would be consulted before the agreement was finally approved. The terms of purchase had virtually been agreed upon, but the document was not signed. He hoped the shareholders would be called together shortly.

In reply to a question, the **Secretary** (Mr. H. F. Woodward) stated that there were about 170 shareholders.

BATH ELECTRIC LIGHT COMPANY.

A general meeting of shareholders was held last week to wind up the Company.

The report of the directors contained the following: The shareholders will recollect that at the extraordinary general meeting of the Company, held on August 7, authority was given to the directors to complete the contract whereby the Company's works were to be sold to the local authority of Bath. The directors have now to report that the sale has been carried into effect, and on the 7th inst. the works were handed over to the Corporation against payment of the contract sum, the Company's statutory power ceasing at the same time. The purchase-money has in part been applied in paying off the bank overdraft—thus at length releasing the directors from the heavy responsibilities of their personal guarantees—the debentures, and the mortgage on the land and buildings. The balance, amounting to £15,000, has been placed on deposit at interest pending its distribution to the shareholders by the liquidators when appointed. There are unrealised assets consisting of plant and materials not purchased by the local authority and book debts, and there are current trading accounts due by the Company to be settled, but the directors are now able to state with confidence that their forecast of August last will be fully realised, and that there will be quite £5 per share to distribute to the shareholders. Under the circumstances, and to save time and expense, the directors have not prepared audited profit and loss accounts for the past year, but call the shareholders together at the earliest possible moment and recommend the passing of the winding-up resolution, as set out in the annexed notice of the extraordinary general meeting, in order that the shareholders may as soon as possible receive the proceeds of the sale of the works. There is no doubt that if the Company had been able to continue its business, the shareholders would in a very short time have had no cause to regret their investment in the Bath electric light works.

The following resolution was carried: "That the Company be wound up voluntarily under the provisions of the Companies' Acts, 1862 to 1869, and that Charles Joseph Wharton, of Palace-chambers, Westminster, electrical engineer; Benjamin Humphries Van Tromp, of 4, Hyde Park-terrace, London, solicitor; and William Jeffery, of the city of Bath, accountant, be, and they are hereby appointed, liquidators for the purpose of such winding-up."

HOVE ELECTRIC LIGHTING COMPANY.

The annual meeting of this Company was held at Cannon-street Hotel on Wednesday, the chair being taken by Colonel H. Wood, C.B., in the absence of Colonel Filgate. The meeting was delayed over a quarter of an hour to secure the attendance of even one shareholder, which fact expresses the satisfaction of the body of shareholders at the way the Company is conducted.

The **Chairman** moved the adoption of the report and accounts (which we have published in these columns), and proposed the declaration of a dividend at the rate of 6 per cent. for the half-year on the share capital.

These motions were carried, and other formal business having been transacted the meeting adjourned.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Jassy (Roumania).—The Municipal Authorities of Jassy are open to receive at once proposals for the establishment of a system of tramways.

Ekaterinoslav (Russia).—The Municipal Authorities will receive tenders on 20th inst. for installing and working the electric light in the town.

South Shields.—The Corporation are prepared to receive tenders for the supply of electric plant and the carrying out of the work connected with the same. Full details appear in our advertisement columns.

Extreme Orient.—The *Moniteur Industrielle* states that the concession holder for the electric tramways of the town of Extrême-Orient is open to negotiate with manufacturers of fixed and rolling stock. Particulars are obtainable at the Brussels Bourse.

Braila (Roumania).—The Local Authorities are prepared to receive up to March 15 offers for a concession for the construction and working of a system of electric tramways. The aggregate length of line would be about 13 miles, and applications and enquiries should be addressed to the Mairie, at Braila.

Glasgow.—Tenders are invited for supplying and fixing in the Olympia, New City-road, during the month of April, a 25-h.p gas-engine, together with 20 arc lamps, each of 2,000 c.p., and a quantity of small incandescent lights, together with all the necessary wire cable, switches, etc. Address tenders to E. H. Bostock,

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care of Lithgow and Son, printers, 76, West Howard-street, Glasgow.

Islington.—The Vestry are prepared to receive tenders for the supply and erection of a combined set, comprising 80-i.h.p. high-speed enclosed engine, 35 to 40 kw. alternator, having very low armature drop and reaction, and 20-kw. continuous-current dynamo, on combination bed-plate. For full particulars see advertisement.

Dresden.—The Saxon State Railway Authorities will receive on March 10 tenders for miscellaneous telegraphic stores, including 3 tons of bronze wire, 59 tons of galvanised iron wire (4mm.), 10 tons of copper wire (6mm.), 2½ tons copper gauze, 1 ton insulated copper wire (strong), 15,000 porcelain insulators, and 10,000 zincs for Meidinger cells. Application to die Königl. Betriebs-Telegraphen Oberinspektion, der Sachsischen Staatseisenbahnen, Dresden.

Tunbridge Wells.—The Corporation invite tenders for the supply and erection of a 350-kilowatt steam alternator with engine combined. Copies of the specification and further particulars can be obtained on application to the borough electrical engineer, Mr. H. L. P. Boon, Town Hall, and on payment of £2. 2s., which will be returned on receipt of a bona fide tender. Tenders, endorsed "Steam Alternator," to be delivered at the office of Mr. W. C. Cripps, town clerk, Town Hall, Tunbridge Wells, by March 13. The person or firm whose tender is accepted will be required to enter into a contract and bond with two approved sureties for the performance of contract.

Morecambe.—The Electric Lighting Committee of the Urban District Council are prepared to receive tenders for the supply and erection of the following plant (the whole bound up in one specification, price £2. 2s., returnable on receipt of a bona fide tender): Section A—Boilers and accessories; Section B—Steam and exhaust pipes, etc.; Section C—Steam dynamos and accessories; Section D—Switchboards, etc.; Section E—The mains; Section F—Arc lamps and posts, etc.; Section G—Transformers; Section H—Secondary batteries; Section I—Apparatus and tools; Section J—Testing instruments and apparatus. Tenderers are at liberty to tender for either section, but not for part of a section. Ground plans of plant and specifications, with terms and conditions of tender and contract, may be obtained at the offices of the Council, Morecambe-street, Morecambe. Tenders, sealed and marked "Tender for Electric Lighting," must be addressed to Mr. Wm. Tilly, clerk to the Council, District Council Offices, Morecambe-street, Morecambe, and be delivered by March 11.

Ashton-under-Lyne.—The Corporation are prepared to receive tenders for the supply and erection complete of the following apparatus and plant: Refuse destructors; multitubular and Lancashire boilers; economiser, tanks, pumps, steam-pipes, etc.; continuous-current steam dynamos, motor-generator, balancing transformer, switchboard, cables, street-boxes, etc.; arc lamps and columns, accumulators, overhead crane, station wiring, meters. Tenders may be sent in for any section or for the whole of the sections, but not for part of a section only. Plans of the district can be seen and copy of the general conditions, specification, and form of tender can be obtained on deposit of £5. 5s., which will be returned on receipt of a bona fide tender, at the Borough Comptroller's Office, Town Hall, Ashton-under-Lyne, or at the offices of the consulting engineers, Messrs Fawcus and Clirehugh, Temple chambers, Brazennose-street, Manchester. Sealed tenders, which must be on the prescribed form, endorsed "Tender for Electric Lighting," to be delivered to Mr. John Neal, borough comptroller, Town Hall, Ashton-under-Lyne, not later than 12 o'clock noon on March 15.

Plymouth.—The Corporation are prepared to receive tenders for the following engineering works in connection with the electricity works of the borough—viz. (Contract No. 1) steam alternators (disc armatures) and dynamos, exciters, motor-generator, rectifiers, etc.; (2) Lancashire boilers with mechanical stokers steam, exhaust, and other piping, ejector condensers, valves, electric pumps, water-tanks, economiser, etc.; (3) electric accumulators, etc.; (4) overhead travelling crane, jib wall crane, turntable, etc.; (5) switchboard (Ferranti type) and instruments; (6) high and low pressure mains, etc.; (7) stoneware conduits, etc.; (8) alternating-current transformers, sub-station switch-gear, etc.; (9) arc lamps for rectified currents, posts, etc. Contractors, who must in all cases be the actual manufacturers of the apparatus tendered for, are at liberty to tender for any of the contracts, but not for a part of any contract. Copies of the conditions, specifications, and forms of tender, bound up together, may be obtained from Mr. John H Rider, borough electrical engineer, East-street, Plymouth, on deposit of a £5 Bank of England note for each copy, which will be returned on receipt of a bona fide tender upon the prescribed form and within the stated time. Should a contractor withdraw his tender, the amount of his deposit will be forfeited. In his application the contractor must state which contract or contracts he proposes to tender for, and copies of the drawings relating thereto will be forwarded with the specifications. Drawings must be returned undamaged with the tenders. Sealed tenders, endorsed "Engineering Contract, No. —," must be delivered to Mr. J. H. Ellis, town clerk, Plymouth, by March 26. The acceptance of any tender will be subject to the contractor paying the standard rate of wages obtaining in the district where the work may be carried on.

RESULTS OF TENDERS.

Southampton.—The Town Council have accepted the tender of Messrs. Playfair and Toole, Southampton, at £8,334, in regard to the erection of buildings under Contract No. 1, the tender being the lowest sent in.

Stockton.—The Tees Conservancy Board have accepted the tender of Messrs. Scott and Mountain, of Newcastle, to light the dock by electricity for £1.195. There was one other tender, from Messrs. J. H. Holmes, of Newcastle, and the amount of this was £1,250.

BUSINESS NOTES.

Torrington.—Shebbear College has been fitted with an installation of the electric light.

Birkdale.—The District Council are talking of adopting the electric light for the town.

Manchester.—The City Council have agreed to several extensions of the electricity mains in the streets.

Commercial Cable Company.—The Company have declared a quarterly dividend of 1¾ per cent. on capital stock.

Leicester.—It is proposed to light the borough lunatic asylum with electricity from the Corporation mains at a cost of a little over 2d. per unit.

The York Tramways.—The tramways company are applying for an order to permit the use of mechanical power in place of horse traction.

Glasgow.—The Town Council have refused the request of the National Telephone Company for wayleave to put underground wires in the city.

Derby.—The Electric Lighting Committee propose to spend a further sum of £20,000 for the extension and improvement of the electric light installation.

Bridlington.—Rather than spend a little money on the new cable and a larger dynamo, the District Council have decided not to extend the electric light to North Cliff.

Totnes.—The Mayor and several members of the Corporation visited the premises of the *Totnes Times* a few days ago to witness the first installation of the electric light in the town.

Brierley Hill.—A meeting of ratepayers has been held for the purpose of empowering the Urban District Council to oppose the Birmingham, Wolverhampton, and District Tramways Bill.

Barnstaple.—The recommendation that the Town Council should purchase a Röntgen-ray apparatus to be kept at the School of Art has been referred back to the Science and Art Committee.

Municipalisation of Tramways.—The Aberdeen Town Council and the Dundee Town Council respectively are negotiating with the local tramway companies for the purchase of their undertakings.

York.—A meeting has been held in Bootham Ward Club to discuss the question of electric lighting and its effect upon the city. The question of municipalisation *versus* company was also discussed.

Newcastle.—The Town Council have given notice of their intention to apply to the Local Government Board for sanction to borrow £820 for lighting by electricity and ventilating the concert-room, etc.

Brazilian Submarine Telegraph Company.—The directors have declared an interim dividend of 3s. per share, or at the rate of 6 per cent. per annum, free of income tax, for the quarter ended December 31 last.

Nantwich.—The Urban District Council have requested Mr. Edmondson (who is acting on behalf of the electric lighting company) to furnish further particulars with regard to his proposed scheme for lighting the town.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended February 28 amounted to £1,275, as compared with £1,056 in the corresponding week of the previous year, being an increase of £219.

The Trunk Telephone System.—Several meetings have been held in Scotland recently to press upon the postal authorities the advisability of adopting various routes for the main trunk telephone lines to be established from Aberdeen.

Colchester.—The Town Council have received sanction from the Local Government Board to the borrowing of £14,900 for purposes of electric lighting, but the loan of £100 for temporary plant at the military hospital is excluded.

Bristol Tramways and Carriage Company, Limited.—The traffic returns for the week ended February 26 were £2 218. 7s. 2d., compared with £1,701. 5s. 1d. for the corresponding period of last year, being an increase of £517. 2s. 1d.

London Lighting Extensions.—The London County Council have given their consent to extensions by the Vestry of St. Pancras. The Hampstead Vestry have also given notice of intention to lay mains in Lower terrace and Elsworthy-road.

Metropolitan Electric Supply Company.—The Company have obtained the sanction of the London County Council Highways Committee to alter the present high-tension supply to a low-pressure distribution, subject to certain conditions.

Swansea.—In continuation of the course of electrical lectures organised by the Swansea Scientific Society, Mr. Wm. Williams, B.Sc., lectured to a large audience at the Royal Institution of South Wales last week on "The Principal Effects Produced by Electricity."

Crystal Electric Lamp Company, Limited.—This Company has been registered, with a capital of £28,000 in £5 shares, to enter into an agreement with a company bearing a similar title, and the liquidator thereof, and to carry on the business of an electric light company in all its branches.

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Walton (Surrey).—A letter was read at the Urban District Council meeting from the Board of Trade with respect to the objection to the application for the Walton electric lighting provisional order laid by the Council, stating that the order in question would not be proceeded with.

Ruabon.—An anonymous writer in a local paper, who signs himself "A Lover of Electric Light," asks why they cannot have electric light in the four parishes of Ruabon. He says there is ample water power, and he hopes to hear that a company will soon be formed to take up the matter.

City and South London Railway.—The returns for the week ended February 28 were £996, compared with £946 for the corresponding period of last year, being an increase of £50. The total receipts for the half-year 1897 were £9,713, compared with £8,860 last year, being an increase of £853.

Appointments Vacant.—The Harrogate Corporation have vacancies for an assistant electrical engineer, three drivers of flywheel steam alternators, three stokers for boiler-house, and one fitter. Apply to Mr. G. Wilkinson, Electrical Engineer's Offices, Montpellier-gardens, Harrogate.

Edinburgh.—Ex-Bailie Lawrence has introduced the electric light into the Forres Mills. The power to drive the dynamo was got by connecting it with the mill shafting, and it supplies a total illumination of about 500 c.p. The machinery, however, is capable of producing double that supply if necessary.

Electric Traction.—The winter course on this subject to the Glasgow and West of Scotland Engine-Keepers' Association concluded last week with a lecture on "Conduit and Battery Systems." The lecturer, Mr. T. Crichton Fulton, A.I.E.E., gave a brief account of the chief features of these systems.

Eccles.—At the Town Council meeting the Town Clerk read a letter he had received from the South Manchester Electric Supply Company, Limited, stating that they had applied to the Board of Trade for the revocation of the Eccles electric lighting provisional order, and for the issue of a new order in their favour.

Tramway Traction in London.—The following resolution was adopted at the meeting of the London County Council: "That it be an instruction to the Highways Committee to investigate and report to the Council upon the latest improved methods of tramway traction suitable for adoption in the streets of London."

Dividend Warrants.—The warrants for the payment of the dividends on the preference and ordinary shares, together with allotment letters for the present issue of 10,000 new ordinary shares of £10 each, part of the 40,000 created by resolution at the same meeting, have been posted by the Board of the City of London Electric Lighting Company.

Liverpool.—It was stated at the City Council meeting with regard to the price of electric light that they had only been at work six months, but it was the intention of the committee to reduce the price as soon as they were able to do so. The lighting of the streets by electricity has, so far as it has been carried out, given great satisfaction.

Blackrock.—At a meeting of the Commissioners the Chairman said the tramway company had sent a petition for the consideration of the Commissioners, asking the Board of Trade to permit them to run their cars at a speed not exceeding 12 miles an hour along the roads outside Blackrock. On the motion of Mr. Wright, the petition was adopted, sealed, and signed.

Clerk of Works Wanted.—The Morley Corporation (Yorks) require a competent man to superintend the erection of buildings for electric lighting works and public baths for the borough. Applications, endorsed "Clerk of Works," stating age, previous experience, and salary required to be sent to Mr. R. Borrough Hopkins, town clerk, before noon on 15th inst.

The Brussels Exhibition.—Sir Albert K. Rollit stated at a recent meeting of the London Chamber of Commerce they were assured of a British industrial section at the forthcoming exhibition at Brussels, large in proportion to the exhibition buildings; far larger than those of Germany and of the United States, though still small in comparison with the display by France.

Hastings.—The Brush Company have received an order from the Hastings Electric Light Company for a 25-kilowatt alternating set, consisting of a 45-i.h.p. "Universal" engine coupled direct to a Mordey-Victoria standard pattern alternator. The plant is intended to take the day load of the station, and considerable economy is expected to result from its use for this purpose.

Worcester.—Mr. Murray (the engineer to the City Council) has written a report on the financial position of the electricity works, which was read at the Council meeting, and which stated that the machinery at Powick was not working at the efficiency that was expected. The subject was referred back to the Electrical Committee for further consideration, with instructions to bring up recommendations upon it.

Burnley.—The Town Council have decided to adopt an alternative system of charging for electrical energy. Consumers will be charged by the actual amount of energy supplied at the rate of 6d. per unit, or, at the option of the consumer, by a fixed charge for capital purpose at the rate of £8 per annum for every 16-c.p. (or their equivalent) lamp burnt at any one time, and 2d. per unit as charged by meter.

Hull.—At the meeting of the Electric Lighting Committee plans were put in for the laying of mains for the supply of electric light to the Station Hotel. The Chairman said the estimated cost of the service would amount to £192, but the committee thought the acceptance of the terms would lead to other business, including the lighting of the station and the offices. On the motion of Mr. Hanger, seconded by Mr. J. G. Hall, the terms were adopted.

Motor Attachment Syndicate, Limited.—This Company has been registered, with a capital of £10,000 in £10 shares, to acquire and work a patent for an improved method of constructing, mounting, and arranging the underframe and driving appliance of electric and other road motor-cars, and means or apparatus for reducing vibrations and oscillations, and to carry on the business of electricians, mechanical engineers, machinists, fitters, founders, etc.

Stockton.—At the meeting of the Tees Conservancy Board, Mr. William Hanson, J.P., explained the steps that had been taken by the Graving Dock Committee as to electrically lighting the dock. Sufficient power would be applied to ensure the complete lighting of the works and the dock, and also for the application of motors for the transmission of power to machines, which would be a great convenience to the ship repairers using the dock.

Sheffield.—Mr. Raworth's new "Universal" engine is to be introduced into the electricity works, the Sheffield Electric Light and Power Company having placed an order with the Brush Company for a 300-kilowatt alternating set, consisting of a 500-i.h.p. "Universal" engine coupled direct to a standard type Mordey-Victoria alternator. We understand that the Brush Company are now extremely busy with orders for "Universal" engines and alternators.

London.—At the meeting of the City Commissioners of Sewers the Streets Committee recommended that an account should be prepared of the expenses of the electrical inspector in connection with the Electric Lighting Orders Confirmation Acts, 1890 and 1891, and application made to the City of London Electric Lighting Company for the reimbursement by them of such expenses, due credit being given for the fees received by the said officer. The Court agreed.

Portishead.—The Council at their last meeting received a report from the Lighting Committee, and decided to let the matter of street-lighting stand over till a reply should be obtained from the gas company in answer to a letter from the Council. The Board decided to form a sub-committee to obtain information with regard to the methods and advisability of lighting the village with electricity. The Lighting Committee was appointed, with Mr. Butler's name added.

Sligo.—It was reported at the meeting of the Finance and Works Committee that the Roads and Lighting Committee had passed the following resolution: "That in our opinion the time has arrived when the whole town should be lighted by electricity, as we believe the Council is not receiving value for the amount paid for gas, and the present light is insufficient." A meeting of the committee appointed six or seven months ago to consider the question has since been summoned.

The Swansea Trams.—The Swansea Improvements and Tramways Bill has complied with the preliminary Standing Orders of Parliament as to notices, etc., and was sent by Mr. Thoms, the examiner, for first reading in the Commons. The Bill, which was unopposed at this stage, confers further powers on the Swansea Improvements and Tramways Company with respect to their tramways and with respect to the electric lighting undertaking of the Swansea Corporation.

Norwich.—The Town Clerk reported at the Town Council meeting that the examiner of Standing Orders had certified to the House of Lords in the case of the Norwich Electric Tramways Bill that the Standing Orders which were applicable to the introduction of the Bill had not been complied with. A petition 900ft. long, and signed by 23,500 citizens over 18 years of age, praying that the Council would support the Bill in Parliament, has been referred to the Parliamentary Committee.

Dover.—At the Town Council meeting Councillor Edwin called attention to the charges for electric light current at the town hall, and asked if there was a contract. They were paying far in excess of what they ought to. The Town Clerk said there was no contract. Councillor Edwin moved that the company be informed that they ought to take into consideration the large quantity of electricity used in the town and supply it at the reduced price of 5d. per unit. Alderman Pepper seconded the motion, which was carried.

Brush Electrical Engineering Company, Limited.—Notice is given that £26,770 second debenture stock, part of the issue of £105,000 second debenture stock of this Company issued in pursuance of trust deed dated October 4, 1895, will be drawn for redemption at £105 per £100 of stock. The drawing will take place at the offices of the Company, 49, Queen Victoria street, London, E.C., at 12 noon on Friday, March 19, 1897. Six months' notice of the date of repayment will be given to the registered holders of drawn stock as soon as possible after such drawing.

Coventry.—The Estates and Finance Committee recommended at the meeting of the City Council that a piece of allotment land off the Stoney Stanton-road be sold for £800 to the New General Traction Company, the promoters of the Electric Tramways Extension Bill. The land is wanted for the purposes of erecting a generating station. Alderman Loudon believed the trams had brought thousands of people into the city, where there had previously been but hundreds, and that the numbers would be augmented by the proposed new tramway service. The committee's recommendation was adopted.

The Proposed Railway from Piccadilly-circus to South Kensington.—In compliance with the Standing Orders of Parliament estimates have been prepared and deposited in the Private Bill Office of the House of Commons of the cost of constructing the proposed underground railway from Piccadilly-circus to South Kensington. The total cost of the railway is estimated at £563,115,

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which includes £33,707 for a generating station, and £5,575 for two subways for foot passengers. The railway, which will be two miles 12 chains in length, will be constructed in two separate tunnels for up and down traffic.

Fatal Accident to a Bradford Engineer. — Mr. Charles Collinson, electrical engineer, a member of the firm of Collinson Bros., electrical engineers and cycle makers. of Aldermanbury, Bradford, met with a fatal accident on Wednesday morning. He was at the Old Post Office Stores, Piccadilly, Bradford, superintending the erection of an electric hoist, and a man named Steele was fixing an iron beam at the top, when the scaffold upon which he was standing fell. Steele managed to cling to the support, but a plank struck Mr. Collinson on the head, and he died before he could be removed to the infirmary.

Sydney Exhibition. – On June 20 an important exhibition is to be opened in the Exhibition Building, Prince Alfred Park. Sydney, New South Wales, and will remain open during July and August. It is intended to embrace engineering in all of its branches, but electricity (Group IX.) will occupy an important place. This group embraces generators, conductors, testing and measuring apparatus, telegraph and telephone apparatus, electric lighting apparatus, electro metallurgy and electro-chemistry, transmission, distribution, and utilisation of power, lightning conductors, electro-thermic apparatus, and electro medical apparatus.

Birmingham.—The deputation appointed by the Public Works Committee to visit certain Continental cities to inspect various forms of tramway traction left Birmingham yesterday (Thursday) for London, and Paris *vid* Calais, arriving in the French capital the same evening. From Paris they will proceed to Rouen, and afterwards visit Brussels, Berlin, Budapest, and probably Nantes. On their return to London they will inspect the Highgate tramway. The deputation consists of Alderman Cook, Alderman Hallam. Mr. Bisseker, and Mr. Lane, and their trip will last about 17 days. On Friday and Saturday last they visited Blackpool and Bristol.

Chelmsford.—In reference to the question of the appointment of an electric light inspector, the Lighting Committee reported at the Town Council meeting that they had directed the town clerk to ascertain whether other towns lighted by electricity supplied by means of companies have appointed an inspector, and if so, what are the salaries and fees paid, and by whom. The committee also recommended that the town clerk be instructed to write to the Chelmsford Electric Lighting Company and inform them that complaints had been made by consumers that the power of the lamps had been defective. These recommendations were agreed to.

West Suburban Railway Bill Withdrawn.—From the group of private Bills interesting to London a withdrawal of some importance has been announced. It has reference to the plans which were deposited in regard to a measure which was known as the West Suburban Railway Bill, which proposed to incorporate a company for making a railway from Praed-street, Paddington, to Willesden, of the length of four miles and 41 chains, to be worked by electricity or cable power. The notice of withdrawal has been formally communicated to the officers of the House, and the Bill accordingly will not be further proceeded with during the ensuing seseion.

Salford.—Councillor Thompson suggested at the meeting of the Union Infirmary Committee that they should consider the question of lighting up the hospital with the electric light, the price of which was now cheap. It would not cost the Guardians much more than gas. By introducing it they would be able to dispense with some of the lights. Mr. Costley said he thought the sooner they took the matter into consideration the better, for the electric light was undoubtedly to be the light of the future. It was decided to consider the matter that day month. The Town Council have decided to advertise for an installation of electric light in the town hall.

Dublin.—The Board of Trade have decided that pending the fitting of the Dublin United Tramway Company's electric cars with governors, the time to be occupied in making the distance between Haddington-road and Dalkey shall not be less than 80 minutes. The company have concluded their agreement with the Rathmines Commissioners for the employment of electricity as the motive power for the cars in that township, and the extension to Pembroke township through Castlewood-avenue ; at the end of 40 years the Commissioners to have the power of buying up the lines at their then value with 30 per cent. added. The agreement was sealed on Saturday.

Calcutta.—At the meeting of the Municipal Commissioners on January 28 the question of substituting electricity for the existing horse traction on the Calcutta tramways was again brought forward, and the whole subject was, after some discussion, again sent back for consideration and report by a sub-committee. It was, however, practically decided that no increase of capital by the Calcutta Tramways Company to put down the necessary electric supply installation and to lay down new rails, etc , was to be permitted or recognised by the Corporation. Messrs. Kilburn and Co. have intimated to the tramways company that they, acting for their principals, now withdraw from the whole business.

Notice —The current number of the *Windsor Magazine*, a copy of which has been forwarded to us by the publishers, contains a popularly written article by Roland Belfort, entitled "Making and Laying an Atlantic Cable." An interview with Mr. Alexander Siemens and a visit to the cable works of Messrs. Siemens Bros. and Co. furnish the basis upon which the text is written. The article is well illustrated. the illustrations including a clear view of the cable-ship "Faraday" at anchor. This vessel, which was designed by Sir William Siemens, is, the writer points out. admirably adapted for the work which she has to perform, and enjoys the distinction of being one of the two largest cable-ships afloat.

Gloucester.—At the meeting of the City Council Alderman Mousell moved that a special committee be appointed to consider what steps should be taken by the Corporation under the Gloucester Corporation Electric Supply Order, 1896. He said they had already had a deputation of influential tradesmen of Gloucester asking the Corporation to supply the electric light, or at any rate give them a means of having it. The time was close at hand when the Corporation must supply it themselves or allow someone else to do so, and he trusted that it would fall into their own hands. Councillor Allen seconded, and the motion was agreed to, the committee consisting of the Mayor, Deputy-Mayor, ex-Mayor, Alderman Mousell, and Councillors Matthews, King, Treasure, Blinkhorn, Branch, Clutterbuck, and Radford.

Cheltenham.—It was reported at the Town Council meeting by the Streets Committee that the draft of the provisional order for the proposed light railway had been settled, and that clauses had been inserted in the order for the protection of the Corporation. The gauge would be 3ft. 6in. ; goods were to be conveyed only in covered carriages ; and goods traffic was to be restricted to the hours between 10 o'clock at night and 9 o'clock in the morning. It was explained by Alderman Norman that the electric lighting of the Promenade would be proceeded with at once in view of the intended visit of the Prince of Wales, and the electrical engineer had been instructed to prepare a scheme for arc lighting in Winchcombe-street also. He further hoped that the lower High-street lighting would be taken in hand at the same time.

Rochdale.—The special committee who were appointed by the Guardians to examine into the question of lighting reported at the last meeting of the Guardians that they had considered a return of the cost of gas at the workhouse during the past five years. This showed that for 1896 the gas bill was £313. 13s. 4d. The committee went into the question as to whether electricity would not be more economical Mr. Wild (who was in the chair) assisted the committee with calculations and estimates. After carefully considering these it appeared to the committee that it would cost less to light the workhouse by electricity than it costs by gas. It was thought, however, that before making a recommendation to the Workhouse Committee the sub committee should visit two or three public institutions already lighted by electricity. Authority for this was given.

Aston.—The Highways and Buildings Committee of the District Council report that they have not presented the petition against the Birmingham City Tramways Bill, for the reason that the solicitors to the company saw the chairman and clerk, and stated that for the purpose of complying with the Standing Orders of the House of Commons it was necessary to obtain the assent of the Council to the Bill on or before February 17, the company offering to give in return for such assent an undertaking to withdraw from the Bill all powers within the jurisdiction of the Council if the Highways Committee should fail to come to an agreement with the company. In these circumstances, and having regard to the fact that there was no time to convene a meeting of the Council, the chairman instructed the clerk to assent to the Bill on the terms above stated, and the committee have approved his action.

Catalogues.—The Edison and Swan United Electric Company, Limited, are now sole agents for "Doulton" and "Doulton Holbein" ware statuettes, brackets, etc., adapted for electric light, and the catalogue they have issued containing illustrations of some specimens shows how effectively the Doulton ware can be utilised for ornamental lighting purposes. As we have previously announced, Section 3 Catalogue has been issued giving full details and illustrations of the "Ediswan" fittings, holders, switches, etc. The book is splendidly got up, and we can only say that every electrical engineer should possess a copy of it ; he will find it most useful.—Messrs. W. B. Haigh and Co., Limited, send us an illustrated price-list of dynamos and electric motors. The output of the dynamos is given in kilowatts at various speeds, and the output of the motors is given in brake horse-power, with the prices of the machines. Messrs. Haigh's address is Globe Iron-works, Oldham.

Electric Lighting for Caracas.—The municipality of Caracas, the capital of Venezuela, according to the *Monthly Bulletin* of the Bureau of American Republics, has recently made a contract for the establishment of an electric lighting plant there. The contract requires the installation of 400 arc lights in the streets, squares, and public places of the city, and 500 incandescent lamps for the municipal buildings. In addition to the installation referred to above, the national Government has ordered 1,000 incandescent lights for the public edifices, and 100 arc lights to be placed in the Paseo de la Independencia, which is the famous drive of the city. The motive power to be used will be water, taken from the falls of the Macuto River, which are estimated as being capable of producing 6,000 h.p. The water will be concentrated at a height of 2,600ft. above the turbines, it is said, being the highest utilised waterfall in the world, exceeding the famous Comstock mines of Nevada, which has a vertical fall of 2,100ft.

A New Transatlantic Cable.—The construction of the new Transatlantic cable, to connect Brest with New York, is being rapidly pushed forward by the French Telegraphic Cables Company, which has a contract with the State. At the workshops at Bezons and at the Calais factory equal progress is being made The new cable will measure not less than 3,250 miles, or more than 6,000 kilometres. The manufacture of the conducting portion itself, which will consist of 13 strands, will consume 975,000 kilos of copper, and 845,000 kilos of raw indiarubber will be used as an

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insulator. The galvanised steel required for the first covering will weigh about 4,687,000 kilos, and 1,495,000 kilos of iron will be used for the iron wires which are to protect portions of the cable. The total weight of the 3,250 miles of material will be something like 10,976,350 kilos. Four vessels of considerable tonnage will be required to transport and place it, and it is hoped that a commencement will be made with the immersion early in the summer.

Paignton.—At the District Council meeting a letter was read from Messrs. Foster and Kite, solicitors, Torquay, informing the Council of the intention to apply to Parliament for powers to construct an electric railway from Torquay to Paignton. The chairman thought that Paignton had more to gain than even Torquay from the proposed tramway. Mr. Parnell also spoke in favour of any additional facilities of communication between the two towns. The only objection he saw was to overhead wires. Mr. Waycott welcomed additional modes of communication, and said that for every customer who went from Paignton to Torquay, one and a half would come by tram from Torquay to Paignton. Mr. Palk spoke strongly in favour of the scheme. The Chairman said overhead wires were only dangerous in case of a storm, and the reason for their use was that they would be already in existence for electric lighting in Torquay. A resolution was unanimously passed agreeing to the principle of the scheme, and expressing concurrence with it.

Cork.—Councillor Casey has been appointed to the Electric Lighting Committee. At the meeting of the Gas Consumers' Company the Chairman said they had two or three times lodged applications for license to supply the electric light, but on the last occasion they refrained from doing so as the Corporation applied for the licence for themselves, and the Board of Trade was always disposed to give the preference to the local authorities. When, after obtaining the license, they advertised for tenders from parties willing to work it for them, the company did not put in for it, because they preferred to leave to others the loss they thought likely to ensue. They also found that their Act of Parliament did not authorise them to apply their funds to any other purpose than the supply of gas, and that they would either have to go to Parliament for extended powers or form a second or subsidiary company for the electric lighting. He did not think they had anything to fear from competition with the electric light. In fact, where towns had adopted that light there had been a notable increase in the demand for gas.

Handsworth.—The Surveyor reported at the Urban District Council meeting that he had been unable to arrange a meeting of the Council with the Sheffield Electric Lighting Company, but he had seen the chairman and engineer, and they did not favourably receive the proposal. Practically it was not feasible. He had since received a letter confirming the opinion given. He had also had an interview with Messrs. Taylor and Field, and had explained the area proposed to be lighted and other details. He had received a letter stating that they were willing to give a professional opinion for 10 guineas. Mr. Haynes proposed that the Council ask the gas company to meet a deputation of the Council to discuss the question of reducing the cost of gas to the public lamps and to private consumers. Mr. Haigh hoped the Woodhouse Company would reduce the price, as 3s. 9d. per 1,000 feet was too much. Mr. Pye said the Council had a right to see after their own cause—that was the public lamps—but had nothing to do with private consumers. Ultimately a deputation (Messrs. Haigh, Herring, Haynes, and Hessey) was appointed to meet the gas company.

Colwyn Bay.—On Tuesday, February 23, the Light Railway Commissioners—namely, the Earl of Jersey, Colonel Boughey, and Mr. Fitzgerald—held their first enquiry in Wales under the Light Railways Act of 1896. The enquiry had reference to the proposed line from Colwyn Bay to Brynybia, which is at the extreme end of Llandudno, a distance of a little over four miles. Mr. Warwick Webb appeared for the promoters, while Mr. Moss (instructed by Messrs. Porter and Amphlett) opposed on behalf of the Colwyn Bay Urban District Council, the Conway Rural Council, and the Penrhynside Parish Council, and the trustees of the Rhos Calvinistic Methodist Chapel; Mr. E. Honoratus Lloyd (instructed by Messrs. Chamberlain and Johnson) on behalf of Sir Everard Cayley, Lord Mostyn, and a number of other owners and occupiers in the neighbourhood of Brynybia-road; Mr. Chamberlain for the Llandudno District Council; Mr. Mains for the London and North-Western Railway Company; Mr. Wakefield, of Combermere Lodge, Rhos-on-Sea, appeared also to oppose on his own behalf. The enquiry was concluded on the following day.

Islington.—Mr. Littlewood has given notice to move at the Vestry meeting this (Friday) evening that the Electric Lighting Committee be instructed to consider and report as to the advisability and probable cost of lighting Hornsey-road, Hornsey-rise, Tollington-park, and Hanley-road by electricity upon the completion of the work now in hand, and also as to the advisability of bringing the question of lighting Stroud Green-road before the Hornsey Urban District Council with a view of obtaining their co-operation. Mr. Hills has also given notice to move: "That before any further application is made to the London County Council for sanction to any loans for the purpose of the electricity works, the Finance and Electric Lighting Committees be requested to report fully to the Vestry as to whether in their opinion it is more conducive to the Vestry's interests and tends to ensure proper financial stability, for any future loans to be repaid within the same period as is allowed by the Local Government Board for the baths and wash-houses buildings and machinery instead of the longer period allowed by the London County Council subject to the condition that no fresh loan shall be applied for for renewals."

Mauritius (Gas and Electric) Lighting Corporation, Limited. This Company has been registered, with a capital of £50,000 in £1 shares, to acquire gas, coal, and electric works at Port Louis, in the island of Mauritius, with the land, plant, machinery, stock, and mains in connection therewith; to manufacture, sell, and supply light in the said island and elsewhere, and to carry on the business of a gas, electric, and coal works corporation in all its branches; to deal with and render saleable coke, coal, tar, pitch, asphaltum, ammoniacal liquor, and other residual products obtained in and from the manufacture of gas; to buy, sell, import, and export coal and coke, and to generally carry on the business of coal merchants in connection with the business of the Corporation; to construct, manufacture, and maintain works for holding, receiving, and purifying gas, and all other buildings and works, meters, pipes, fittings, machinery, apparatus, and appliances convenient or necessary for the purposes of the Corporation, either for gas, coal, or electric lighting purposes; as manufacturers of and dealers in stoves, engines, cables, wires, lines, accumulators, lamps, and other apparatus which may seem calculated, directly or indirectly, to promote the consumption of gas or electric lighting; as mechanical engineers, etc.

Belfast.—The report of the Electric Committee, which was read at the meeting of the Corporation, stated: "Acting on the advice of their engineer, your committee have approved of a change of the declared pressure to 220 volts instead of 110 and 220 as at present, and have authorised him to effect this change accordingly, which involves an estimated expenditure to the department of £2,500. A copy of the chairman's and engineer's report is appended hereto for the information of members. Your committee have still under consideration the changes referred to in these reports, and they are glad to see that the information confirms the engineer's original recommendations already adopted by the Council. The plans, specifications, and estimates are now in course of preparation for the new undertaking. Mr. V. A. H. M'Cowen, electrical engineer, reported having, by instructions of the committee, visited, with a view to obtaining information in the generation and distribution of electric current, Liverpool, Chester, Birkenhead, Bradford, City of London Company's station, Bankside, London; St. James's and Pall Mall Company, London; and Brighton; and that, after having had an opportunity of seeing the practice in the towns visited, he saw no reason to alter the general scheme recommended in his report of September 17, 1896." The report was adopted.

Bournemouth.—A special sessions for the county of Dorset was held at the Shire Hall, Dorchester, last week, to hear an appeal by the Poole Board of Guardians, as the Assessment Committee of the Poole Union, against the decision of the county magistrates sitting at Branksome in reference to the appeal made against their assessment by the Bournemouth and District Electric Light Company. The Assessment Committee of the Poole Union had assessed the works of the Bournemouth Electric Light Company, situate in the parish of Branksome, at £2,850 gross and £1,900 ratable. Against this the company appealed to a special petty sessions for Wimborne, sitting at Branksome on December 14, 1896, when the justices reduced the assessment from the amounts as stated above to £656 gross and £465. 10s. ratable. It was against this decision that the Assessment Committee now appealed. After hearing the evidence and addresses from learned counsel, the Bench allowed the appeal, but recommended that the gross value of the property should be put at £2 190 and the ratable £1,460. They also granted the appellants their costs, which it was agreed should be taxed out of session, but if that course were not adopted the Court intimated that they had decided to fix them at 500 guineas. Mr. Freeman asked for a case, but the Chairman said the Court did not feel that there was any question of law involved, and therefore were not inclined to grant it.

Peterborough.—Mr. Clifton proposed at the Town Council meeting: "That a further application be made to the Local Government Board for leave to borrow an amount for the installation of the electric lighting for the borough, and that it be referred to the committee, with power to act, to fix the amount to be applied for." He said municipal electric lighting was bringing in handsome profits all over the country, and it did not interfere with the gas trade. The ratepayers would lose thousands of pounds if they let the matter go by. Councillor Hunting seconded, and said the electric light had just caused the Northampton Gas Company to reduce their price 10 per cent. Councillor Batten opposed, because the money, he said, was wanted for other purposes. Alderman Barrett said the borrowing powers were sufficient for everything. Councillor Manton was in favour of selling the provisional order and the Queen-street premises, while Alderman Beaver and Councillor Nichols thought the Corporation should make the installation in the interest of the city. Councillors Cliffe and Miller opposed, and on a vote being taken the motion was lost by one vote—10 to 9. Councillor Batten then proposed that the Council sell the provisional order, and Councillor Risley seconded, remarking that the way the Council were playing with the matter would not enhance their reputation as business men. Alderman Beaver thought it would be a shame to do so, and Councillor Foote said the matter had better be deferred for a month, which was agreed to.

Aberdeen.—At a meeting of the Gas and Electric Lighting Committee the electric lighting accounts for the year ending December 31 were submitted. From these it appeared that the total income amounted to £4,579. 1s. 9d., and that after paying working expenses there remained a balance of £2,219. 10s. 9d., which, however, was more than taken up by interest on mortgage

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and other loans, depreciation on buildings and plant, and left an adverse balance on the year of £192. 15s. 3d. This was due to the reduction that had been made in the price of current and the lowering of the rent of meters. The loss, however, was more than met by the balance of £435 brought from the previous year's account. The principal items of income were: sale of current per meter, £4,126. 6s. 10d.; public lighting, £209 8s. 5d.; rental of meters, £118. 10s. 8d.; hire of engine and dynamo at Ballater, £92. 5s. 10d.; and sale of motors, £32. 10s. The total quantity of units sold was 210,185, as compared with 138,372 in 1895. It may be mentioned that last year the price of the electric current was reduced 1d. per Board of Trade unit, and that the meter rents were reduced by one-half. The price of the current is now 5d. per Board of Trade unit. The Gas and Electric Lighting Committee of the Town Council have had before them letters from Messrs. P. C. Middleton and Co., electrical engineers, stating that several residents in the west end of the city had been in communication with them as to the introduction of electric light in the district, pending the extension of the Corporation mains, and requesting the Council's permission to erect a temporary generating station for that purpose in the vicinity of Forest-road, from which they propose to run overhead wires. The committee did not see their way to recommend the Council to entertain the proposal

Torquay.—The Electric Lighting Committee reported at the Town Council meeting that they had invited proposals, with terms and conditions, from companies and persons for the free wiring of premises, and asked that they might be authorised to consider such proposals and deal with them as they think fit. The Town Clerk mentioned that the electric lighting works would be shortly commenced. Alderman Harrison explained that the "free wiring" meant that firms would undertake to wire houses in connection with the electric lighting on condition that they should receive, say, ¾d. per unit of the electricity consumed. Persons who paid for their own wiring would get electricity at 6d. per unit; others, whose houses were free wired, would pay 6¾d. The free wiring would be a popular way of getting the light taken in. Objection was taken to the words "deal with as they think fit," but eventually the motion was carried. Messrs. Foster and Kite wrote concerning the proposed Torquay and Paignton tramway. The company proposed to apply in May next for an order under the Light Railways Act, 1896, authorising the company to construct and work a light railway or tramway between Torquay and Paignton, the motive power being electricity. Before making the application the company had instructed them to consult the local authorities, and with this object they wished to place before the Council a general outline of the proposed tramway. The company suggested that a car should run from the Haldon Pier to the Torquay railway station every 10 minutes, and to Paignton every 20 minutes. The proposed fare to Torquay railway station was 1d., and for the whole journey 3d. Alderman Bovey moved that the letter be referred to the Roads Committee. It should receive careful consideration. Mr. T. H. Wills seconded, and the motion was carried.

Lanark.—At the meeting of the Middle Ward District Committee the Chairman said he would like to state, with regard to the scheme for the lighting of Cambuslang by electricity, that when negotiations were proceeding with the gas company it was found that there was danger in laying pipes through the district where there were underground coal workings. It had occurred to the committee that Cambuslang was peculiarly circumstanced in the respect that there was a weir across the Clyde half a mile up the river, which at a comparatively small cost would supply power for electric lighting very much on the same lines as had borne excellent results at Fort William. The advantages of the scheme were that the streets could be lighted all night with very little more expense than would be incurred were they lighted only for an hour or two. This would afford greater security to Cambuslang. He was assured that the police viewed the scheme with infinite satisfaction, as would also all who were interested in the preservation of law and order. The attractions of Cambuslang as a place of residence would be enhanced, and its extension would be fostered. It would be a great boon to the working-classes when they went to their work early in the mornings. The committee contemplated lighting the streets only, and as gas was supplied to the town gratis before the formation of the special lighting district, the introduction of the electric light would benefit the company. Electric lighting would be cheaper than gas. This was the experience of Fort William, and it had been verified by calculations which had been made by experts. The Chairman pointed out the difficulties which the committee had to confront owing to the confusion in the Acts of Parliament as to who was the local authority whose consent must be obtained to an application to the Board of Trade, and concluded by moving a resolution to the effect that with the view of enabling the District Committee to approve of electric light being introduced into Cambuslang the meeting resolves to ask the County Council to give their consent to an application to the Board of Trade for a license or provisional order, either by the District Committee or by any person or company with whom the District Committee might arrange for the supplying of electricity, and that the annual expenditure necessary for the payment of electricity to any person or company be defrayed out of the special district rate, as provided for under Section 44 of the Local Government (Scotland) Act, 1894. Mr. Rutherglen seconded, and the motion was adopted.

Battersea.—It was stated in the report of the Works Committee at the Vestry meeting that, acting upon the authority of the Vestry, they had directed the necessary proceedings to be taken, by injunction or otherwise, to restrain the County of London and Brush Provincial Electric Lighting Company, Limited, from using the electric light mains laid in the portion of Trinity-road in the parish without the permission of the Vestry, and for the removal of the mains The mains were laid by the Brush Electrical Engineering Company, Limited, for the County of London and Brush Provincial Electric Lighting Company, Limited, and the committee begged to recommend that the necessary proceedings be taken against the Brush, etc., Company, to recover the penalties incurred by them. Mr. Manser moved that the matter be referred back, but after a long discussion, in which it was stated that the committee were advised that the Vestry had no alternative, and the matter was now *sub judice*, the reference back was defeated by 56 votes to 24. A further amendment was moved by Mr. Haythornthwaite that further action be suspended with the view of making some arrangement with the company, but this also was lost.—At the meeting of the London County Council the following report of the Finance Committee was read: "We have considered an application from the Vestry of Battersea for a loan of £13,900 to purchase a site for an electric lighting station. The Vestry propose to purchase the freehold of two parcels of land and premises in Lombard-road, Battersea, comprising two adjoining wharves, known respectively as "Grove" and "Canada" Wharf (on the west side of the road), the Grove Wharf having a river frontage of 85ft., with frontage to a dumb dock at the side of 145ft., and containing an area of about 16,460 square feet, and Canada Wharf a frontage to the dumb dock of 21ft. 9in., and containing an area of about 9,137 square feet, and second, land and premises on the east side of Lombard-road, abutting on Harroway-road in the rear with a frontage of 114ft. 8in., and two houses, known as Nos. 37 and 39, Lombard-road, the whole containing an area of about 20,000 square feet. The Vestry consider the position of this property to be a most eligible site for the proposed electric lighting station, but have met with considerable difficulty from the fact of some of the owners requiring excessive prices for their property, and having no compulsory power to purchase have been unable to make better terms. We accordingly recommend that, subject to the Council hereafter giving its written consent under seal to the borrowing, the application be granted, on condition that the loan be taken up at once, interest being charged thereon at the rate of £2. 17s. 6d. per cent. per annum, payable quarterly, and the principal being repaid by equal annual instalments within a period of 52 years."

Dudley.—At the meeting of the Town Council the Mayor read a communication from the British Electric Traction Company, stating that they returned the clauses submitted to them on behalf of the Dudley Corporation by their parliamentary agents, altered by them in the way in which they were prepared to accept them. The negotiations with the Corporation of Wolverhampton had arrived at a stage at which it had become evident that it would be impossible to include the tramways of the Wolverhampton Company and of the Dudley and Stourbridge Company in the Bill now before Parliament. But they did not abandon the hope that the negotiations with the Corporation of Wolverhampton would be resumed, and that the company's original scheme of consolidating various tramway undertakings would be carried out. So far as the present Bill was concerned, it was clear that the scheme would have to be confined to the tramways of the Dudley and Stourbridge Company. The company were advised that it would greatly expedite the carrying out of the electrical equipment of these tramways if the arrangement with the Corporation of Dudley was embodied in an agreement between the Corporation and the company. Upon that being done the company would lose no time in completing the provisional contract for the purchase of the tramways of the Dudley and Stourbridge Company, and arrange to carry on the undertaking under the existing powers of that company without at present applying for any further Act of Parliament. With regard to the proposed new lines to Netherton and Rowley Regis in one direction, and to Kingswinsford in another, they were prepared to make it part of their agreement with the Dudley Corporation that they would, in April next, promote an order under the Light Railways Act, authorising the construction of these lines. The Mayor said he had had an opportunity of studying the Light Railways Act, and as far as his experience went there did not appear to be any reason why they should not accede to the request of the company. At the same time, under the Tramways Act, tramways which would be promoted by the company would in the course of time become the property of the Corporation. That was not the case under the Light Railways Act, and, although it might be possible to make a special arrangement that the light railway or the tramway should eventually become the property of the Corporation, there was no clause in the Light Railways Act which would have that effect. At present 28 light railways had been promoted under the Act, and the cost of them varied from £1,400 per mile to £9,000 per mile. In which category the scheme would come in the matter of expense they were not acquainted. It seemed to him, therefore, that the Council should form itself into a committee and thrash the matter out. The suggestion was adopted.

PROVISIONAL PATENTS, 1897.

FEBRUARY 22.

4755. Improvements in electric motor propelled vehicles. Henry Gurney Morris and Pedro Grotjau Salom, 47, Lincoln's-inn-fields, London.

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FEBRUARY 23.

4810. Improvements in or connected with apparatus for electrically illuminating and displaying letters, numerals, devices, and the like for advertising and decorative purposes. Timpron P. Martin, 15, Water-street, Liverpool.

4824. Improvements in rail bonds for electric railways. Fred Harris Daniels, 62, St. Vincent-street, Glasgow.

4831. Improvements in electric welding. George William de Tunzelmann and Cecil William Baker, 27, Martin's-lane, Cannon-street, London.

4844. Improvements in electric arc lamps. Henry Mostyn Darrah and William John Croft, 55, Market-street, Manchester.

4871. Improvements in apparatus for receiving and distributing audible sounds or messages sent by telephones or instruments of the like kind. John Pullman, 65, Chancery-lane, London.

4878. Improvements in electric railway systems. Constant François de Redon, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

4898. Filaments for incandescence electric lamps. Theodor Balzer, 40, Chancery-lane, London.

4904. Improvements in alternating-current motors. Walter Langdon Davies, 16, Red Lion-street, Clerkenwell, London.

4916. Improvements in electric accumulators. Edward Heyl, 37, Chancery-lane, London.

4934. Improvements in electric arc lamps. Hippolyte Delavau and François Félix Bréra, 7, Quality-court, Chancery-lane, London. (Complete specification.)

FEBRUARY 24.

4979. Improvements in station indicators for electric railways or tramways. James Steffen, 89, Chancery-lane, London. (Complete specification.)

4993. Improvements in apparatus for automatically cutting out electrical currents from dynamos when rising above or falling below a determined maximum or minimum, and for gradually turning on such currents. Edward Lionel Joseph, 65, Chancery-lane, London. (Complete specification.)

4994. Portable electric lighting device. Alfred Julius Boult, 111, Hatton-garden, London. (Harry Cross Hubbell and Thomas Francis Boland, United States.)

5031. Method and apparatus for seeing distant objects by electrical means. Jan Szczepanik and Ludwig Kleinberg, 46, Lincoln's-inn-fields, London.

5040. A new or improved telegraph relay suitable for long submarine cables. John Rymer-Jones, Norfolk House, Norfolk-street, Strand, London.

FEBRUARY 25

5055. Improvements in and relating to telegraphic transmitting apparatus. Frederick George Creed, 96, Buchanan-street, Glasgow.

5100. An apparatus for advertising or signalling purposes by means of electrically illuminated lamps. Henry Harvey Pinches and Frank Morley, 3, Martell-road, West Dulwich, London.

5102. Improvements in the construction of secondary batteries. William Stevens Squire, Clarendon House, St. John's Wood-park London.

5104. Improvements in the method of insulating or covering electric cables, wires, or conductors by means of dehydrated paper. Walter Hepworth Collins and Timothy Yates Nuttall, Darwen Paper Mills, Darwen.

5105. An improved paper specially adapted for insulating electrical cables, wires, conductors, storage batteries, and for other electrical insulating purposes. Walter Hepworth Collins and Timothy Yates Nuttall, Darwen Paper Mills, Darwen.

5129. Improvements in dynamo-electric machines. George Luman Campbell, 55, Chancery-lane, London.

5131. Improvements relating to electrical resistances. Edward Wingfield Bowles, 6, Bream's-buildings, Chancery-lane, London.

5136. Improved electric tan-bark bath and apparatus therefor. Johan Jakob Stanger, 322, High Holborn, London.

5152. Improvements in central-valve steam-engines commonly known as Willans central-valve engines. John Smith Raworth, 46, Lincoln's-inn-fields, London.

5157. Improvements in electric arc lamps. William James Davy and George Thomas-Davies, 40, Chancery-lane, London.

FEBRUARY 26.

5166. Improvements in primary and secondary electric batteries. Douglas Neale, 21, Rutland-square, Edinburgh.

5171. Improvements in electric conductors. William Wood, 15, King's-square, Bristol.

5222. Improvements in electric wiring and in apparatus connected therewith. Francis Charles Raphael, 1, Salisbury-court, Fleet-street, London.

5206. Luminous electrical bell-push. John Wilson White, Halstead, near Sevenoaks, Kent.

5224. Improvements in electric arc lamps. Ralph Gaynor, 11, Southampton-buildings, Chancery-lane, London.

5237. Improvements in the suspension of electrical accumulators or batteries on motor carriages. The Hon. Reginald Thomas Dudley Brougham and Walter Charles Bersey, 24, Southampton-buildings, Chancery-lane, London.

5258. Improvements in electrically-propelled vehicles. Ludwig Epstein, 28, Southampton-buildings, Chancery-lane, London (Complete specification.)

FEBRUARY 27.

5360. A method of and apparatus for utilising electric energy. Harry Barringer Cox, Norfolk House, Victoria-embankment, London.

SPECIFICATIONS PUBLISHED.

1896.

2224. Prepayment mechanism for electrical or other meters. Bastian and Hodges.

2324. Electric coupling. Tucker.

2335. Electric meters. McWhirter.

2707. Incandescent electric lampholders and the like. Howard.

3409. Recording electric meters. Wright.

4082. Apparatus for electrically igniting miners' safety lamps. Ackroyd and Best.

4774. Automatically operating variable resistances in electrical circuits. Callow and Bevis.

4996. Jointing boxes for conduits carrying electrical conductors. Bathurst.

7166. Electric fire alarms. Shanahan.

15488. Electric furnace. Haviland, Holloway, Collier, and Murch.

21560. Tandem-parallel controllers for induction motors. The British Thomson-Houston Company, Limited. (Potter and Case)

23556. Electrical wire joint or connection. Melhuish.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	9-9½
Brush Company, Ordinary	3	6 ⅛
—— Non. Cum., 6 per cent. Pref.	2	1½-1¾
—— 4½ per cent. Debenture Stock	100	107-111 xd
—— 4½ per cent. 2nd Debenture Stock	100	94 98
Callender's Cable Company, Debentures	100	104-109
Central London Railway, Ordinary	10	9½-10
——	6	5½-5¾
Charing Cross and Strand	5	9½-10½
Chelsea Electricity Company	5	9-9½
—— 4½ per cent. Debentures	100	112-115
City of London, Ordinary	10	19- 9
—— 6 per cent. Cumulative Pref.	10	16½-17½ xd
—— 5 per cent. Debenture Stock	100	132-136
City and South London Railway, Consolidated Ordinary	100	59 61
—— 4 per cent. Debenture Stock	100	139-141
—— 5 per cent. Pref. Shares	10	15½-16
County of London and Brush Provincial Co., Ordinary	10	10½-11½
—— 6 per cent. Cum. Pref.	10	14½-15½
—— 4½ per cent. 2nd Debenture Stock	10	14½-14¾
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	1¾ 2½
—— 5 per cent. Debentures	—	96 98
Edison and Swan United Ordinary	2	1¾-2½
—— 5 per cent. Debentures	5	3-4
—— 4½ per cent. Debentures	100	105-110
Electric Construction, Limited	2	1½-1¾ xd
—— 7 per cent. Cumulative Pref.	2	2½-3
Elmore's Copper Depositing	1	⅞-1⅛
Elmore's Wire Company	2	⅜ ½
W. T. Henley's Telegraph Works, Ordinary	10	19½ 20½
—— 7 per cent. Preference	10	18½-19½
—— 4½ per cent. Debentures	100	107-112 xd
House-to-House Company, Ordinary	5	5½-5¾
—— 7 per cent. Preference	5	8¾-9½ xd
India Rubber and Gutta Percha Works	10	20½-21½ xd
—— 4½ per cent. Debentures	100	106-109
Kensington and Knightsbridge Ordinary	5	10½-11 xd
—— 6 per cent. Pref.	5	8-8½
London Electric Supply	5	1½-1¾
Metropolitan Electric Supply	10	13½-14½
—— 4½ per cent. First Mortgage Debenture Stock	100	120-124
National Telephone, Ordinary	5	7-7½ xd
—— 6 per cent. Cum. First Pref.	10	16-18 xd
—— 6 per cent. Cum. Second Pref.	10	16-18 xd
—— 5 per cent. Non. Cum. Third Pref.	5	6½-6¾ xd
—— 3½ per cent. Deb. Stock	100	104-107
Notting Hill Company	10	12-13
Oriental, Limited, £1 shares	1	1½-2
—— £5 Shares	5	8½-9
—— £4½ shares	4½	7½-8
Oriental Telephone and Electric Company	1	11/16-13/16
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	103-105
St. James's and Pall Mall, Ordinary	5	13½-14½
—— 7 per cent. Pref.	5	9-10
Telegraph Construction and Maintenance	12	39-42
—— 5 per cent. Bonds	100	103-106
Waterloo and City Railway, Ordinary	8	1⅛-11
Westminster Electric Supply, Ordinary	5	12½-13½
Yorkshire House-to-House	5	7½-7¾

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NOTES.

Meteorological Society.—The society's show of instruments is fixed for March 16 to 19 at the "Civil Engineers," Great George-street, Westminster.

New Elections.—It is announced that Prof. W. Ramsay has been elected a corresponding member of the Royal Academy of Bohemia, and also of the Academy of Sciences of Turin; and Mr. Violle has been elected a member of the Physics Section of the Paris Academy of Sciences, in succession to the late Mr. Fizeau.

North-East Coast Engineers.—The meeting of the North-East Coast Engineers will be held in the Athenæum, West Hartlepool, to-morrow (Saturday), at 6 p.m. The business is the discussion on Mr. A. E. Sharp's paper on "The Resistance Areas of Transverse Sections," the discussion on Mr. Robert Wallis's paper on "Liquid Fuel," and a paper on "The Machine Cutting of Accurate Bevel and Worm Gears," by Mr. J. H. Gibson. There are special train arrangements as usual.

Microphone Resistance.—Prof. R. A. Fessendine, writing in the *American Electrician*, says he has ascertained that the material of microphones must be such that the oxide formed by the substance which gives the contact must be a gas or else a conductor, "if satisfactory and coherent results are to be obtained." In an atmosphere of chlorine a similar law applies. This looks upsetting for the usual theory, but probably it only amounts to a specification for absolutely clean contact points.

Institution of Electrical Engineers.—There will be a students' visit to the works of the Electric Welding Company, Hindon-street, Pimlico, S.W., on Saturday, March 20. Students desiring to join the party should at once give notice to the secretary of the Students' Committee, Mr. W. Burm, 23, Oxford-road, Stroud Green, N. As the party will have to be limited, applications will be dealt with in order of receipt. The party will meet at the Institution of Electrical Engineers, 28, Victoria-street, S.W.

Honorary Degrees.—There are still a few people left in the world who do not in the least care to write a collection of capital letters after their names. The *Athenæum* says the council of the senate of the University of Cambridge recently agreed to propose a grace to the senate to confer the honorary degree of doctor of science on Mr. Herbert Spencer. Mr. Spencer, however, on being asked whether he would accept such a degree has replied in accordance with his uniform practice that he cannot accept an honour of the description proposed.

Matters Mathematical.—The Continental mathematicians have come to the conclusion that they ought to hold an international congress like the other people do; so a committee has been formed for the purpose of organising a congress, to be held at Zurich on August 9, 10, and 11, 1897, in which mathematicians from all parts of the world are invited to participate. The committee includes Prof. A. G. Greenhill, of Woolwich. All communications or enquiries relative to the congress are to be addressed to Prof. Geiser, Küsnacht-Zürich; and it is expected that a large number of mathematicians will attend.

Prize Papers.—The Société de l' Industrie Minérale of St. Etienne has invited original communications from its members on mining, metallurgy, and mechanics, for which the council will award premiums varying from £20 to £40. Among the subjects to be dealt with are in the mining section, the working of thick coal seams and underground haulage by compressed air or electric locomotives; and in the mechanical section, the use of high-pressure cut-off gears, compounding and condensation in winding engines, and the employment of superheating in steam-engines. The papers must be in French, and must be in the secretary's hands by December 31, 1897.

Personal.—Mr. R. Stuart Hampson, M.I.E.E., has recently been promoted from the position of telegraph superintendent to the Manchester, Sheffield, and Lincolnshire Railway Company, a post he held under the control of the engineer-in-chief, to that of electrical engineer to the company, responsible direct to the general manager. Mr. Hampson was trained in the electrical department of the Lancashire and Yorkshire Railway Company, but has been in the service of the Manchester, Sheffield, and Lincolnshire Railway Company for more than 10 years. He is president of the Railway Telegraph Superintendents' and Electrical Engineers' Conferences, and is the inventor of several well-known instruments used for railway purposes. He has designed special electrical locking for swing bridges, and is an expert on lock and block.

More New Cells.—A couple of new galvanic combinations have been described by Mr. H. Pauling in the *Zeitschrift für Elektrochemie*. Number one has carbon electrodes which are supposed to be unacted on, and the energy is obtained from the action of chlorine water on sodium thiosulphate (the "hypo" of the photographer). There appears to be a deposit of sulphur, but the chemistry of the business we must leave to those select few who have made a special study of the sulphur acids. The E.M.F. is about half a volt. The second is also a chlorine-consuming cell, inasmuch as chlorine is used to regenerate the ferric chloride. But it also eats iron, which is cheaper than zinc (that is where the point of it is supposed to come in). The combination is carbon—ferric chloride—iron. As may be supposed, the E.M.F. is not a high one.

Sun Spottery.—Last Monday, at the Imperial Institute, Prof. J. Norman Lockyer lectured on "Imperial Aid to Solar Research." Sir George Baden-Powell, M.P., was in the chair. Mr. Lockyer remarked that if the sun was to be studied at all it must be studied continuously, because it was always changing. Hence its study must be on an Imperial basis, and not depend on the life of individuals. (There appear to be gaps in the logic, but that may be due to the summarised report, which is all we have before us.) To us of course the special interest of the subject is the question of establishing a coincidence between the variations of magnetic phenomena on the earth and the amount of spotted area on the sun, and what that would mean when it is established. But one does not talk so confidently on these matters now as was customary a few years ago.

The Ferraris Memorial.—A committee has been formed for the purpose of erecting a suitable memorial to Prof. Galileo Ferraris in Turin, "the city which was to him a second fatherland, where he studied, where he discovered the great principle of the rotating magnetic field, where he created that school of electrotechnics which in a short space rose to European fame—where, in short, he became a man of science who commanded the admiration of the whole world." With this end a strongly representative committee has been formed, and subscriptions are invited not only in Italy but also from abroad. The form of the memorial is not definitely stated, but apparently some kind of statue or bust is contemplated to be erected in the Turin Museum of Industry, but it will not be confined to this alone if sufficient funds are collected. The secretary of the executive committee is Mr. C. Montù, and subscription lists should be forwarded to Cavalier Zappata, the city treasurer of Turin.

Government and the Telephones.—On Monday in the House of Commons Mr. Henniker Heaton made yet another attempt to get from the Secretary to the Treasury

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some intimation as to the general policy of the Government on the question of the telephones. Mr. Hanbury, in reply, said he had no change of policy to announce. Her Majesty's Government did not propose to take any steps to acquire the business of the National Telephone Company. But the Postmaster-General "will carefully enquire into any complaints which he may receive from any locality of the inefficiency or inadequacy of the service which the company is supplying, and should he consider that such complaints are well founded, and that the inefficiency or inadequacy of the service is due to the fault or neglect of the company, he will carefully consider, on the merits of each case, what steps it may be desirable to take to remedy the defect." And yet no one seems a bit grateful for all this amount of care and consideration.

The Engines and Boilers Bill.—The Liberty and Property Defence League has issued a protest against the Boilers Bill, which has been read a second time in the House of Commons, in which it is stated that during the last 20 years no accident attributable to ignorance or incompetence on the part of "persons in charge" has occurred in the United Kingdom, except in cases which would be exempted under this Bill. (That is so. Generally speaking, the portable engine would be exempt.) If the Bill became law no engine could be started in the majority of factories or in any steam-power-using enterprise in the United Kingdom unless an officially "certificated person in charge" handled the throttle-valve. There are other difficulties which are not mentioned by the league people. Now boiler accidents are rare, but in towns A may reasonably wish to know that a boiler of B's which he has to live next to is safe, and that is what is being relied on to get a Bill through which would really increase instead of diminish what danger there may be.

Rontgen Radiations.—Dr. Julius Precht, of Heidelberg, has published a thesis on the Röntgen rays and other radiations emanating from Crookes tubes. He has discovered (which most of us already knew) that the radiations are of a complex character. According to Dr. Precht, interference phenomena obtained with direct and reflected Röntgen rays have given a wave-length ranging from 370 to 830 millionths of a millimetre. If this is really so, there is nothing for it but to conclude that the Röntgen rays are not of the character of ordinary light waves. But it is by no means clear what it was that was really measured. Other observers by other methods have believed they have got other values, and until there is some better means of separating out a given wave-length, it is not easy to see how any of the results can be depended on. So far, however, as they have gone, all but Dr. Precht's are much smaller than light waves (they vary from one-third to one-thirtieth). Some of these are shadow methods, which of course give maximum values, if they give anything at all.

The Electro-Harmonic Society.—An Electro-Harmonic smoking concert is fixed for Friday, March 26, 1897, at the St. James's Hall Restaurant, Regent-street, W., at eight o'clock. The following will be the programme: Part I.—overture, "Maritana" (Wallace), String Orchestra; song, "When Day is Bright" (J. L. Hatton), Mr. Albert James; humorous sketch, Mr. Robert Ganthony; piano solo, "Nocturne" and "Caprice" (Paderewski), Mr. Alfred E. Izard; song, Mr. Wingrove Ives; recitation, Mr. John Proctor; selection, "Schlummerlied" (Ersfeld), String Orchestra; musical monologue, "Sweethearts" (Marshall and Seldon), Mr. Charles Nott. Part II.—selection, "Andante Religioso" (Thomé) and "Little Grandmother" (Langer), String Orchestra; old ballad, "I Loved the Maid for Loving Me" (G. W. Maddison), Mr. Albert James; violin solo, "Scénes de la Czarda" (Jeno ¡Hubay), Mr. T. E. Gatehouse; humorous sketch, Mr. Robert Ganthony; song, Mr. Wingrove Ives; recitation, Mr. John Proctor; burlesque ballad, "All is not Gold that Glitters" (Marshall), Mr. Charles Nott; march, "Tannhauser" (Wagner), String Orchestra.

A Book on Acetylene.—We have received from G. Carré and C. Naud (Paris, rue Racine 3) an octavo volume of 230 pages dealing with acetylene lighting. The French have taken up the question of using this fascinating, but decidedly tricky, and not altogether safe gas with considerable ardour, and, therefore, it is in books like "L'Eclairage à l'Acétylène," by Mr. G. Pelissier, that we must look for a collected account of what has been actually done in that direction at present. The object of the author in the present work is to describe the existing state of affairs as to the use of acetylene, its possible dangers, and the conditions which must be realised for its safe preparation and employment. For all purposes of illumination which admit of a store of gas being kept under a pressure of a few pounds only there should be a future for acetylene, and, therefore, the description of generators in Mr. Pelissier's book will be useful. But that acetylene will ever be distributed in pipes like ordinary gas is unlikely, while recent explosions have only too well confirmed the prophecies of the chemists that when under high pressure in steel bottles it would prove decidedly dangerous.

Alternating-Current Wiring.—From a couple of articles in the *American Electrician* the conclusion is drawn that "where in interior wiring large alternating currents are involved multiple circuits should be used," and the inductive drop made negligible so that the conductors may be calculated on the basis of resistance only. The point brought out to lead up to this is that the inductive drop is larger with large wires for the reason that in all practical cases the current increases with the size of wire; therefore with large wires there are large currents and consequently large inductive drops. In fact, for all practical purpose, the inductive drop on a given line may be considered to depend upon the current alone, so preponderating is that factor. Bearing this in mind, the reason is plain why the so-called impedance factor, or the ratio between simple ohmic drop and inductive drop, increases so greatly as the size of the wire increases. If, for instance, the diameter of a wire is doubled its ohmic resistance is quartered, while, on the other hand, the inductive drop is comparatively decreased. Consequently, the combined resistance and inductive drops or the total drop decreases at a much less rate than the ohmic drop, from which it follows that the ratio of the ohmic resistance to the total drop is largely increased by increasing the size of wire.

Royal Institution.—Mr. Shelford Bidwell's discourse on "Vision" at the Royal Institution on Friday last was exceedingly interesting. He showed his audience for the first time quite a quantity of things which they had been "seeing" all their lives, but never before perceived. One at least of the discoveries is, the writer believes, entirely new, and the most curious thing about them all is that the apparatus necessary is within the reach of everybody, and can in most cases be made with nothing more expensive than cardboard, scissors, and a paste-pot. The fact is that, Helmholtz and a few others apart, the subject has been shirked by almost everyone, or treated in an altogether perfunctory manner. In the library were some of Mr. Ives's colour stereoscopes, and while one of the new rooms was dark for Röntgen ray exhibitions, the other was rather brighter than day, with three "Pioneer" enclosed arc lamps. Mr. Marks, who looks after that particular pattern of enclosed arc, was very much there. There were some

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tram-rail bonds (copper, not scrip) shown by Messrs. Laing, Wharton, and Down, and other pretty things. This (Friday) evening we are to have Prof. Smithell on the "Source of Light in Flames," and next week "Palæography," by way of a change. Lord Rayleigh's and Dr. Waller's lectures are mentioned elsewhere.

Regulations in Spain.—After an interval of one number the *Revista de Obras Publicas* has resumed and finished the publication of the new rules for public electric lighting in Spain. Inside conductors must not heat more than 50deg. C. for double current. Conductors must be taken through walls and under floors in tubing and have additional insulation there. There must also be additional insulation where wires cross and so forth, with a number of general prescriptions. Arc lamps must be in globes. Theatre-lighting must be in accordance with the regulations of March 30, 1888. In bare overhead lines the leakage (to earth) must not exceed ·006 ampere per kilometre. The lightning arresters must be "sufficient," and in tramways the means to prevent sparking at the trolleys or wheels "the most perfect possible." In rail returns the maximum difference of potential allowable between the end of the return and the station must not exceed seven volts. The connection of the return to the positive terminal of the dynamo is recommended in order to avoid effects of electrolysis and also the provision of feeders. There are some further regulations as to underground conductors, and the rules conclude with three articles providing respectively for inspection by the local authorities, that the rules shall not be retrospective in operation as regards existing con cessions, and a proviso that nothing in the regulations shall be considered as conferring any right to go over private property without the consent of the owner.

The Junior Engineers.—Last Saturday the Institution of Junior Engineers held its annual conversazione at the Westminster Palace Hotel. The president (Mr. A. R. Binnie) and Mrs. Binnie, and the chairman (Mr. H. Bloomfield Vorley) and Mrs. M. Vorley received the members and the guests. There was a large collection of exhibits of an engineering character, and in the pure science section Prof. Greenhill, F.R.S., described his algebraic spherical catenaries, which had been calculated and drawn by Mr. T. Dewar. Mr. J. Macfarlane Gray exhibited the multiplying machine which he had devised for use in these calculations. He also gave demonstrations with his gyroscope. A number of original photographs taken during Dr. Nansen's polar expeditions naturally attracted great attention, as did also some very fine specimens of the latest results in colour photography by the Chassagne process. In the lantern-room were given at frequent intervals exhibitions of the theatrograph (animated photographs) by Mr. Robert W. Paul; "The Delights of a Globe Trotter," by Mr. D. Thomas Keymer; and "One Irish Injustice the Less: A Pictorial Non-Political Narrative," by Mr. W. J. Tennant, the latter describing a trip to Ireland in advance, the council having decided that the ensuing summer meeting of the institution shall be held at Dublin and Belfast. One of the rooms was devoted to an installation of the electrophone laid on to several of the theatres. There were also short concerts.

The Chambers of Commerce.—The annual meeting of the Associated Chambers of Commerce began on Tuesday, Sir Stafford Northcote presiding. In the course of the day's proceedings Mr. Ritchie, M.P., President of the Board of Trade, delivered an address. Mr. Ritchie appears to be a victim of the common belief that the inability of English schoolmasters to teach a foreign language is part of the unchangeable order of nature. After that, he went on to the metric system. With regard to the subject of weights and measures, the Government had not proceeded very far. Last year they did introduce a Bill for dealing with the matter. It was not introduced with any idea of being passed then, but for the purpose of collecting the opinion of the commercial community respecting it, and, as far as he knew, there had not been one adverse note concerning the principle of the Bill. All the adverse criticism had been that it was a permissive Bill instead of a compulsory one. From all he could hear there was every chance that a permissive Bill would be accepted by all parties, and it was his intention, therefore, to bring in the Bill again, he hoped very early, and he did not see the slightest reason why it should not pass into law this session—(at this there was applause, the Chambers being evidently thankful for small mercies)—and thus remove the ridiculous and absurd anomaly that a person could make a contract for the delivery of goods in metres, but that if he happened to have in his possession a metre measure for the purpose of trade he was liable to a penalty. Sir Courtney Boyle was also at the meeting.

The Force of a Ton.—The controversy goes on. Indeed, *vires acquirit eundo*, it used to be the force of a pound; now it is the force of a ton. In *Nature* "O. J. L." asks Prof. Greenhill and Prof. Fitzgerald quite a quantity of questions, not without scorn, and says the physical factor *g*, which turns mass into weight without necessarily altering the numerical specification in any way, is not a thing to be lightly ignored or introduced for the sake of some entirely imaginary convenience about units; not even for the sake of complicating mechanics, after all these years, by trying to express mass in something else than mere grammes or pounds or tons. "Let the British student say so many pounds when he interprets *m*, and let him say so many *pounds-weight* when he interprets *mg*, and there is no difficulty whatever." (Quite so, if you can once get him to do it.) But the field of conflict shows a tendency to transfer itself to the pages of the *Engineer*. There they call it "Dynamical Terminology," which is enough to frighten any reader away. There also Mr. Oliver J. Lodge and Prof. Greenhill get to closer quarters. Moreover, the occasional outsider cuts in. A remark by Mr. Deeley has nothing to do with the subject, but is so eminently sensible that it may be dragged in here, as it was there, anyhow. It is that if technical schools are to work hand-in-hand with the engineering works, some privileges as regards working hours in the shop must be given to those pupils or apprentices who attend the classes. That boys shall work from 6 a.m. to 5.30 p.m., and yet be in a fit condition to attend evening classes, is too much to expect from ordinary constitutions. Although this is patent (or ought to be) to all, schools, colleges, and institutes are founded, and surprise then expressed that those who ought to use them do not do so.

One-Man Companies.—In the House of Commons Mr. Herbert Lewis has asked the Attorney-General whether the attention of the Government had been drawn to the recent case of a one-man company, practically consisting of a single individual, and formed by him to take over his own business, and through which he continued to trade for his own benefit under limited liability; and also to the judgment of the House of Lords (reversing that of the Court of Appeal), in which it was held that debentures issued to himself by such individual were validly secured upon goods supplied to the company by ordinary trade creditors, which had not been paid for, and were entitled to take priority in the distribution of the company's assets arising from the sale of such goods over the claims of the creditors who had supplied them; and whether, seeing that such cases were of frequent occurrence, the Government

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would take immediate steps to check the abuses thence arising. All the reply he got from Sir Richard Webster amounted to a statement that he (Sir Richard) was alive to the necessity that existed for an amendment of the law regarding trading companies, and that a Bill as to companies had already been introduced into the House of Lords, and was now before the Standing Committee on Law, which would have an opportunity of considering the point raised in the question (if it were brought before them). What the particular advantage is of putting off the thing in this way is not evident. The particular matter that is referred to by Mr. Lewis relates to a use of the Companies' Acts which was certainly never contemplated by their authors (the wonder is that it should have remained so long undiscovered and unexploited); and it might very well be dealt with shortly and sharply on its own demerits without waiting for the slow and debate-raising question of recasting and reforming the whole of our law as to joint-stock trading.

Animal Electricity.—It can hardly be said that Dr. Waller's lecture at the Royal Institution on Tuesday last brought his hearers any definite stage further in the course of the exposition of animal electricity which he is now giving. It rather dealt with miscellaneous matters. Dr. Waller showed the frog's leg copper iron combination of Galvani, which gives a twitching when the circuit is completed, and the Aldini experiment, where the same effect is produced without any metals in the circuit by the current of injury transmitted through a detached nerve. Dr. Waller devoted considerable time to vindicating the claims of Aldini as a discoverer, who appears to have suffered unmerited discredit at the hands of Du Bois Reymond in his history of the subject. An interesting example of the way history gets written is that in which Galvani's wife, Lucia, has come to be credited with a share in the work. An unnamed, perhaps unknown translator, misled by the fact that *personne* in French makes the following pronouns feminine, went wrong, and led all the rest astray. If the Latin of the original document is consulted, the investigator is seen to be as masculine as that language can make him. Among other experiments shown by Dr. Waller on Tuesday was the arrest of the heart's action (a frog's heart) when the vagus nerve is stimulated (this comes somewhat before its time in the course) and the increased action that follows when the inhibitory action is removed, in a way which is not altogether unlike the action of and subsequent recovery from treatment with carbonic acid. Dr. Waller also showed the very rapid effect of chloroform in stopping the heart's beat. The action of ether is much weaker in this respect than that of chloroform (ether as an anæsthetic has other disadvantages of its own) and recovery is easier. This, however, is hardly our business. For any who care to follow Dr. Waller's work in this direction it may be said that the current number of *Brain* contains a paper by him upon the action of anæsthetics, sedatives, and narcotics upon the isolated nerve, with about 40 illustrations showing the effect of various drugs.

Electricity in Agriculture.—Mr. John McGhie has contributed to *Cassier's Magazine* an article which summarises something of what has been done in the way of the application of electrical methods to agricultural operations, beginning with the curious results obtained by Mr. Spekneff at the Kief Botanical Gardens as to the stimulating effect of the "static discharge" upon plant growth. "On a selected number of plots were planted poles with crown-shaped collectors all connected by wire. The plants therefore matured in the midst of a highly electrified atmosphere. These experiments were carried on for five years." In the case of rye, wheat, oats, barley, peas, clover, potatoes, and flax the result showed a considerable, often large, increase in the yield. In the grains the increase was very marked both in straw and seed; the theory (which is decidedly doubtful) being that a slow discharge of static electricity assisted the plants in assimilating nitrogen. This is quite out of accord with the fact that the ripening was more rapid, barley coming to maturity about 12 days earlier "under electroculture." It was also shown that potatoes grown under the electric influence became much more resistant to disease. After some American experiments in forcing plants by electric light so that they should grow night and day, we come to the driving of various homestead machinery by electric motors instead of a steam-engine. Where there happens to be a convenient power there is nothing beyond what is obvious in that. The following is an example: "In 1894 Messrs. Ganz and Co., of Budapest, installed a power plant for agricultural purposes on an estate in Moravia. The power is supplied from a steam sawmill at one end of the estate, a continuous-current generator of 30 h.p. being erected in the mill. The current is taken along two circuits, one running to a flour mill and dairy, with a branch to a neighbouring farm, while the other circuit runs to another large farm. At the dairy a 10-h.p. motor drives two centrifugal separators, a pump and other apparatus, and helps out an adjacent flour mill, which, owing to the limited supply of water, could previously be run only for a short time during the year. Each farm has a 12-h.p. motor mounted on a covered wagon for transportation to different parts of the farm, there to operate thrashing machines. By an ingenious contrivance the motor-wagon can travel from point to point of the field, where the grain is stacked ready for threshing. After the harvest is in, these portable wagon motors are used for pumping purposes, and one of them finds useful occupation on a distillery on the estate. As the fuel for the steam plant is sawdust and waste wood, the cost of the current is little or nothing, and the electric power service entails an extremely small outlay when compared with that necessary for a steam-driven thrashing machine, or a fixed steam plant in the dairy or mill." The last sentence, of course, embodies highly disputable points. Almost at the end of the article comes the Zimmermann electric plough. We have before stated in these columns that we believe that there will be a future for some such system of mechanical cultivation some day, but it will be a day of large holdings possibly worked by companies and when agriculture is conducted upon the same business lines as any other pursuit, and not influenced by sentimental preferences for the preservation of any particular social system. The effect will be anything but the Arcadian one Mr. McGhie anticipates. But that gentleman does not appear to be an agricultural expert, nor should we feel quite so confident as he is as to the applicability of the alternating-current motor in its present stage of development to much agricultural work. The conditions are considerably more severe than, say, a tramway.

Prevention of Electrical Fires.—Mr. Bathurst's paper on the prevention of fires due to leakage of electricity was read at the Society of Arts on Wednesday. Beginning with the elements of the subject, Mr. Bathurst drew an "analogy between gas-pipe service and electric wire service," in that "it is the frail insulating covering of the electric wire which corresponds to the substantial metallic coat which forms the gas-pipe." Most insurance companies prefaced their rules for electric wiring by reciting the principal sources of danger to be anticipated, including them under the following headings: (1) inferior material and workmanship, particularly in joints, fittings, and connections; (2) conductors of inadequate size and con-

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ductivity; (3) perishable and inferior insulating materials; (4) dust, dirt, and moisture; (5) undue heating; (6) neglect of frequent testing and inspection. Mr. Bathurst cuts this half-dozen causes of danger down to three—viz.: (1) imperfect insulation; (2) imperfect conductivity; (3) imperfect workmanship. His idea of the proper way to avoid them is well known in the profession, and has been expounded and discussed at the Institution of Electrical Engineers and elsewhere. One need not, therefore, go into the details of a comparison of Mr. Bathurst's method of house wiring with our old acquaintance the grooved wood case, but may go straight to the conclusion, which is that "perfect electric wiring should combine in the fullest degree the attributes of safety, accessibility, convenience, economy, and durability." (Granted: only it is so hard to get perfection in this world of ours.) What the author endeavours to point out is that an insulating tube method of wiring does provide safety by giving the greatest surety of action and freedom from the danger of fire. In respect to accessibility, it provides for examination, replacement, or repair to any part of the circuit with a minimum of trouble and expense. With respect to convenience, the insulating tube is first fixed, due regard being given to the requirements of the building, and then completely fulfils its function of protecting the conductors. In regard to economy, "material utilised in the highest degree must admittedly be economical" (only that is not exactly what people mean when they talk about being economical). Finally, as to durability, a tube can be constructed the materials of which are in themselves practically imperishable, and which at the same time affords preservation for the conductors. "In short, an insulating tube system fully meets the various conditions of safe and perfect wiring, compensating crass ignorance, and counteracting gross carelessness on the part of those installing or using the electrical service," and "the true principle which should guide the insurance interests is really the absolute prevention of fire, inasmuch as any fire loss at all necessitates that the community at large suffers, the rates charged being regulated from the total actual loss of the combined companies." (But no risk should mean no premium and no insurance.) Finally, "The continued extension in the employment of electricity for power, light, and heat must, if properly directed, tend to minimise the occurrence of any fires, and it is hoped that a case has been made out to show that an insulating tube or conduit system of wiring provides the best means of preventing fires arising from the leakage of current to earth and the other causes of danger in electrical installation." As to all of which, it is very nice indeed to take your wires through tubes, but if your house is already built, wood casing, or some such affair, can be run up rather cheaper. And in the pursuit of perfection it is inadvisable to propagate the notion that with almost any way of wiring a house lighted by electricity it is not a great deal safer than if lighted by gas, paraffin, candles, or any other means whatever.

Lord Rayleigh at Albemarle-street.—At the Royal Institution last Saturday, before a more than usually distinguished audience, Lord Rayleigh began a course of six lectures on "Electricity and Electrical Vibrations." That is a title that will cover a good deal. What exactly we are going to have from Lord Rayleigh is just a little uncertain, as may be judged from the remarks with which he opened his lecture. He was not, he said, going to attempt the whole of electrical science (even Lord Rayleigh could not cram all that into six lectures), nor would he try to cast the matters he intended to bring forward into any particular logical order. Indeed, he intended to mix up the more difficult and the more easy parts, so that in each lecture there would be a chance of having something new for those who had some acquaintance with the subject, and at the same time there would be something also for those who were less advanced. Beginning with the latter, Lord Rayleigh commenced with the galvanometer, and illustrated its action by means of a large-size model. (That is reversing the habit of models, which is to be on a smaller scale.) A coil of insulated copper wire was connected with a source of electricity, and in the centre of the coil hung a magnet. When a current was sent through the coil the magnet tended to set itself axial to the direction of the current, or perpendicular to its normal position, which was downwards, owing to the earth's magnetic force. Moreover, one current in one circuit could induce a current in another. A coil of wire was used as a primary circuit, a second coil as a secondary circuit, and this latter was connected by wires with a galvanometer. A current being sent through the primary a current was induced in the secondary, when this was held parallel to the former, and the spot of light reflected on the screen from the galvanometer was seen to be deflected. When the secondary was held perpendicular to the primary there was hardly any deflection. Owing to the earth's lines of magnetic force it was hardly possible to move the secondary coil about without getting deflections, and when it was turned over on the table a large deflection took place. Electrical phenomena had their parallel in mechanical phenomena, and an apparatus was shown to illustrate mechanically the action of induced currents. The principle was that of the ordinary Huygens clock gearing, in which an endless cord ran over two pulleys, and two weights hung in running pulley blocks in the two bights of the cord. On the pulleys at the top were a red and a blue lath. Obviously, on a change in the rotation of one of these, the inertia of the weights and running pulley blocks gave an induced rotation in the other lath. It is safe to say that only those who did not in the least need it rightly understood the bearing of the illustration on the subject. After about half an hour of this sort of thing we came to something interesting. And that was neither more or less than an exhibition of the apparatus for removing the nitrogen from the air in order to obtain argon. The whole thing was set up in the theatre of the Royal Institution. Though few have actually seen it, the apparatus is well known. The alkali solution for absorbing the nitrates as quickly as they are formed is fountained up by means of an electromotor so as to run down the sides of the glass globe. This not only gives a large absorbing surface, but protects the glass from any possible effects from the 2,000-volt alternating arc which flames up from the two platinum terminals. A curious thing about these is that they will heat unequally, one, for instance, getting occasionally almost ready to melt, while the other is little more than red hot. The cause is unknown, but the effect appears to go with a slight roughening of the surface. To get his arc, Lord Rayleigh uses a Swinburne oil insulation transformer which with the primary on a 100-volt circuit would give 8,000 volts; but, as a matter of fact, a choking coil is inserted in the primary to bring down the voltage in the secondary to about 2,000. As to the work done, the current in the primary was about 40 amperes, which with the voltage reduced by the choking coil to 30 or so would seem to give 1,200 watts, but there is a power factor which reduces it to 800 watts, or a little over a horse-power. A comparatively large vessel appears to be essential for successful working, and Lord Rayleigh added that from experiments made at Terling it appeared that increased pressure had little effect on the rate of combination.

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THE MECHANICAL CONSTRUCTION OF ELECTRICAL MACHINERY.

BY F. M. WEYMOUTH.

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(Continued from page 297.)

THE DYNAMO.

Combination Bed-plates (continued).—In Figs. 83 to 85 herewith we have some more possible sections for the dynamo end of a combination bed-plate. Fig. 83 is a section which channel sections, as shown in Fig. 81, sometimes tend to merge into. A case in point is exemplified in Fig. 94 in the section on *e f*, though the transformation from one section to the other is not complete. Fig. 84 represents

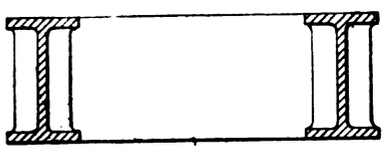

FIG. 83.

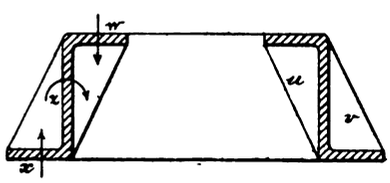

FIG. 84.

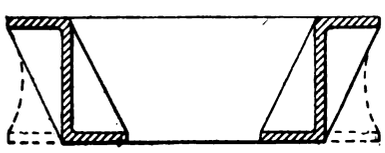

FIG. 85.

an arrangement adopted in a bed-plate made by Messrs. Hayward Tyler and Co., but without the ribs, *u v*. From a strictly mechanical point of view, however, this cannot be considered a very strong or economical section, owing to the upper and lower flanges, *w*, *x*, not being opposite each other. For if exposed to a vertical bending strain, and

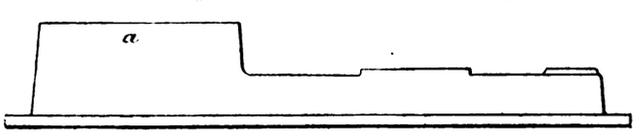

FIG. 86

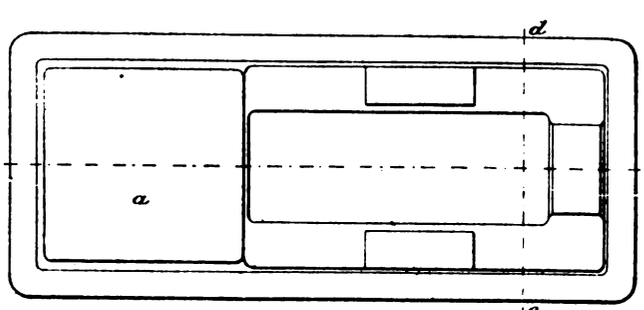

FIG. 87.

supposing the ends to be supported and the load in the middle, then the load acting as indicated by the arrow at *w*, and the stress or reaction of the lower flange acting as indicated by the arrow at *x*, these will form a couple tending to twist the section as shown by the curved arrow, *z*. This bed-plate is approximated in Figs. 86 and 87, which show

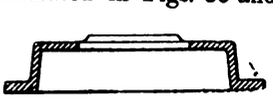

FIG. 88.

an elevation and plan respectively, while Fig. 88 is a section on *d e*. Unlike Figs. 77 and 78, we have here a case where the engine complete with its own base is put on the prolongation of the dynamo bed-plate, and the part *a* is a raised pedestal on which the engine is stood.

The arrangement shown (in full lines, Fig. 85) can scarcely be considered feasible, unless, indeed, a ribbed flange be thrown out as indicated in dotted lines, forming a kind of hybrid section offering some of the advantages contained in that which we next describe.

Though the combination of channel sections (Fig. 81) with open sides inwards is probably the more common, we have in Figs. 89 to 91 an example where they are combined, as was shown in Fig. 82—that is, what may be described as back-to-back. This was alluded to in connection with that illustration. These views show a design by Messrs. G. E. Belliss and Co., and represent a light gunmetal dynamo bed-plate bolted end on to the cast-iron engine bed-plate, as shown at *r r*, in which latter respect it is the more interesting, inasmuch as it illustrates the third method of combining the engine and dynamo mentioned in our opening remarks. This design is especially intended for use on torpedo boats and destroyers and such light craft, wherewith a minimum weight is a leading consideration. By casting the bed-plate itself in gunmetal, the need for gunmetal shoes or brackets for carrying the magnets is obviated; and also, there is no necessity to enlarge the base on account of magnetic leakage. Hence, in both ways a saving of weight is effected. It will be noted that the channel section extends from *c* to *d*; but that from *d* to *e*

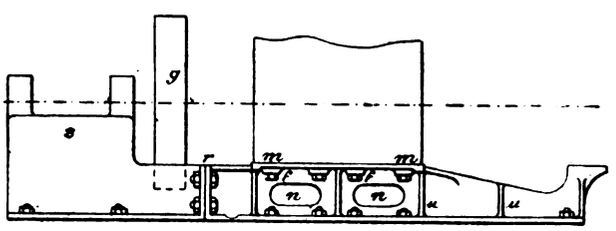

FIG. 89.

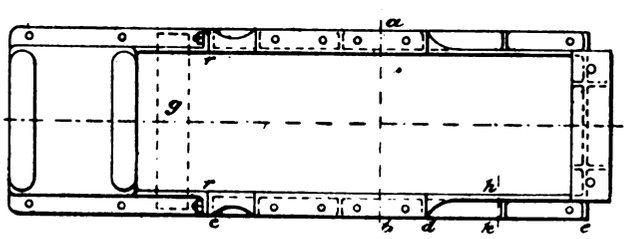

FIG 90.

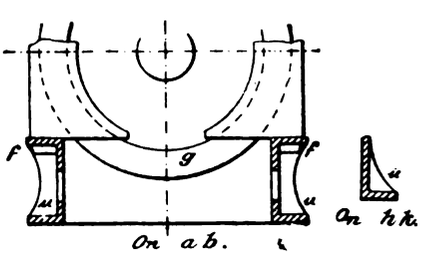

FIG. 91.—Sections.

there is a simple L section as depicted (Fig. 91) in the section on *h k*; and there are ribs, *u u*. The attaching tap-bolts for the magnets pass through horse-shoe-shaped bosses, lettered *f f*; but there are no raised facings for the nuts of the holding-down bolts in the lower flange. These latter may thus have sunk facings as shown (Figs. 74 to 76). A point that may be noted is that in order to secure a raised facing for the magnets to stand on, and at the same time economise in weight of metal, the upper flange of the channel is stepped up bodily, as shown from *m* to *m* (Fig. 89). The flywheel is lettered *g* in all these views. Lightening holes, *n n*, save metal, but they also assist in the ventilation of the armature, for which purpose they are sometimes provided.

We now approach some examples of combination bed-plates wherewith the dynamo ends are formed of channel sections arranged open side inwards, contrary to the last discussed, and like the method shown, Fig. 81. With these it will be seen that we come to examples from actual practice which have a general similarity to the outline

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designs shown, Figs. 77 and 79. The same lowered end for the bearing will be observed; while sections in Figs. 94 and 99 replace sections *x* and *y* in Fig. 79. The first of these is again a design by Messrs. G. E. Belliss and Co., Birmingham, to whom we have to express our great obligation for the drawing of which Figs. 92 to 94 are a reproduction, and is one that will doubtlessly be recognised as a well-known type made by this firm. Fig. 92 is a side elevation, Fig. 93 a half plan and sectional half plan, while Fig. 94 shows sections as lettered.

The first point we may note is that the sections, as on *e f* and *g h*, are very deep in proportion to their width, and we thus find that these side members have great strength, more especially in a vertical direction. A peculiarity, indicated at *l* in sections on *g h*, *a b*, and *c d*, is a small lip beneath the edge of the upper flange of the channel, added, no doubt, for the sake of giving additional stiffness. This is that to which we alluded to in connection with Figs. 80 and 81 as a slight approach to a flange on an edge of the channel when two of these are combined open sides

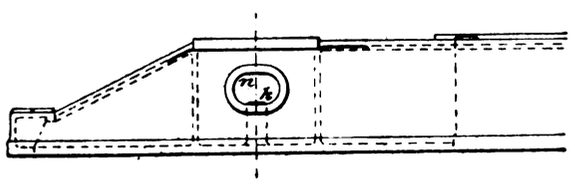

FIG. 92.

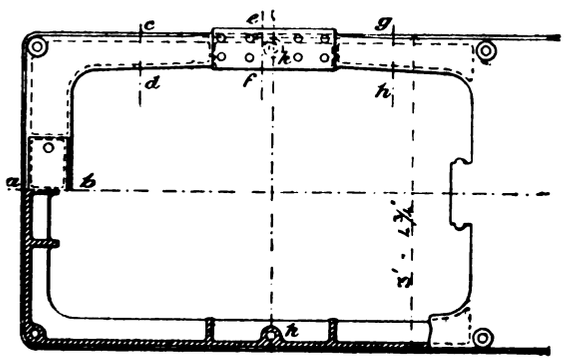

FIG. 93.

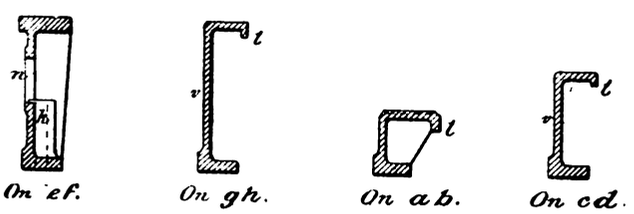

FIG. 94.—Sections.

inwards, though, when viewed in that light, it is not very large. The total length of this bed-plate is given as 8ft. 1½in., and the width is indicated (Fig. 93). The thickness of the vertical walls, as at *v v* (Fig. 94) is about ⅝in. We thus perceive that this is an example of casting which is light in proportion to its size, such as was referred to when discussing this point on an earlier page. One lightening and ventilation hole is provided at *n*, and this is taken advantage of to lower the height of the boss for the holding-down bolt, as indicated at *k*. The nut can easily be worked with a spanner through the hole. Other bosses (shown in the plan) are embodied where there are corners. It will be noted, as regards ribs, that these are only placed two under the magnets and three under the bearing, and the bottom flange, though thicker, is for the most part narrower than the upper flange of the channel. The narrowness of both these flanges would make the whole structure, in fact, seem rather weak sideways. It is to be remarked, however, that this design is for central station lighting, wherewith no special side strains are to be anticipated: while further, by reason of the outer ends of these side members being rigidly joined across by the bearing member, any side strain acting horizontally at one of the corners, in order to cause any deflection, would be obliged to produce a double bend in both of the sides. This is indicated diagrammatically in Fig. 95 herewith. To cause thus any given degree of deflection, at least twice the force would be required that would otherwise be necessary were the ends merely united by a member jointed at the corners, as shown in Fig. 96. In this latter case only a single bend is set up in each side member; and of the outer angles, *a* and *b*, one is free to close and the other to open. But in the former arrangement these two angles are both maintained rigidly right angles. This hence applies to all such bed-plates as that of the kind we are now discussing.

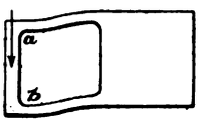

FIG. 95.

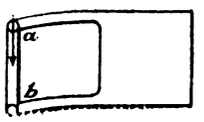

FIG. 96.

There may, perhaps, be said to be two principal strains on the side members carrying the magnets. One is the mutual attraction of the pole-pieces to the armature between them, and the other is simply what may be described as the "effort" necessary to maintain steadiness. The first, however, can, of course, be eliminated by putting a gunmetal distance-piece between the lower horns; while that required for the second must be a matter of judgment and experience. It is thus to be noted that though such sections as those on *e f* and *g h* may seem narrow for their height, experience justifies them as being sufficiently strong, especially with the holding-down bolts so opportunely and advantageously placed as at *k k*, where they are able to exercise a considerable steadying effect on the magnets. This bed-plate is carried the same width throughout to the engine end, and, commencing at the magnets, is maintained the same height.

A further example of this type of bed-plate which we may glance at is represented in Figs. 97 to 99. These are reproduced from a drawing giving outside views only, for which we have to thank very much Messrs. Willans and

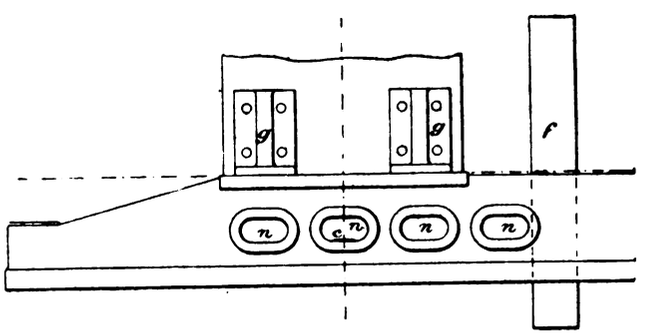

FIG. 97.

Robinson, Thames Ditton. Fig. 97 is an elevation showing the flywheel, *f*, and the lower end of the magnets, supported by gunmetal brackets, *g g*. Fig. 98 is a plan partly in

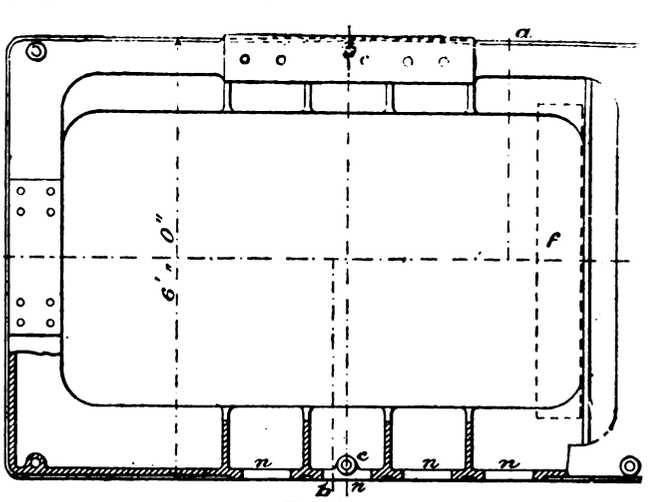

FIG. 98.

section, this latter being approximate as regards the thickness of the metal. Fig. 99 is an approximate section on

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a b, and in all views the flywheel is lettered *f*. The dynamo is by Messrs. Siemens Bros., and the whole plant, with a triple-crank Willans engine, is such as was supplied to Bradford. This bed-plate is 16ft. 2⅝in. in length; and like the last we have discussed, is of the same height and width throughout, excepting only for the lowered end for the dynamo bearing.

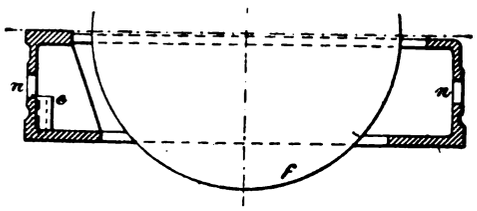

FIG. 99.

We thus find that comparing this with the last it is considerably longer. In proportion to its width it is also much shallower. But we find here, as shown plainly in Fig. 99, an example wherein the lower flange of the channel section is given a greater width than the upper, this being permitted by the flywheel, as was discussed in connection with Fig. 80, and shown dotted therein. There is thus a greater appearance of strength sideways. Four lightening and ventilation holes, *n n*, are provided on each side; and, as was the case in the previous bed-plate (Fig. 92), one of these is taken advantage of for reducing the height of the boss for the holding-down bolt, as shown at *c*. We may note, that as made clear in Figs. 97 and 99, the flywheel here projects much below the bed-plate bottom, thereby requiring a pit in the foundations, an effect not so necessary in the Belliss bed-plate, owing to its much greater height as compared with its width.

In these two cases above cited we thus have bed-plates by well-known makers, both designed on the same system as regards the adaptation of the channel sections: and, as we have pointed out, for ordinary station work where there are properly prepared foundations, or for any case where there are no special side strains across the commutator bearing end to be anticipated, this system offers the most advantages, and is the most economical as regards the placing of the metal, the latter being almost entirely in the outer periphery of the general transverse section. The shaft is practically about as low down as it is feasible to get it, while still preserving the possibility of withdrawing the armature endways over the lowered end of the bed-plate; and by this means the total height of the plant is also reduced to a minimum. For, with the latter dimension, the height of the central-station building is also affected, if not the clearance for the travelling crane overhead; or, on board ship, the vertical dimension between decks is an analogous consideration.

(To be continued.)

THE "SIMPLEX" CONDUIT SYSTEM OF ELECTRICAL TRACTION.

The busy little town of Prescot, Lancashire, was invaded on Tuesday, the 9th inst., by a large party of gentlemen interested in the progress of electrical traction—the occasion being the inspection of a model line of tramway which has been laid by the Simplex Electric Tramway Conduit Syndicate, Limited, 48, Castle-street, Liverpool. The company, invited by the syndicate, included among its members deputies from the principal corporate bodies in the United Kingdom who at the present moment are interested in the question of electrical traction. A special train had been chartered, and a start was made for Prescot from Lime-street Station, Liverpool, punctually at 12 o'clock noon, a stop being made at Edge Hill to pick up the London contingent of visitors. Prescot Station was soon reached, and from thence the party was conducted to the works of the British Insulated Wire Company, about three minutes' distant, upon whose property the length of track inspected has been constructed. The weather unfortunately was unpropitious, but this in no way seemed to damp the interest of the assembled guests, who proceeded to minutely inspect the length of track, the broad principles of the system being lucidly explained by Mr. J. E. Waller, M.I.C.E., the consulting engineer to the syndicate. Several trips were made up and down the line, the car which had been provided for that purpose being packed to its utmost capacity each journey. Some of the incredulous seemed to think that a possible source of trouble with the "Simplex" conduit system in practice would be through stones getting wedged in the slot, and so interfering with the passage of the collector; but the fallacy of this idea was successfully demonstrated by hammering stones and pieces of brick firmly in the slot. These obstructions the collector treated as if they were so many pieces of cheese and received not the slightest damage in return.

We described the principles of the "Simplex" system a few years back, but it was then in advance of the age. Not much disposition was shown at that time to adopt electrical traction in our towns on account of the initial cost of installing any electrical system other than the overhead wire being very great as compared with other methods of traction. As for the overhead wire system, it is well known what a prejudice, even now, exists against its adoption in most of our towns. In fact, the few lines which have been established were subjected to strenuous opposition. The great initial cost of conduit systems has hitherto been chiefly responsible for the small mileage constructed. This drawback the "Simplex"

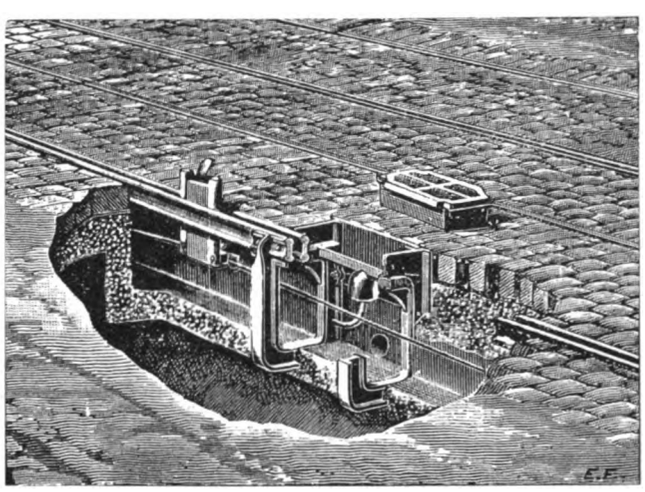

FIG. 1A.—Longitudinal Section of Conductor showing Hatch-box and Conductor.

system is claimed to have largely removed. We are informed that, compared with other conduit systems, the Simplex is very much cheaper. Though not differing essentially from the system as described in the *Electrical Engineer* a few years back, there have been various modifications in detail, and it has become even more efficient owing to the great improvements which electrical apparatus generally has undergone. The demonstrative line which has just been completed at Prescot is a single track about a quarter of a mile in length. But although it is, comparatively speaking, insignificant in length, it combines all the difficulties likely to be met with in ordinary practice. For instance, the length includes a bend having a 45ft. inner rail radius, and the gradient is 1 in 25 for quite half the run. Besides this, the points which divert the car into its shed have been placed at an exceptionally difficult angle, much more difficult than would have been necessary in ordinary practice. In fact, the line has been deliberately made as difficult as possible in order to demonstrate the extreme facility with which these difficulties may be overcome with the Simplex system. One of the principal differing features as compared with other conduit systems is in the employment of a flexible conductor, the cable used consisting of 49/22's manufactured by the British Insulated Wire Company, Limited. This conductor is situated in a conduit at one side of the track just inside the rails, as shown in Fig. 1. The concrete conduit takes the form of the inner surface of the cast-iron yokes or chairs, which support the bearing and guide rails. These yokes occur

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at intervals of 4ft., but at the points where one rail joins another they are only 1ft. 6in. apart—the object being, of course, to give a good firm support to the end of each rail. It may be mentioned that the rails are bolted to the yokes, which, therefore, have to carry the whole weight upon the rails. A solid setting of concrete, 4in. thick, supports the yokes, and at the same time forms a floor for the conduit. Where the rail junctures occur—that is, at 30ft. intervals—hatch-boxes (Fig. 2) are led into the conduit between the yokes supporting the rail ends. These boxes have a framework of cast iron and a cover of the same material. Into the framework of each box, just below the under surface of

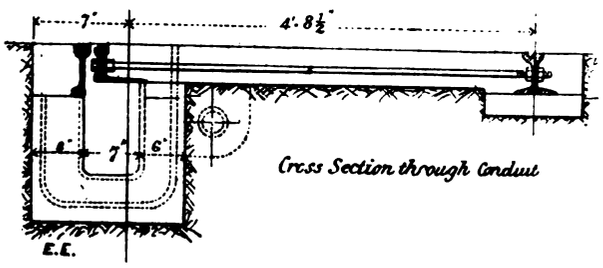

FIG. 1.

the cover, a notch is cut, into which fits a bar of iron of square section, which in its turn supports, by means of a nut and bolt, an insulated metal arm or carrier bar (Fig. 3). On these insulated carrier bars, which are placed at intervals of 30ft. where the line is straight, rests the conductor. It merely rests lightly on the bars, being free to move in a vertical direction. At a curve, however, where the conductor would tend to take a straight line were tension brought to bear on it, the carrier bars are not quite so simple. The hatch-boxes on the curve are placed much closer together than on the straight, and the iron bar let into the frame of each box supports two insulators instead of one, which in their turn carry a swivel carrier bar of different design to that described above. Fig. 3 shows a sectional elevation of one

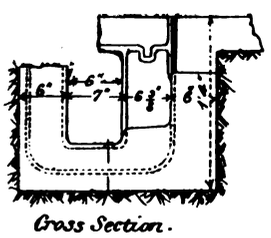

FIG. 2.—Cross-section of Ordinary Hatch.

of these carrier bars, while a side view, a front view, and side sections of the actual carrier are also shown. The object of this special design of carrier for curves, as will be readily understood, is to prevent the cable from being carried off of its insulated supports by the

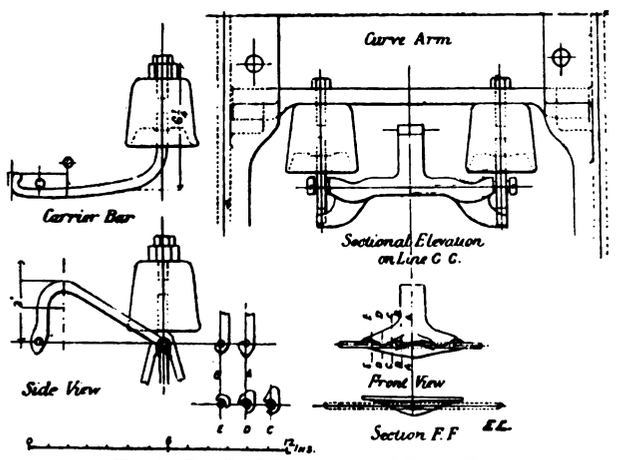

FIG. 3.—Details of Curve Arm and Carrier Bar.

action of a passing collector. The swivel attachment allows the carrier a direct vertical lift, but no lateral play, and the carrier holds the cable firmly, so that an upward pressure on the arm lifts cable and carrier together in a vertical line, the cable being allowed no independent vertical movement, as is the case where the line is straight. Thus the tendency of a cable to assume a straight line when at a

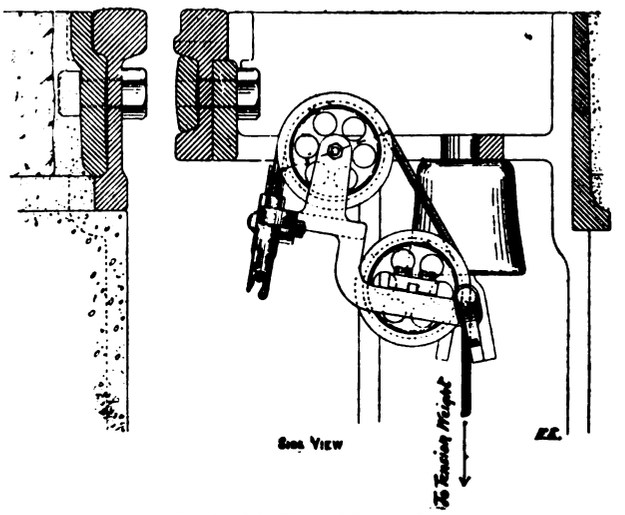

FIG. 4.—Side View of Tension Gear.

tension is overcome in an exceedingly neat and efficient manner.

While this special form of carrier used on the curves embraces the conductor quite firmly so as to allow of no lateral movement when the conductor is at a tension, yet,

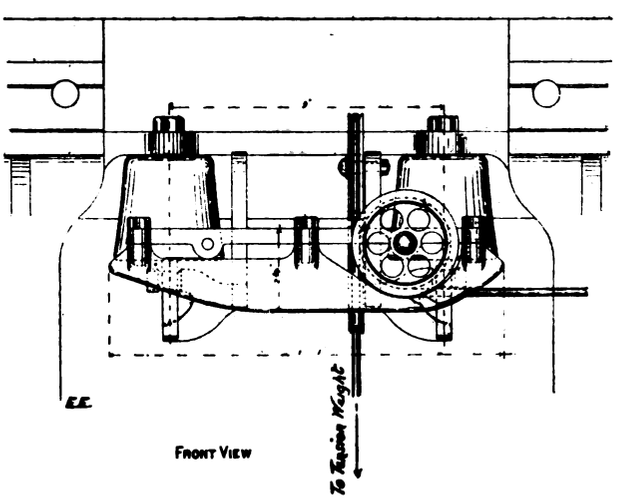

FIG. 5.—Side View of Tension Gear.

as will be readily understood with the aid of Fig. 3, the conductor can be disengaged with great facility by simply slackening it slightly and buckling it clear of the grooved lip with which the carrier is provided. It may also be worthy of mention that all the conductor carriers, whether on the curve or otherwise, can be removed with ease from their respective hatch-boxes, together with their insulators and

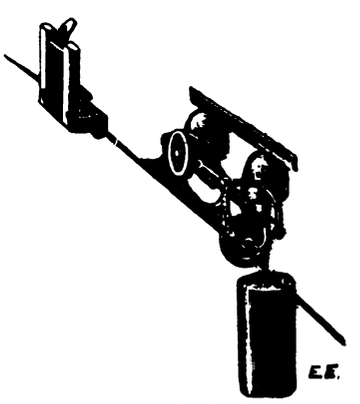

FIG. 6.—Tension Gear.

horizontal supports. All parts, moreover, are interchangeable, so as to facilitate repairs.

The device for keeping a constant tension on the conductor (shown in Figs. 4, 5, and 6) is also of special interest.

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The apparatus serving this purpose is connected to a rocking frame mounted on insulators similar to the curve arms. On this rocking frame are mounted three pulley wheels, which serve, first, to deflect the cable vertically and then

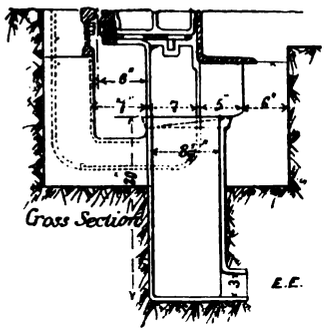

FIG. 7.—Cross-section of Well Hatch for Tension Gear.

horizontally, so as to be out of the way of the collecting-shoe during its passage. The cable is carried down vertically through the centre of rotation of the rocking frame, and a lead weight of 102lb. is attached to the free end of the cable. The object of taking the cable through the axis of rotation is to prevent this considerable weight either lifting or lowering the rocking frame. By this means, although there is considerable tension on the conductor itself, the frame is as free to be lifted by a passing collector as is the ordinary curve arm without any weight attached. Indeed, it offers little more resistance to the passage of a collector than the conductor itself when merely resting on its insulated supports.

In practice this tension apparatus would be fixed at intervals of about a quarter of a mile, and also at any points or crossings where a break in the conductor occurred. An extra deep hatch-box is provided where this apparatus is fixed (Fig. 7). The tension regulators also serve as feeder points, each quarter of a mile section being complete in itself and separately fed. The main feeder is enclosed in an earthenware drain-pipe placed between the rails adjacent to the conduit, as shown in Fig. 8. Branch wires from this feeder feed each section of the conductor through the frames of the tension apparatus placed at either end of the sections. We think we have made it sufficiently clear that the conductor is broken up into

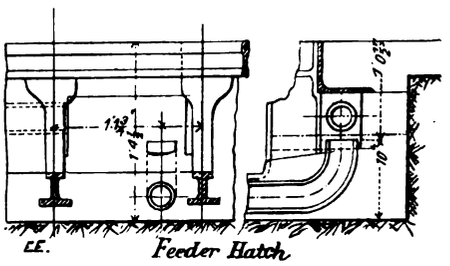

FIG. 8.—Longitudinal and Cross-sections through Feeder Pipe.

sections with straining or tension regulating devices fixed at the free ends of each length. Any section can therefore be cut off from the rest, and a fault thereby located without difficulty. The conductor, in fact, presents a series of gaps at quarter-mile intervals. We shall explain presently how these breaks are negotiated so as to prevent sparking at the collector shoe. Before we come to this, however, we will endeavour to describe the special form of point which is another novel feature of the system, also exemplified at Prescot. This point is so formed that it can be made at will to automatically spring

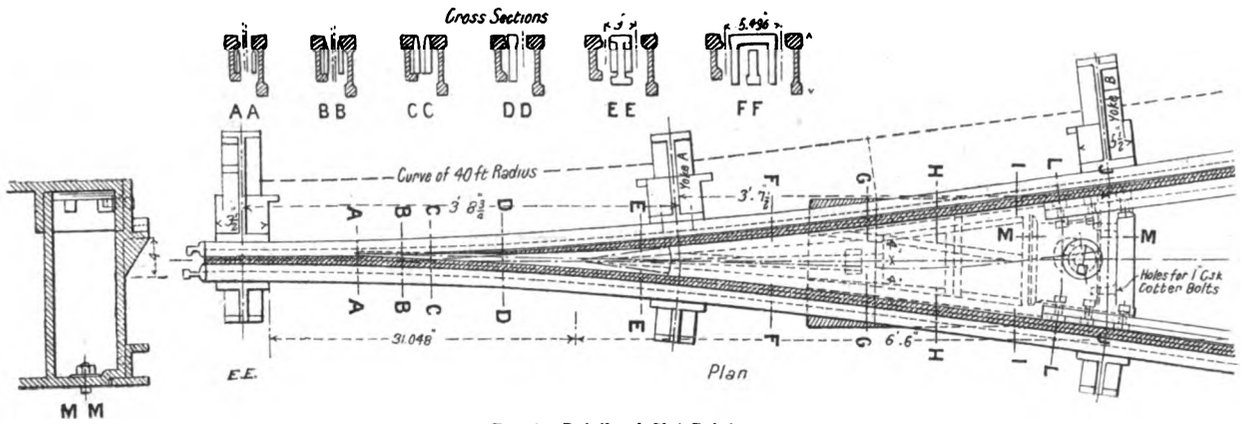

FIG. 9.—Details of Slot Point.

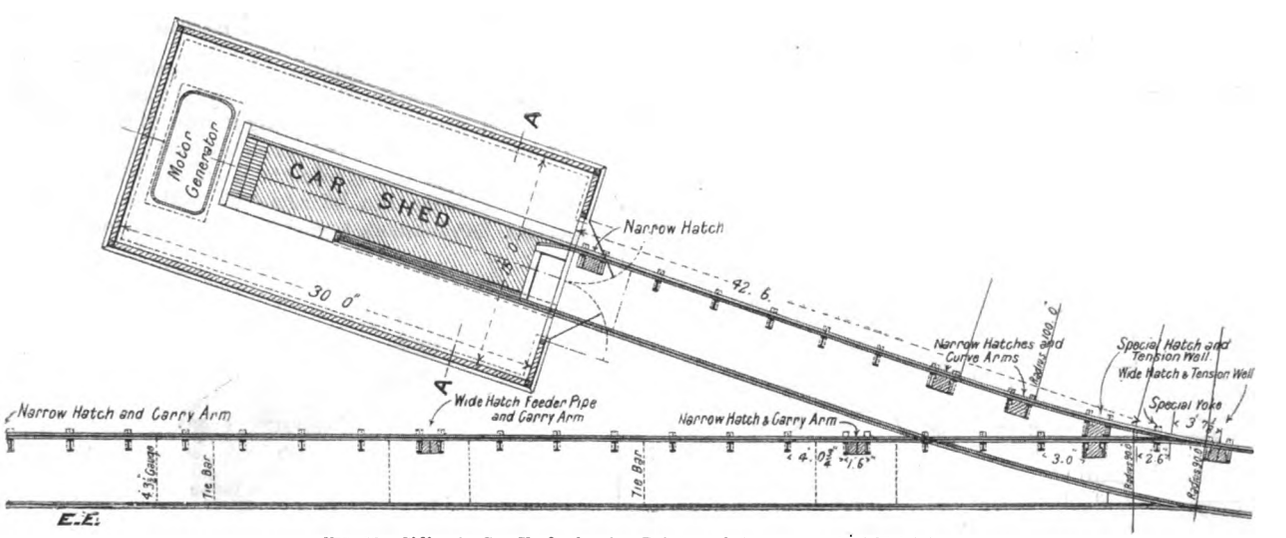

FIG. 10.—Siding to Car Shed, showing Points and Arrangement of Hatch-boxes.

back to guide the traffic either into the right-hand or left-hand track, but in passing-places it is usual to have the point set to divert the traffic to the left. The same point is applicable at junctions. In ordinary practice junction points are moved by hand, but the "Simplex" point works automatically as required. This is accomplished by carrying an arm below the surface of the point casting in extension of the point tongue, and providing a spring to press against the arm. By means of a

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simple cam arrangement this spring can be deflected so as to press the tongue either against the left-hand or right-hand rail. Fig. 9 shows the points as arranged at Prescot, and Fig. 10 gives a general idea of the hatch-box arrangements and siding to car-shed. The slot along which the collector shank passes, also shown in Fig. 9, is about ¾in. in width. It is an opening between the bearing and guide rails at one side of the track. We must not forget to mention that the conductor is not placed immediately beneath this slot, but is situated to the side of the conduit sheltered by the guide rail. Thus the danger of any foreign substance getting into contact with the conductor is minimised. The collector, the construction of which is shown in Fig. 11, consists of a hollow shank through which a conductor, insulated with rubber and ebonite, passes to a collecting shoe, the form of which is shown in Fig. 11. The rubbing surface of the shoe is of brass. Though the collector is perfectly rigid in itself, free side play is allowed to enable it to adapt itself to sharp curves; or it would, perhaps, be more correct to say to allow the car itself to take up a relatively different position with regard to the collector

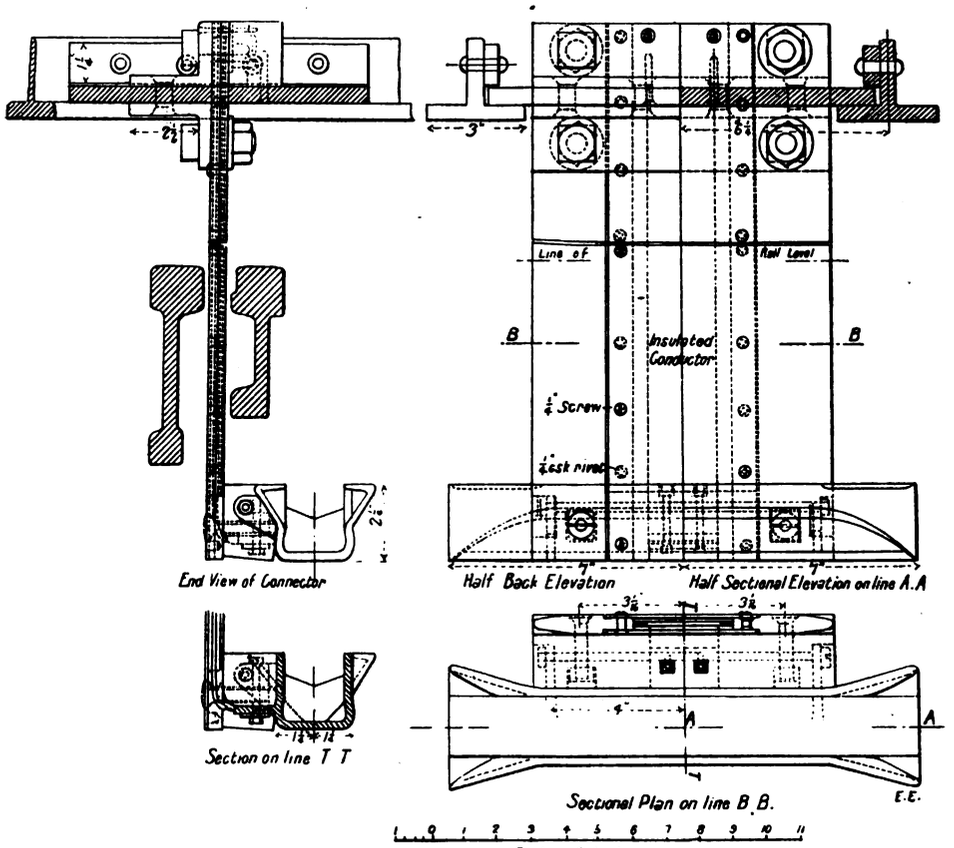

FIG. 11.—Details of Collector Shoe and Shank.

when negotiating sharp curves. This is accomplished by allowing the base of the collector free travel along channel-iron supports fixed to the car frame, and giving the collector a flexible connection to the resistance coils in connection with the motor. When the car is in motion the collector shoe makes contact with the under side of the conductor, which it gently lifts clear of its support arms as it proceeds. The swivel conductor carriers at the curves and the tension apparatus are lifted by the collector shoe in the same way. But the normal position is again assumed directly the car has passed by. The conductor carriers, both in connection with the swivel arms and the tension apparatus, it may be mentioned, are bevelled off so as to offer the least possible resistance to passage of the collector shoe. Each car is provided with two collectors, one at each end, so that one or other of the collectors is always in contact with the conductor, as they easily bridge over the gaps between the section and so prevent sparking. The car which is being used was supplied by Messrs. Milnes and Co., of Birkenhead. It weighs 5 tons 13cwt. empty, and will accommodate 20 persons. A 15-h.p. motor is attached to it. The lighting of the car is by means of five 100-volt lamps connected in series direct to the conductor. The tram rails are utilised as the return. Current is supplied to the line from the British Insulated Wire Company's works through a motor-transformer capable of taking 222 amperes at 135 volts, and transforming up to 67 amperes at 540 volts. This transformer, together with the car, motor, and other electrical fittings, was supplied by the General Electric Company, U.S.A. Insulators of the Etna type are used throughout. From what we saw of the "Simplex" conduit system of electrical traction on Tuesday it seems to combine the advantages compatible with an ideal conduit system without some disadvantages experienced with other conduit systems. The low initial cost of construction which is claimed, the remarkable simplicity and efficiency of its parts, and the facility with which a conductor can be replaced or other repairs effected without disturbing the permanent way, are features greatly in favour of the "Simplex" system of traction. These are features, moreover, which promise great possibilities for the future of the system. For our part, we hope the "Simplex" system will give that stimulus to electrical traction which has so long been waited for in this country. Mr. J. E. Waller, M.I.C.E., of Westminster, who, as previously mentioned, is the consulting engineer to the syndicate, is to be heartily congratulated on the success of the demonstration which took place on Tuesday. After the inspection of the line had been duly made the return trip to Liverpool was undertaken, where an excellent luncheon was served in the North-Western Hotel.

Luncheon over, the usual toast to the Queen was proposed by Mr. E. H. MUSPRATT, J.P., chairman of the syndicate (in the chair); and then Mr. S. Z. DE FERRANTI proposed "The 'Simplex' System." He remarked that our rapidly-growing towns and congested cities were becoming less and less suitable for residential purposes, and a quick means of transit was necessary to enable residents to reside as far from congested centres as possible. America was well served with a good service of rapid transit, but there it was by means of the overhead electrical system, which was not popular in England. This difficulty had, then, to be overcome by the ingenuity of engineers, and nothing so well met the case as what those present had seen that day. His reason for thinking highly of the Simplex system was on account of his being unable himself to invent a better, although he had devoted his energies to the solving of the

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problem. One great advantage in connection with the system was that the mechanical details might be completed before the electrical parts were put in. In his opinion the points of simplicity in the system were so great as to command rapid success. He hoped the syndicate would soon be doing good work in many large and important towns.

Mr. J. B. ATHERTON, to replying to this toast, said that the system had attracted attention in America. Several American engineers had investigated the demonstrative line at Prescot, and the adoption of the system in America was under serious consideration.

"Electric Traction" was next proposed by Mr. R. D. HOLT, J.P., who believed implicitly in electric traction. He had assisted at the opening of the Liverpool Overhead Railway, which had been highly gratifying in its results. He hoped to see a better system of traction introduced into the Liverpool streets than the present horse cars, which were noisy and otherwise objectionable. If electric traction was introduced it would provide a day load for the Corporation's splendid plant at the electric light works, which at present was generally at a standstill during the day. He would couple the toast with the name of Mr. J. E. Waller.

Mr. WALLER, in responding, said that a satisfactory conduit system of electrical traction would meet the objection to overhead wires. At Budapest the conduit system in vogue had been satisfactory, but the chief objection to that system was that the roads had to be frequently pulled up to effect repairs. The Simplex system avoided this objection.

"The Guests" were proposed by Mr. J. P. SNAPE, J.P. He said that overhead wires were both unsightly and dangerous, many accidents occurring in America through the breaking of wires. He would like to see his countrymen delivered from the dangers which beset Americans.

Alderman Isaac A. Mack, J.P., Mayor of Bootle; Alderman Higginbottom, Manchester; and Mr. Bailie Wallace, of Glasgow, were called upon to respond to this toast. Alderman HIGGINBOTTOM said that Manchester would soon have to deal with the question of electrical traction. The Corporation owned about 70 miles of permanent way, which they leased to companies, but the question would soon have to be decided whether the Corporation should take the tramways over and work them electrically themselves, or re-lease them with the proviso that an electrical method of working them should be adopted. The electric supply at Manchester was at the right tension for traction purposes, but an overhead system would not be tolerated. To instance the feeling against the adoption of overhead wires, he said that the Manchester Corporation was applying for powers to supply four outside townships with electricity for lighting and traction purposes, but a clause had had to be inserted prohibiting the use of overhead wires. Mr. Bailie WALLACE said that Glasgow was decidedly against the introduction of an overhead system. He thought the Simplex system was a step in the right direction.

A toast to the directors, proposed by Mr. J. HENDERSON, J.P., which was briefly responded to by the CHAIRMAN, wound up the very successful proceedings of the day.

SHEFFIELD.

REPORT ON TRAMWAY TRACTION.

(Continued from page 307.)

HAMBURG.—Population, 626,000.

[Note.—In addition to this population, Altona, which is practically part of Hamburg, has a population of 280,000.]

In Hamburg the deputation had interviews with Rath Dr. Sthamer and the deputy engineer, representing the Municipality, and with the director of the principal tramway company, and the company's electrical engineer. From these gentlemen most of the information respecting the Hamburg tramways was obtained. The electrical tramway system in Hamburg must be regarded as the most important in Europe in point of size and completeness.

The city of Hamburg generally is flat, and some of the streets are very wide, while others, especially some of the business streets, are narrow (the narrowest streets through which the tramways run being about 23ft. from kerb to kerb). The gradients are not very steep (the worst being 1 in 20), but some of the curves are sharp, having a radius of only about 50ft. Generally the paving is of granite and basalt, with a concrete foundation, and the joints are grouted up with asphalte. There is no wood paving, this material not being liked on account of its short life. There is a small length of asphalte put down as an experiment. The paving on the tramlines is in nearly all cases from rail to rail, the rails being of the girder pattern, jointed to form a return for the electric current, and where possible a distance of about 10ft. is allowed between the kerb and the rail. In some cases the electric cars are running over the same rails and paving as were used by the old horse cars, but it is considered to be the most economical course to take up the old rails, if of light section, and lay heavier rails of the girder section (weight 106lb. per yard). The scavenging is, of course, very much decreased by the removal of so many horses from the streets, and the Municipality propose shortly to scavenge the lines at their own expense instead of at the expense of the company, as has been the case heretofore. The tracks are nearly all double, both the company and the public preferring this to single lines with crossing places. The total length of the streets traversed by the tramways is about 67 miles, and the gauge is 4ft. 8½in. The tramways are at present in the hands of three companies, but two of them have only a small mileage compared with the other. The capital of the larger company is about £750,000 in shares and £450,000 in obligations.

There are three systems of tramway traction in use in Hamburg—namely, (1) horse, (2) steam, (3) electric overhead. The terms of the concession are generally as follows: Duration until 1925; Municipality take 1pfg. ($\frac{1}{10}$d.) per passenger. The roadways are repaired by the company, but eventually it is expected the Municipality will do the work at a fixed charge. The company provide the rails, cars, etc. The tramways will fall into the hands of the Municipality at the end of the term for a certain price. The company are bound to take their current from the lighting company (who have also concession from Municipality, paying a percentage for the privilege) at a certain price (1d. per unit). Probably before dealing with the electric tramways it will be better to say that the other two systems need not be taken into serious consideration as far as Hamburg is concerned. There are only 21 steam and about 100 horse cars left as against 440 electric cars and 300 trailer cars, and these would have been superseded some time ago had not the output of electricity at the power station been smaller than the demand. Very large additions, however, were being made at the station, which it was expected would be complete in a few months, when both the steam and horse cars would be abolished. This system has been in use since March, 1894. Previous to permission being given, the authorities were opposed to it on the ground of appearance, and before it was definitely adopted experiments were made to convince them the system was the best available.

The current is carried along the various routes by means of overhead wires supported by rosettes and brackets attached to houses and other buildings, and where permission for rosettes has not been obtained by means of poles. Nearly all the brackets and poles are very well designed; in fact, some of the wrought ironwork is so artistic that it is an ornament to the streets rather than otherwise. Where, however, permission can be obtained to fix the rosettes, these are preferred by the tramway company for economy, and by the Municipality for convenience. The cost of the rosettes is about 25s. each. The price for the poles varies according to their appearance and size. Permission to fix the rosettes has to be obtained from the Municipality, who require to be satisfied not only that the householder is willing, but also that the electric lighting and telephone companies are not injuriously affected, as otherwise the two companies, and especially the latter, might object on the ground of interference with the efficiency of their apparatus. Permission may afterwards

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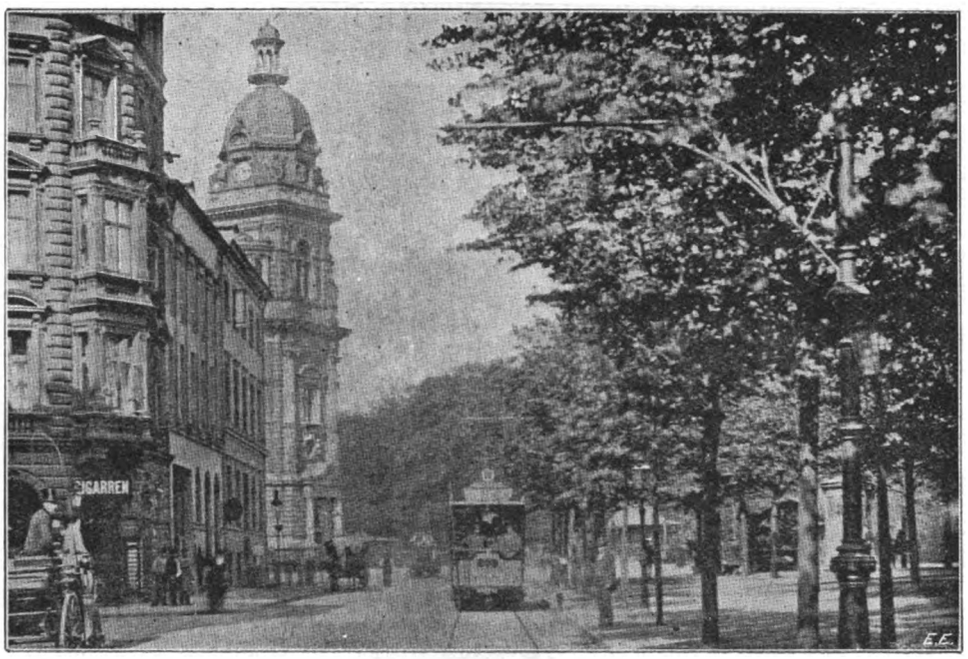
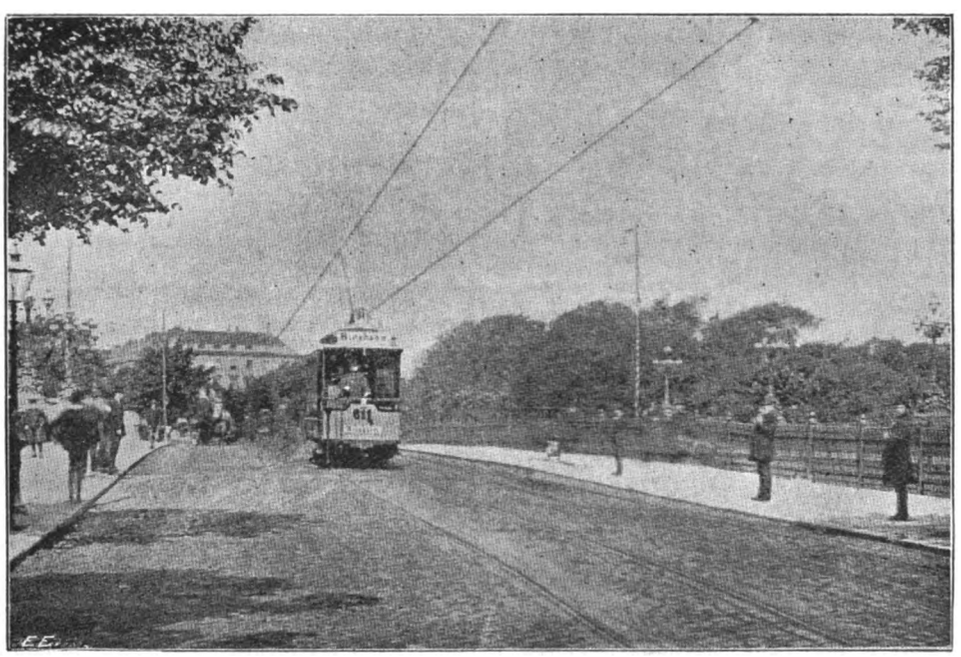
be withdrawn. Practically there is no difficulty in obtaining permission, and now no complaints are made respecting the rosettes. When they were first fixed in Hamburg, however, in some cases noise was caused in the houses; but this is stopped by placing rubber between the wire and the rosette. Great ingenuity and skill has been used in arranging the wires in the open spaces to avoid the use of poles. In one case of an open space opposite the Post Office, 150ft. wide, poles are used on the side near the Post Office only (this being because the Post Office would not grant permission for rosettes), and rosettes on the opposite side, with span wires between them. In the Gansemarkt, which in one place is almost 90 yards wide, the wires are carried round a curve for a distance of about 140 yards without poles by means of rosettes and guy wires, while across the Lombards Bridge (shown in the illustration) there is a span of 130 yards without poles. A plan of the Gansemarkt and two other photographs illustrating the overhead electric system in Hamburg are also given. Usually the distance between poles or span wires is from 30 to 40 yards. In some of the large open spaces where poles are used they spring from clusters of lamps, and the artistic effect is very good.

There are two power stations belonging to an electric company with 1,800 h.p. and 3,600 h.p. respectively, including reserves. The heaviest load on Sundays is 3,800 amperes. Accumulators are provided (12,000 amperes at 110 volts), so that in case of a breakdown there need be no stoppage of traffic. The large new new station is a very fine one, erected and worked by the lighting company. The lighting company pay to the Municipality 20 per cent. of their income, and therefore, as before mentioned, in granting the concession to the tramway company, it was stipulated that the current should be taken from the lighting company for the term of the concession. The Municipality also impose conditions as to the smoke from the chimneys of the power station, and in order to comply with these it has been found necessary to use Welsh smokeless coal. This costs about 18s. per ton in Hamburg. The workmen at the station are paid 4s. 6d. per day and the firemen 4s. In addition to the power station and depôt mentioned above, there are 16 other depôts, 12 of them for electric cars.

The cars are constructed and fitted in a very superior style. They are beautifully painted and lighted, and are kept clean and in good condition. In fact, the deputa-



Hamburg Tramways.—View of the Overhead Electric Tramways (Thomson-Houston) on the Esplanade, showing how slightly the poles, brackets, wires, etc., affect the appearance of the street.



Hamburg Tramways.—View of the Overhead Electric Tramways (Thomson-Houston) on Lombard Bridge.

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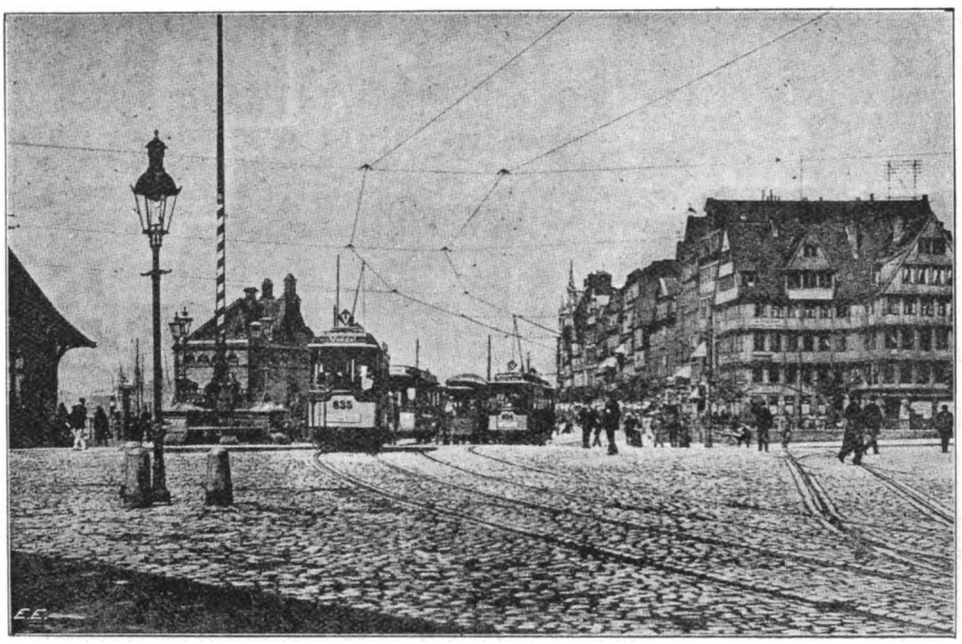
tion were altogether pleased with them. It was, however, stated that the painting of the cars was an important expense, as it was necessary to repaint them every other year. The lighting is by electric lamps, five in number, three inside the car and one at each end. Besides these, there are other five lamps used for the lighting of the motors, weight empty about 7½ tons; and 300 trailer cars, weight empty about 2¼ tons. The deputation were invited to inspect the trial of a patent car with radial axle, designed for taking sharp curves. They witnessed the tests and rode in the car, but for the reasons already given scarcely think it would be suitable for any but long journeys

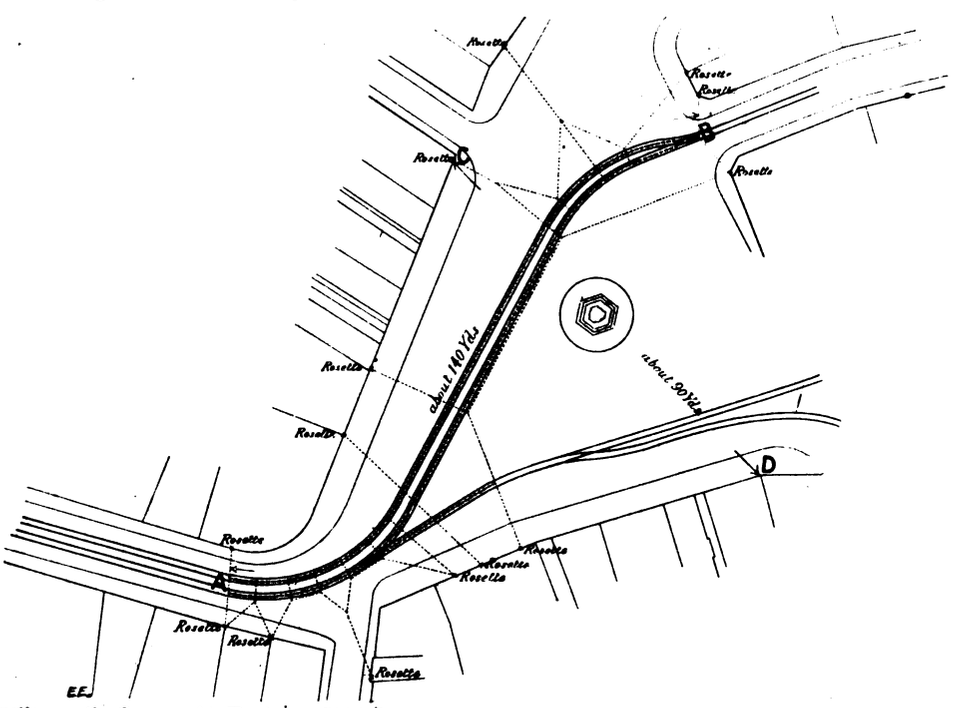


Hamburg Tramways.—View of the Overhead Electric Tramways (Thomson-Houston) on the Baumwall.

signs and the platforms. There are no outside seats. The ventilation of the car is by means of special small windows just under the roof. There is no practical difficulty in providing outside seats, but small cars and frequent service are preferred, except for long journeys with few stoppages. The small cars can be emptied, filled, and restarted almost in a few seconds, consequently the traffic is much less inconvenienced and less time is wasted than if larger or two-storeyed cars were with few stoppages. The car travelled very easily round sharp curves.

In Hamburg only the "fishing-rod" form of trolley is used. It is said that the "bow" trolley or collector takes curves better, but wears the wires more.

The fares are stated to be as low as in any other city (a little more than ½d. per mile), and it is proposed to make considerable further reductions. The ticket system is in force as in Sheffield.



Overhead Line Construction on the Gansemarkt, Hamburg. Thick dotted lines show Trolley Wires; thin dotted lines show Guy Wires; the word "Rosette denotes a Rosette affixed to the building at that point; distance A to B, about 140 yards; distance C to D, about 90 yards.

used. Twenty passengers are carried inside, and nine or eleven on the platforms in the front and rear of the car. Trailer cars are used chiefly for smokers. The motors are of 15 h.p. Some of the cars have two motors, while in general there is only one. The cost of an ordinary car with one motor, complete, as used in Hamburg, is about £550. There are 350 cars with one motor, weight empty about 6½ tons; 90 cars with two

Stopping places are arranged, and the cars do not stop between. The system is reported to work satisfactorily.

The current is supplied to the tramways in sections; red poles, to indicate the divisions, being fixed about a quarter of a mile apart. In these poles switches are fixed, by means of which firemen or tram drivers and conductors can cut off the current in any particular section if necessary. Passengers would then have to walk from one section to

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the other. When a wire breaks it can be cut off by the driver or conductor, who is provided with shears, and indiarubber gloves, as are also the firemen. So far, no accidents have occurred from this cause in Hamburg, though it it is reported that two horses were killed by falling wires in Hanover. When telephone wires cross the trolley wires, the latter are protected with wood casing to avert danger in case of an accident to the former. In case of fire the escapes are wheeled horizontally. An ingenious contrivance is also provided in the shape of a small iron bridge which fits in the tramlines, and under which the hose can be carried without interfering with the traffic. Another plan adopted is to carry the hose over the wires by means of elongated trestles. Some of these devices which the deputation inspected, with other apparatus at the fire station, can be used to equally good purpose when repairs are proceeding, and might with advantage be adopted in Sheffield. Distributed over the whole line are 150 sets of lifting apparatus with rollers, to move away from the track wagons with broken axles, etc.

When the electric system was first introduced, both horses and electric cars were running on the same lines, but at different speeds, and as the public had not then become accustomed to the difference, several accidents occurred. They also frequently took place when horses drew the cars. Now, however, it appears, accidents are very occasional. At first the public were a little alarmed at the speed of the electric cars, but this now regulated, and the rate varies from $3\frac{3}{4}$ miles an hour in the busier parts of the city to about $11\frac{1}{4}$ in the suburbs. An official map is published showing the speed attained on the different routes, and it is intended to fix indicators outside each car, for the information of the police, who have to regulate the speed. The cars are provided with loud-sounding bells, and at night with brilliant headlights to give warning of their approach, and the bells are also used to warn drivers of vehicles, or the public, who may be on the car track. Should a driver of a cart or other vehicle not move from the track on hearing the bell he may be fined for obstruction. The same rule applies to the drivers of carriages, etc., standing at the sides of narrow streets where there is not the regulation distance between kerb and rail. Several kinds of fenders or cow-catchers are in use to prevent people who may be knocked down from being run over, but at present none of them are considered to be quite satisfactory. If an accident does occur the company are bound to report it, and an official enquiry is held. The onus of proof is thrown upon the company, who may have to pay damages. The authorities say if the public take reasonable care there is no additional danger from the electric system. There is a public insurance fund against accidents. There is no complaint as to electrical disturbance, and the deputation were informed that the wires suspended in the streets are no detriment to health.

From Dr. Sthamer the deputation learned that before a man can be licensed as a driver or conductor he has to undergo training and examination, the driver as to efficiency and engineering knowledge, the conductor as to physique, smartness, etc. Having passed his examination, the applicant has to satisfy the chief of the Municipal Department, who then gives him his license. The selection of men is considered to be of great importance, as the company have so much responsibility in case of accidents, and the character of each applicant is enquired into. Should a driver be proved guilty of negligence he may be fined a maximum penalty of about £45 or imprisoned for a term not exceeding three years.

The deputation learned that at first the Municipality opposed the introduction of electricity, but now they support it, and would not like to revert to horses. The electric system is quicker and cheaper. The service is frequent (about every five minutes), the speed good, and although the lines were laid in a hurry the running is smooth, except where the roads have no foundation. The company's report says passengers always take the electric trams in preference to those drawn by horses. Emergencies can be very much better met by the electric system than with horses, as now, in times of extra traffic, every car can be used, instead of being entirely dependent upon the number of horses as formerly. There is not much inconvenience to the carriage traffic, and, generally, the conveniences far outweigh the inconveniences. The Municipality and the inhabitants generally soon became accustomed to the sight of the poles and wires, and do not now consider them objectionable. In the concession granted by the Hamburg authorities it is provided that in case such improvements are made in electric traction as will enable the company to successfully and profitably work the lines without overhead wires, the company will have to abandon the overhead system, and instal such a system as may be found suitable.

INSTITUTION OF ELECTRICAL ENGINEERS, Mar. 11.

At last night's meeting of the Institution the following candidates were balloted for:

Foreign Member.—Xavier Gosselin, 135, Boulevard Magenta, Paris.

Associates.—Alexander Davidson, Casilla, 120, Lima, Peru; Philip Millais Benest, 40, Craster-road, Brixton Hill, S.W.; Alfred Seymour Hewett, Trull, Taunton, Somerset.

Students.—Comer Sandys Ball, Monte Rosa, St. Leonards; Arthur O. Berry, 11, Rozel-road, Clapham, S.W.; Edward H. Freeman, Woodlands, 6, Woodberry-down, N.; Francis R. Gibbons, Central Technical College, Exhibition-road, S.W.; G. D'A. Meynell, 5, Girdlers-road, West Kensington, W.; Gilbert A. Pechey, 6, Bramerton-street, Chelsea, S.W.; Menzies A. Stapley, 29, Maryon-road, Old Charlton, S.E.

A paper entitled "On Some Repairs to the South American Company's Cable off Cape Verde in 1893 and 1895," by Mr. H. Benest, A.M.I.C.E., associate, was then read. We hope to publish this paper in due course.

THE CAMERA CLUB.—The growing importance of the connection between photographic advances and engineering matters has made the doings of the Camera Club of considerable interest to engineers, and on Wednesday an interesting exhibition of recent advances in photography and X-ray work was made in connection with a dinner given in honour of Mr. R. L. Cocks on the occasion of his retirement from the honorary secretaryship. It is not generally known that the house of this club is fitted up with every necessary for photographic work in rooms at the disposal of every member. This includes not only the ordinary well-known apparatus, but the necessary plant for photographic printing by artificial light. In one room there is fitted up a 20-ampere arc lamp, by means of which a considerable number of photographs may be printed at any time. This lamp is suspended by a bottle-jack apparatus, which gives it a slow rotating motion, purposely a little eccentric and alternate in direction; the object of this is to secure the elimination of the effect of any imperfections in the glass or shadows or variable reflection of the lamp shade and the circular reflectors. The light of an arc lamp such as the one used, which burns with great steadiness, is practically a fixed quantity, and, therefore, having once found the right time to print from a negative, it is easy to print again without the trouble of continually looking to see whether the print is done, all that is necessary being to take the time of the trial print and give the next the same exposure. An interesting field for experiment and observation is opened when you have an unvarying light to print with. Many will have noticed some prints are done under one negative and how tediously long they will take under a second negative, which looks to the eye almost the same as the first, but evidently does not transmit light so freely. With the unvarying light some prints may be made out as to the light-transmitting powers of comparatively similar negatives. The arrangements have been made by Mr. H. H. P. Powles and Mr. Reginald Belfield, two well-known engineering members of the club. Prints can now, therefore, be made by members whenever the weather is not suitable for any outdoor occupation. The workshops also for the convenience of members include one containing a lathe, shaping and drilling machines, circular saws, and carpenter's benches and tools, so that the members have all the advantages not only of a club in the ordinary sense, but of every convenience necessary for making apparatus and experiments. The *Journal* published by the club gives a good idea of the wide field now covered by the work of those who employ the camera. On Wednesday, Mr. Justice Wills gave an interesting lecture on "Forty Years of Mountaineering," illustrated by a very large number of beautifu views; Mr. Campbell Swinton will give one on X-ray work on April 12.

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TO CORRESPONDENTS.

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All communications intended for the Editor should be addressed C. H. W. Biggs, *139-140, Salisbury Court, Fleet Street, London, E.C Anonymous communications will not be noticed.*

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Vol. XVIII. of new series of "The Electrical Engineer" can be had bound in blue cloth, gilt lettered, price 8s. 6d. Subscribers can have their own copies bound for 2s. 6d., or covers for binding can be obtained, price 2s.

THE TELEPHONE SERVICE.

On Monday the Secretary for the Treasury reaffirmed with emphasis the decision of the Government, first announced a year ago, not to take over or acquire the business and system of the National Telephone Company. How the Government proposes to take up the running in 1911, when the company's license expires, without having previously supplied itself with wires, is not stated, nor do we propose to discuss a position pregnant with so many possibilities on the present occasion.

Twelve months ago we said that a policy of non-acquisition would be entirely detrimental to the public interest unless collateral action of some kind were adopted, for failing that, its effect would be simply to confirm the National Telephone Company's monopoly. We stated that three courses were open: (1) maintenance of the existing monopoly; (2) active and business-like competition by the Post Office at reasonable rates; (3) issue of new licenses.

In effect, the Post Office has adopted the first of these alternatives, for its delay and shilly-shally has effectually kept the field for the company. Complainers of bad service and high rates, and applicants for licenses to work telephone systems as contemplated by Parliament in 1892, have persistently knocked at the door of St. Martin's-le-Grand, but their rat-tat-tat-tats have been unheeded—the Postmaster-General has refused to answer the door! And so, without declining to grant licenses in so many words, which he could not very well do seeing that Parliament has said that they are to be granted, he has done so in effect by omitting to give any replies at all.

Is this the straightforward and independent action that the public has a right to expect from the chief of a department which, theoretically at least, exists for the public use and convenience? Parliament in 1892 was induced to sanction the Treasury minute which forms the present telephone law of Great Britain by the explicit assurances of Sir James Fergusson, then Postmaster-General, that "nothing could be more erroneous than the suggestion that the possession of the trunk lines by the Government would be detrimental to competition. It was, on the contrary, the very circumstance likely to encourage competition. A new company with no trunk lines could not compete with an older company that had trunk lines. . . . Having acquired the trunk lines and mains the Government would be able to promote free competition and the commercial development of telephones." So sang Sir James Fergusson when he wanted £1,000,000 for his department!

What has been the sequel? Serious complaints from most parts of the country led in 1895 to the appointment of a Select Committee to enquire into the adequacy of the telephone service. Instead of doing that, the committee set about endeavouring to prove that the service *was* adequate, but the unexpected dissolution of Parliament prevented any report from being presented. The courageous denunciation of this committee by our contemporary, the *Pall Mall Gazette*, will be remembered by many of our readers.

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Amongst its members were several shareholders of the National Telephone Company, Mr. Arnold Morley (the partner of a director of the National Telephone Company), and Sir James Fergusson, who has since become a director of the same company, and as such the stern opponent of competition. The committee, as the *Pall Mall Gazette* stated, heard evidence in favour of the National Telephone Company without any restriction—other evidence was as far as possible excluded.

The new Government did not reappoint the committee for reasons best known to itself, and, instead, pursued the policy of inactivity which has had the effect of so greatly strengthening the position of the National Telephone Company. The strange complication into which matters have fallen is illustrated by the fact that Sir James Fergusson, whose utterances we have quoted above, appeared lately before the Glasgow Town Council in the *rôle* of director of the National Telephone Company and pleaded eloquently against the feasibility of competition. One of the Glasgow magistrates seems to have been a bit scandalised by this proceeding, since he told Sir James that he questioned the propriety of the connection of "prominent politicians responsible for the action of Government with a huge commercial concern pocketing enormous profits by such action." That is our mind too.

But the Glasgow Corporation, the States of Guernsey, and the Town Council of Tunbridge Wells, the most sturdy of the applicants for licenses, are not easily defeated by a policy of not-answer-the-door. Their persistent baiting led Mr. Hanbury to promise on Monday night that careful enquiry shall be made into every application. This is a step in the right direction if a real and not a bogus enquiry is intended. There must be no repetition of the Select Committee of 1895, nor must the Post Office be entrusted with the position of judge, for which its pro-National Telephone Company leanings entirely disqualify it. We suggest that the procedure adopted in the case of applications for provisional electric light orders is eminently suitable for applications for telephone licenses too, and that the enquiries be conducted by the Board of Trade in the town or locality concerned.

THE WORCESTER REPORT.

In our last issue we gave an abstract of the accounts and report of the Worcester lighting. The report deals with many questions which cannot be discussed in these columns, but others are ever recurring and always presenting new points for examination. The inevitable question of how best to charge for electrical energy is presented, and the engineer suggests the adoption of the Brighton system, charging 6d., and afterwards 2½d. We imagine that, on the whole, this system has been found to work equitably, otherwise it would not be so largely adopted. Three points, however, are not so indisputably good: (1) the giving of a lamp for a certain number of units used; (2) the abolition of meter rents where the units demanded exceed a certain number per annum; and (3) free wiring by companies acting between the consumer and the authority. The latter we object to entirely. It is wrong in principle and bad in practice. The question must not, however, be mistaken for free wiring by the authority itself. The latter may be good. It is the interpolation of the company we object to. The company does not work for any other benefit than dividends to shareholders, and these come out of the consumers' pockets. The acquisition of lighting and water concerns by local authorities is largely to get rid of the incubus of a company working to produce something necessary for the good of the community generally. With regard to the other points, one of the fixed principles of all modern business is that the larger the consumer the less his payment per unit, and the giving of lamps or the abolition of meter rents is carrying out this principle. The means of carrying out the principle may not be the best, but it is very difficult to suggest a perfect method.

FORTHCOMING EVENTS.

The following are some of the announcements for forthcoming week:

TO-DAY (FRIDAY).—Physical Society (Mr. Barlow on Structure in Crystals and Molecules), 5 p.m.—Royal Institution (Prof. Arthur Smithells on the Source of Light in Flames), 9 p.m.—Civil Engineers' students' meeting ("The Inverness Section of the Inverness and Aviemore Railway," by Mr. H. F. Brand; Mr. J C Hawkshaw will preside), 8 p.m.—Junior Engineers (Mr. Beckton on the Protection of Buildings from Fire), Westminster Palace Hotel, at 8 p.m.

TO-MORROW (SATURDAY).—Royal Institution, Lord Rayleigh's second lecture on "Electricity," 3 p.m.—Also, at West Hartlepool, North East Coast Engineers' meeting ("The Machine Cutting of Accurate Bevel and Worm Gears," by Mr. J. H. Gibson), 6 p.m.

MONDAY, MARCH 15.—Society of Arts, John-street, Adelphi (Cantor lecture on "Alloys," by Prof. W. Chandler Roberts-Austen, C.B., F.R.S.), 8 p.m.

TUESDAY, MARCH 16.—Royal Institution (Dr. Waller's ninth lecture), 3 p.m.—Institution of Civil Engineers (Mr. Humphrey on the Mond Gas Producer Plant), 8 p.m.—Society of Arts (Foreign and Colonial Section, The Progress of Australasia During Her Majesty's Reign, by Mr. J. Bonwick), 8 p.m.

WEDNESDAY, MARCH 17.—London Chamber of Commerce, Eastcheap, 2.30 (Mr. Stanley Machin on Food Supply in War Time).—Society of Arts ("Music in England at the Queen's Accession," by Mr. J. Spencer Curwen). Sir W. C. F. Robinson, G.C.M.G., will preside.—Crystal Palace lecture (Captain Abney on Photography), 8 p.m.—And at Liverpool (Liverpool Engineering Society, Cold Stores)

THURSDAY, MARCH 18.—Royal Institution (Prof. Percy Gardner Litt D, F.S.A., on Greek History and Extant Monuments Lecture III), 3 p.m.—Chemical Society meeting, Burlington House—Also at Dundee, Institute meeting.

FRIDAY, MARCH 19.—Royal Institution (Sir E Maunde Thompson K.C.B., on Greek and Latin Palæography), 9 p.m.—And at Paris, meeting of the Civil Engineers of France.

SATURDAY, MARCH 20.—Royal Institution, Lord Rayleigh's third lecture.—Institution of Electrical Engineers, students' visit to the Electric Welding Company's Works, Pimlico.

REVIEWS.

Dynamo Attendants and Their Dynamos. By ALFRED H. GIBBINGS, A.I.E.E. Third edition. Price, 1s. Sidney Rentell, 11, Ludgate-hill, London, E.C.

That the third edition of this little book has made its appearance is sufficient evidence as to its usefulness, apart from what we can say. The object of the book, as explained by the author in his preface, is to provide elementary hints to those who, having the charge of small dynamos, are yet scarcely past the threshold of electrical knowledge. Beyond this limited purpose the book does not pretend to serve. The author starts with the dynamo-room, and goes on to describe in a concise manner the various types of small direct-current machines which may be met with in a private installation or small isolated

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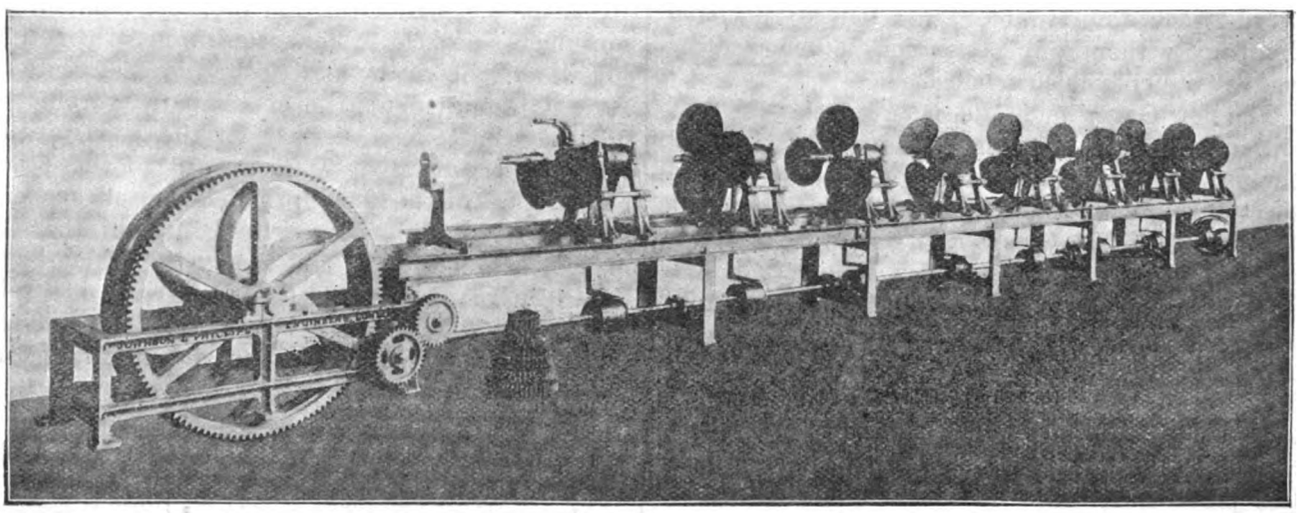
plant. No unnecessary details are entered into, the idea being to simply explain the purposes of typical machines and the other apparatus in use in a small dynamo-room. A portion of the book is devoted to possible faults which may develop themselves in the dynamo-room, and their prevention or remedy. Various methods of connecting up to the switchboard 'bus bars are also dealt with. The little book will be found most useful to those who with no previous knowledge of electrical apparatus find themselves entrusted with the charge of electrical machinery. In the many cases in which spare power is utilised to drive electrical machinery, ordinary engine-drivers with no knowledge whatever of electrical machinery are entrusted with its care. To these we heartily commend the book.

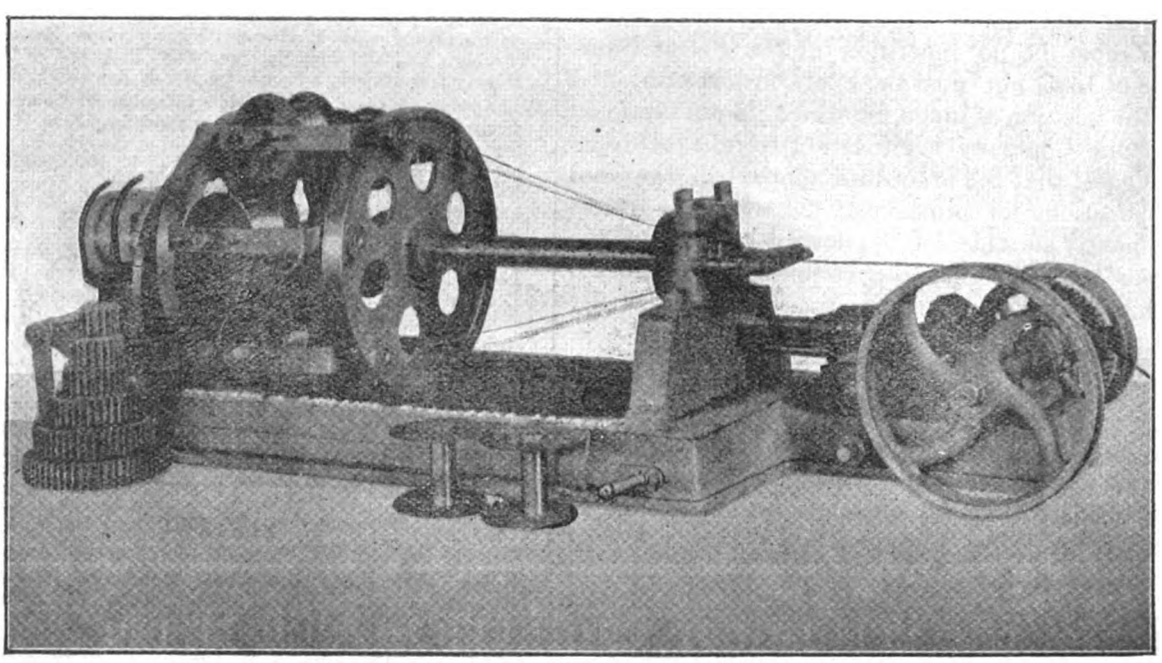


Paper Taping Machine.

JOHNSON AND PHILLIPS, CHARLTON.

On Monday last, by invitation of Messrs. Johnson and Phillips, a visit of inspection was made by representatives of most of the technical journals to the Victoria Works at Old Charlton. Messrs. Johnson and Phillips occupy something more than a representative position among makers of cable-manufacturing machinery, and of what there is to be seen in that way examples can mostly be found without going beyond the Charlton works. Some stress is with justice laid by the firm on the fact that they are themselves users as well as makers of the machinery, and are therefore in a position to produce machines embodying all the points and details dictated by the commercial, as distinct from the experimental, working. In fact, when they know what a purchaser wants done, they can be sure of giving him something that will do it properly. That being so, in these days, when the approaching industrial supremacy of the German is becoming somewhat of a bugbear with many people, it was interesting to hear it remarked again and again in the course of the inspection, "We send these to Germany," or "This is for Russia," or even "for Japan."

For Monday a special programme had been drawn up, which included a detailed inspection of about a dozen machines. A paper-insulating machine in the erecting shop came first, a four-headed vertical taping machine in the engineers' shop in the lower factory next, and a steel-tape-sheathing machine in course of construction. This is at present only partly erected. A drawing of it was on view. Then the following factory machines in operation: large 12-bobbin cabling machine, longitudinal rubber-covering machine, rubber-lapping machine, double-headed horizontal taping machine, indiarubber-cutting machine, braiding machines



Six-Wire Stranding Machine.

silk-covering machines, cotton-covering machines, vulcanising cures, fault testing, winding gears, etc.

Most unfortunately, something went wrong with one of the boilers on Monday morning, so that on reaching Charlton there was not steam enough obtainable to run all the tools. This somewhat upset the programme. However, there was plenty to see. Fortunately, the running of the first machine on the list, which is new, was not affected.

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This was the paper-taping or insulating machine, which is illustrated above. The machine is for insulating electric wires with paper instead of indiarubber. It is of abnormal length, owing to the many covers superposed, and consists of a number of box-framed standards, which are mounted along wrought-iron girders. These girders carry three heads, each one of which is fitted with three discs containing spools of paper which would give 24 coverings, but as each strip of paper is arranged to half-lap itself at each revolution this really gives 48 coverings at one operation. The discs are carried on quadrant studs, by which they can be set at any angle to suit the different sizes of cables and widths of paper.

As has been remarked before, the rest of the programme was somewhat deranged. As a type, however, of what was looked at may be taken the six-wire stranding machine, not so much on account of its special importance as because it is one of the machines of which several have been made for exportation to Germany and elsewhere abroad. The illustration represents the usual type of machine of the horizontal pattern made by the firm. It is fitted with a lay head and middle disc run on adjustable anti-friction rollers with belt gear arranged for right or left hand driving, a die bracket adjustable on guide-rods to suit different "lays," and special brake gear for quick stopping.

After the special cable machinery had been seen there was only time for a hurried look over the rest of the works. In the dynamo-room the writer noticed the armatures of some induction motors among the other machines in the course of manufacture, as well as many other things which he has not space at command to even mention.

It should be stated that the party were received and conducted round by Mr. Esson and Mr. Hughes, and everything was done that could be to make the visit an enjoyable one.

THE GENERAL ELECTRIC DINNER.

On Saturday last the staff dinner of the above firm was given in the Caledonian Saloon of the Holborn Restaurant. We noticed with pleasure the presence of the wives of the members of the staff, who are thus recognised officially. The lady typewriters were also represented, and we understand that a premium had to be charged for a seat adjacent to them, owing to the large number of applicants. Amongst the invited guests were Mr. Dane Sinclair, Mr. E. Manville, Mr. A. H. Preece, Mr. Phipps, Mr. P. Sellon, Mr. Crookes, Mr. Mountain, Mr. Erskine, Mr. Voelklein, Mr. Neale, Mr. Alabaster, Mr. Weekes, Dr. Kochman, Mr. Hemingway, Mr. Sunderland, Mr. Seymour, Mr. Warburg, Mr. Alloway, Mr. Scott, Mr. Hands, Mr. Bauer, and Mr. Schramm.

After a well-served dinner, Mr. G. BINSWANGER-BYNG (the chairman) commenced a short toast list by proposing "The Queen." He referred briefly to the events of the last 60 years, and to the great strides electrical engineering had made in that time.

After a song from Miss Hammacott, the CHAIRMAN proposed "The Staff." He reviewed the progress the firm had made, and said that without the energetic co-operation of the staff such progress would have been impossible. The past year had been a most prosperous one, and he had particularly noted that the staff had realised this. He gathered this from the number of those who wished to get married, and so to add to the responsibility of the firm. In such matters he advised caution.

Mr. BEVIS, in replying, made a humorous speech, in which he assumed that the work done by a member of the staff varied in the inverse proportion to the height of his headgear. Mr. BELL also responded to the toast, and acknowledged the way in which the directors appreciated and rewarded those who stuck to their work.

Mr. H. HIRST proposed "The Guests." He compared the composition of the firm to that of the British Isles. Messrs. G. and M. Binswanger-Byng were supposed to be England and Wales. He took on himself the character of Scotland, and as McHirst declared that the works department had all the Irish characteristics. If anything went wrong the broad shoulders of the works had to take the blame, but did not do so without a vigorous protest. He referred to the scattered departments now included in the firm, such as a lamp factory at Brook-green, an accessories and engineering factory at Manchester, a fittings factory at Hammersmith, besides the numerous provincial and foreign branches, and the main warehouses in London. He trusted that the development of the firm would not make it unwieldy, but took courage from the fact that Mr. Sinclair ably controlled a much larger concern. He coupled with the toast of the visitors, who he was most pleased to see present, the names of Mr. Dane Sinclair and Mr. Percy Sellon.

Mr. DANE SINCLAIR said he was pleased to be there, and assured Mr. Hirst that a directorate of three with two always absent was the best possible government for any firm. There was no fear of the firm declining unless the directors got too big for their position, which was not likely. He advised the staff to attend to their smaller duties with equal vigour.

Mr. SELLON said he thought that a lady should have replied in his place. As a bachelor he could without risk tell what one of the ladies would have said: that was, that electrical men are peculiar in their habits and most unsociable; that they reckon 14 hours an ordinary working day, and never get home at a respectable time.

After these few toasts an agreeable evening was concluded by a concert, in which the following artistes assisted: Miss Margaret G. Cooper, R.A.M., Mr. T. H. Harrison, Mr. L. Hillier, Mr. F. Zola, Mr. H. Leffler, Mr. Gurney Russell, Mr. Ernest Frey, Mr. Sam Wright, and Mr. Steve Blamphin. Mr. E. J. Dale also gave an exhibition of his animatoscope.

A CONVECTION-SCOPE AND CALORIMETER.*

BY ALFRED R. BENNETT, M.I.E.E

(*Concluded from page 275.*)

On suspending the leaden box at a temperature of 52·6deg. F. in the chimney, the running water being at 41·4deg., a difference of 11·2deg., it caused the vane to rotate 101·5 times. The copper box, similarly treated, and with the same terminal temperatures, gave 307·4 rotations. Taking the specific heat of lead at ·031, this, by direct proportion, made that of copper ·09388, which is in exact accord with accepted figures.

Subsequently, by the same method, the specific heat of the iron box came out at ·1070, and of the aluminium box at ·2116, being respectively ·0068 and ·0027 lower than the accepted figures. The motion caused by the lead box lasted 22 minutes and yielded 104·4 rotations; that due to the aluminium endured 2 hours 19 minutes and gave 712·6 rotations.

The near agreements with accepted figures obtained, especially between metals so wide apart as lead and aluminium, show that the loss of heat from the substance under test must be very small. The differences observed may be due to this loss; to impurities in the metals, which were ordinary commercial ones; to variations in barometrical and hygroscopic conditions during the experiments; or to all these causes combined. It is, of course, necessary to employ a very delicate and accurately-poised vane for such tests as these. Any bias or tendency to stop in one position will curtail the period of rotation, and the error caused will be by no means a constant one for all substances, as some, like lead, have but a short period of rotation and fall rapidly to a stop, and others, like aluminium, cool but slowly, and have a long period of slow rotations during which any defect in the vane tells more than when the movement is brisk. Towards the close of an experiment the convection current is excessively feeble, and may sometimes be stopped by a push against the table, or by walking across the room. This affects the air current itself and not the vane.

It is necessary to allow an interval of several hours to elapse between every test. When this is not done, the vane will no longer give the same number of revolutions for equal amounts of introduced heat. This effect I am inclined to ascribe to the distribution of water vapour on the glass and other surfaces having been altered by the first heat introduced and still further modified by subsequent ones. When the instrument is quite cold, some of the vapour present is condensed upon the surfaces. A portion of this becomes vaporised by the first heat, and more by subsequent ones if they follow rapidly, so that the film is driven off the glass and its ability to absorb heat modified. By carefully drying the surfaces and using dry air in the gas-jar as far as possible this difficulty could probably be avoided. Such comparative tests as I have described must be conducted under similar barometrical pressures. It is not practicable to work with constant volume, since

* Paper read before the Manchester Literary and Philosophical Society, January 26, 1897.

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the unequal amounts of heat introduced with different substances would cause unequal pressures in the jar and quite vitiate results. It is, of course, necessary before repeating a test to wait until the inner thermometer registers exactly the same temperature as when the first was commenced.

A noteworthy point is that with this system of measurement the character of the surface of the substance under test appears a matter of indifference. The rate and duration of discharge, and consequently the form of the cooling curve, may be affected by a dull or bright surface; but ultimately all the heat comes out and the usual proportion of it made manifest in rotations. I have not, however, tried a very brightly-polished surface.

As all substances are not capable of being formed into boxes, I tried suspending some in scraps in a leaden box, the value of which, when empty, in rotations was accurately known. The results of the few experiments which I have had time to make were only roughly in proportion to the specific heats.

With regard to the energy required to start and maintain the convection current, 4·2 thermal units would raise 6oz. of water through 11·2deg. F., the difference of temperature employed. As the specific heats of water and lead are as 1 : ·031, a 6oz. leaden box would absorb only ·1302 unit. As this yielded 101·5 rotations, it follows that one thermal unit would produce 779·5 rotations under the pressure and other conditions of the test. But this figure is in reality a little too high, because *all* the introduced heat does not become visible in the shape of rotations, for, as already stated, the movement ceases before the inner thermometer has quite sunk to the temperature of the running water. When comparing specific heats, this error, being a constant one, may be neglected.

The calorimeter may be used to determine the relative heat-retaining properties of textile fabrics and other materials. The chimney, A (Fig. 11), is carefully covered with non-conducting material. If this were not the case, some of the heat radiated by W would find its way by conduction to the outside of the chimney, where it would set up exterior convection currents which would not affect the vane. A naked copper chimney consequently forms a shunt or short circuit, and considerably reduces the number of rotations obtainable from a given amount of introduced heat. Figures expressive of the relative heat-retaining powers of silk, cotton, linen, woollens, furs, asbestos, boiler composition, etc., may be got by successively covering the chimney with equal thicknesses of those materials, and noting the number of rotations.

If the substance, W, be suspended by a thin wire instead of silk, the number of rotations is reduced because some of the heat escapes by conduction over the wire. By using a metal instead of a glass stopper, and putting it in contact with the circulating water, this effect would no doubt be accentuated, and a method of comparing the relative heat conductivities of threads and fine wires afforded.

My experiments have all been conducted with heated substances hung in the chimney, but the form of apparatus shown in Fig. 9 would probably yield equally good results. S is a chamber thermally insulated by non-conducting material, but open to the chimney at the top. A heated substance popped into the chamber could only lose heat in an upward direction, principally against the under surfaces of the vane. The arrangement would be better for a small reflector in the chimney above the vane. The same figure indicates how heat could be conveyed into the chamber by the circulation of fluid through a coiled tube, S^1 S^2, the heating being effected at any distant point, S^6, and the fluid led to the instrument in non-conducting pipes, S^3 S^4. The specific heat of gases could probably be compared in this way, the instrument being, of course, surrounded by running water. It is obvious that the forms shown in Figs. 6 and 7 could be adapted to use as measurers of electricity, since the heat generated in the incandescent lamps or in substituted coils would bear a definite proportion to the current passing, while the speed of rotation would be determined by the heat evolved. Variations in the current would not, however, become immediately revealed by changes in the speed, since the motor surfaces would have to part with or acquire some heat before the vane could fall into the new step. Thus rotation would continue for some minutes after the current had ceased. A correction for pressure would have to be determined to ensure correct readings. The resemblance of these two modifications to Prof. Forbes's electricity meter will, of course, be recognised.

Nothing has yet been said as to the feasibility of registering the rotations of the vane. When the motor is of large size (some have been made with fans measuring 15in. by 9in.) the spindle, which in such a case is pivoted at top and bottom, may be arranged to actuate a delicate counter, or to alternately close and open a pair of light electrical contacts, by means of which a record of the revolutions might be preserved. When the vane is only resting on a needle point, the plan shown in Fig. 12 may be adopted. A magnetised needle, Y, is fixed to the vane, E, and a narrow coil of fine wire, Y^1, is arranged vertically so as to surround the vane without sensibly diminishing the air-way of the chimney, A. Connecting wires lead from the coil to the place where it is desired to note the rotations, and there a sensitive dead-beat Thomson or d'Arsonval galvanometer is included in the circuit. The magnetised needle rotating within the coil induces alternating currents, which are made visible by the galvanometer in the shape of deflections to the right and left. Instead of a galvanometer, a syphon-recorder may be used, and a continuous record obtained. The state of the sky in London or Edinburgh might in this way be automatically telegraphed to Manchester or elsewhere; but the sensitiveness of the vane is, of course, reduced by the complication.

In conclusion, I may mention that I have recently commenced an investigation, with the aid of the calorimeter shown in Fig. 11, into the relative sensitiveness of different gases to convection. The gas-jar is filled with the gas to be tested, and the suspended substance, W, is replaced by a delicate thermometer (Fig. 13), having its bulb enclosed in an airtight aluminium box, and its stem taken airtight through an accurately-fitting stopper. The thermometer is gradually heated to 130deg. F., and then allowed to cool slowly, and when it registers 100deg. F. exactly it is popped into the gas-jar. A constant difference between the amount of introduced heat and the temperature of the running water is in this manner readily obtained. The tests, so far, have revealed unexpected differences in convective sensitiveness between gases which do not differ widely in their densities, specific heats, or coefficients of expansion. I do not feel justified in giving further particulars to-night, because I have not hitherto worked with dry gases, and it is possible that the introduced

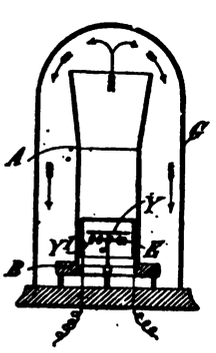

FIG. 12.

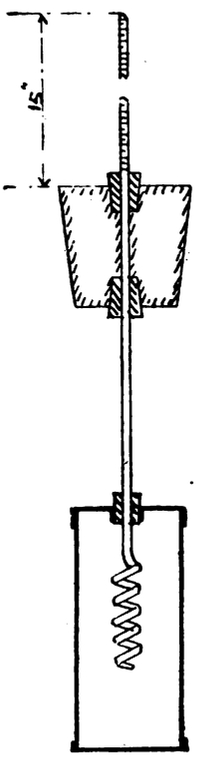

FIG. 13.

heat may have been reinforced in some cases by chemical action between the introduced gas and the motor surfaces in the presence of water vapour. This would in itself be an interesting effect, but it would defeat the object in view of ascertaining the comparative convective sensitiveness of different gases when exposed to the same terminal temperatures under precisely the same conditions.

METHODS OF CHARGING FOR ELECTRICITY SUPPLY.*

BY R. P. WILSON, MEMBER.

This subject has recently received some considerable attention at the hands of central-station engineers, both in this country and on the Continent, and several more or less successful attempts have been made to arrive at and substitute for the primitive method of giving discounts in proportion only to the number of units consumed, a system which is equitable to the consumers generally and remunerative to the undertakers. The following systems are at present in use: (1) discount based on the number of units consumed; (2) discount based on the number of units consumed per lamp installed; (3) "day-light" circuits at reduced rates; (4) motive power and cooking at reduced rates; (5) Wright's maximum demand method; (6) Andrews's modification, as used at Hastings; (7) the sliding

* Paper read before the Northern Society of Electrical Engineers, March 8, 1897.

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scale, adopted at Ayr; (8) differential rates, based on time of demand, as at Norwich; (9) differential rates, based on time of demand, as at Bristol. In this paper it has not been considered necessary to attempt to convince those who do not admit the shortcomings of the first of these systems, and the author contends that Dr. Hopkinson's statement of the case is fundamentally correct—that it is a statement of fact, not an expression of opinion. The first of these systems was adopted by several of the London stations and continues to exist, because the agreement entered into between undertakers whose areas of supply overlap, and who are consequently in competition with each other, has not yet terminated. The Westminster Company still maintain that this system is right, for the reasons given in Mr. Hordern's recent contributions to lighting.

Before considering the merits of any system, it will be well to emphasise the fact that the ultimate objects of any system are: (1) to popularise the use of electrical energy; (2) to reduce the cost of production; (3) to enable electricity to compete favourably with gas; (4) to provide an equitable basis of charging. These objects can only be achieved by increasing the output of the plant, or, as Dr. Hopkinson expressed it, the rate of output; it therefore follows that the first step must necessarily be to ascertain the existing rate of production, and the second to improve it by encouraging or subsidising those consumers who are profitable, and by pointing out the error of their ways to those who are not profitable.

The first system, or lack of system, does not fulfil any of these conditions, and the only purpose it serves is to prove Dr. Hopkinson's theory, which it does conclusively by the familiar method known as *reductio ad absurdum*.

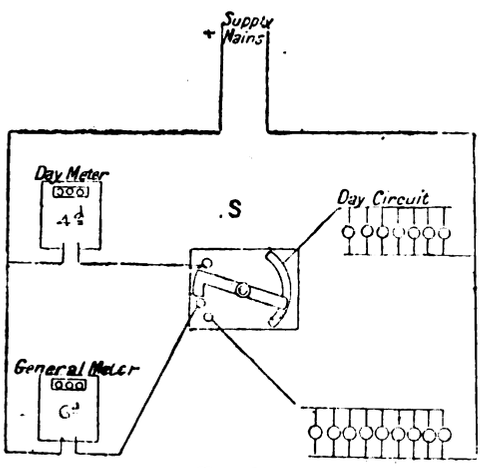

FIG. 1.

The second scheme, which, as far as the author is aware, was devised by Dr. Hopkinson with a view to satisfying his conditions to some extent, is a considerable advance in the desired direction. The objection to it is a fatal one, and consists in the fact that it discourages the use of lamps anywhere, except where they are burnt for long hours, or where they may be considered a necessity; thus a consumer has no inducement to use electric light throughout his premises, although there are many positions where lamps burnt only an hour a day may be most profitable to the station, but if the consumer's discount varies inversely with the lamps installed he naturally restricts their number.

We now come to the "daylight" circuit. This system is in use at the Kensington Court station of the Kensington and Knightsbridge Company, and elsewhere, but is by no means satisfactory to the consumer. The principle on which this method is based is that a reduced charge should be made during hours of daylight. Two meters are provided and connected to the circuits, as shown in Fig. 1, in such a way that the turning on of any one lamp on the control circuits brings the high-rate meter into operation and cuts out the other. This method involves considerable expense in wiring the premises, inasmuch as two distinct circuits are necessary. It is, as far as the author is aware, only used in shops. The shopkeepers find it very inconvenient, because the cost of rearranging the circuits makes it impossible to materially alter the distribution of the articles to be displayed. In cases where all three wires of a three-wire system are brought into the house no less than four meters are required, and the distributing board must be provided with five 'bus bars, as well as the specially constructed switches for the control circuit (see Fig. 2). The complications necessary to carry out this system on a five-wire circuit are too appalling for anyone but Mr. Wordingham to contemplate. The author will be glad to hear anything that can be said in support of this method, which appears to him crude and complicated.

The fourth system provides for the consumption of power in motors and cooking utensils at reduced rates. Here, again, at least two distinct circuits and meters are required, but the possible, and, in fact, inevitable, overlapping of the consumption in the power and lighting circuits is ignored, and it is quite conceivable that a consumer using power without restriction would be comparatively unprofitable. This system is a very small modification of the reduction on taking a quantity method, and is, indeed, not as comprehensive unless worked in conjunction with it, as consumers of light alone derive no benefit from it. It is quite as important to popularise the use of electricity for light as it is for motive power, for the reason that by far the majority of a central station's existing consumers do not, and never will, use motors, even if they can be induced to cook by electricity.

The details of Wright's maximum demand method are so well known and are so clearly set forth in Mr. Wright's paper, read before the Municipal Electrical Association of June 11 last, that it would be superfluous to describe them here. The last time the author had the pleasure of addressing this society, he strongly advocated the use of the maximum demand indicator, and is given to understand that it has been very largely adopted, with eminently satisfactory results in every case. It is unfortunately impossible to devise a system that shall be in all respects perfect, and the results obtained at Brighton tend to show that Wright's method leaves very little to be desired; it has, however, one small defect apart from its complication and expense—viz., that the spirit of the method has to be departed from because the indicated demands are not all simultaneous; as a matter of fact, the sum of the demand indicator readings is 50 per cent. more than the actual maximum demand as represented by the actual output of the station at Brighton. And although, in making out the accounts, this discrepancy is taken into consideration, all the consumers do not benefit in the proper proportion.

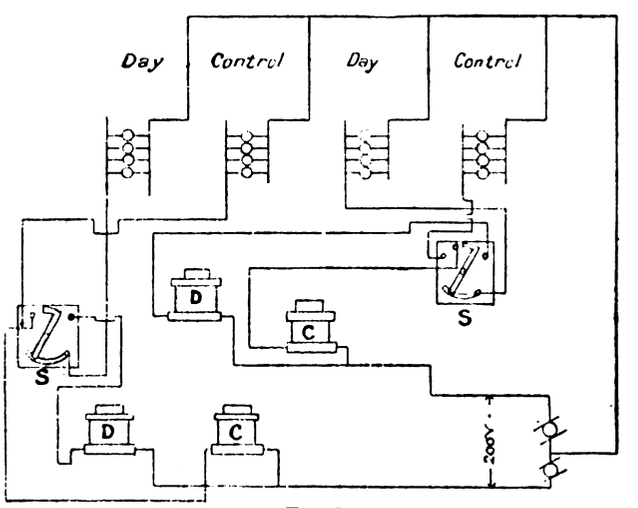

FIG. 2.

Mr. Andrews, at Hastings, has, with a view to avoiding the apparent complications of the demand indicator, devised and put in practice a method of charging which takes Wright's formula as a basis, but instead of so much per unit of maximum demand for the first hour, he charges 1s. per 8-c.p. lamps used simultaneously per quarter, and 6d. per unit consumed. This arrangement produces a tendency to turn on as few lamps simultaneously as possible, and thus attains the end in view; but there is some force in Mr. Wright's criticism that it would tend to reduce the number of lights installed, because the consumer argues that by reducing the number of lamps installed he reduces the number that can be turned on simultaneously. Mr. Andrews has not found this effect at Hastings, and there is no doubt that his charge is much simpler to explain to the consumer than Wright's. The average layman cannot grasp the subtleties of a charge based on the maximum demand, and this, after all, is not surprising when we consider how many years it has taken central station-engineers to realise its advantages. At Blackburn the consumers are agitating because they do not understand the system, and therefore fail to realise on what ground the tramway company should pay only 2d. per unit. It has been contended that there is only one Brighton, and that the magnificent results obtained by the maximum demand system at Brighton would not be realised anywhere else. Brighton may have peculiarities. It is, in fact, unique, in that there is only one Mr. Arthur Wright, but that the conditions of electricity supply are materially different to those that obtain in general is not supported by any evidence; on the contrary, the demand indicator produces the same results wherever it is adopted, whence it follows that the virtue lies in the system, not in the site. Mr. Hordern presumably contends that no system would have the effect of inducing consumers to extend their lighting or to use power more effectually than his sliding

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scale of discounts. The word "his" has been used advisedly because he has made the system so entirely his own, in that he appears to be its only champion, but the results actually obtained wherever a differential charge is made show that this contention is not justiable. In the Westminster area there are an enormous number of residential flats, and in the majority of cases electric light is not used in passages, staircases, and basements, and in some cases the hall porter turns out the electric light and lights the gas every night at 9 p.m., and thus the supply company deprives itself of a large number of the most profitable lamps in the district. Another drawback to the use of the maximum demand method is that an abnormal maximum may be indicated if more than the usual number of lights is used simultaneously for any one evening during the quarter, and to obviate excessive charges arising from this cause, consumers are advised that they will have the privilege of paying only for the light they consume on such occasions if they will previously advise the undertakers. This is no doubt satisfactory to the consumer (if he remembers to give notice), but it must be borne in mind that if his normal maximum demand is allowed to stand as the basis of his bill, he not only creates an objectionable rise in the peak of the load curve, but gets a larger number of units at a discount than a more profitable consumer. Many sliding scales have been devised and tried, with more or less satisfactory results.

Mr. Ernest G. Pink adopted a system at Ayr which consisted in giving discounts to the various consumers based on the duration of their demand, or in the case of shops on the hour of closing. Shops closing at 7 p.m. get no discount; public-houses, restaurants, etc., closing at 10 p.m., 22½ per cent.; private houses, 35 per cent. This system apparently worked very well at Ayr, and in other places where it has been

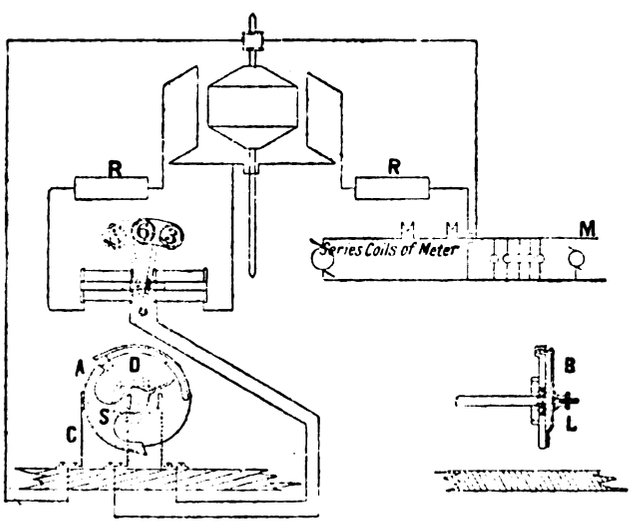

FIG. 3.

used, but the complication in the accounts due to giving one or more different discounts to every consumer militates against its adoption even in small towns. One of the consumers at Ayr, who applied for a discount on the ground that he burnt lights in dark corners for very long hours, received no encouragement, although he was probably the most profitable consumer connected, on the ground that the undertakers were "not responsible for structural difficulties."

We now come to what, in the author's opinion, is by far the most satisfactory principle—namely, the differential rates based on the time of day as compared with the period and the area of the load curve peak. The essential difference between this principle and Wright's is, that whereas his charges are based on individual demands, the time rates are based on the actual output of the station as a whole. If, as has been generally admitted, it is equitable to grant discounts to the most profitable consumers, it follows that those who contribute least to the peak should benefit most largely by the system of discounts. It is quite reasonable that all consumers should pay some proportion of the standing charges, but it is not reasonable to charge an early morning consumer whose demand is 10 amperes the same proportion as one whose 10 amperes is demanded during the heavy load. Mr. Gisbert Kapp was the first who took this into consideration, and he patented what may be called a "time-switch," whose duty it was to automatically control the registration of the meter in such a way that all the current consumed up to a certain hour should be charged at a reduced rate, and all the current consumed during the hours of heavy load should be charged at full price. This method has the unquestionable merit of simplicity, and the author has so far been unable to learn any sound objection to it as a principle. Mr. Kapp's time-switches are used at Bristol, but only to a limited extent—that is to say, in the premises of only a few consumers who have, or appear to have, special claims on the consideration of the undertakers as being exceptionally profitable consumers, but it is difficult to understand how one unit supplied at 10 a.m. can be more profitable than another.

At Norwich the principle is applied to every consumer on the circuit, so that every consumer is automatically given a discount in direct proportion to his value to the undertakers as a source of profit, irrespective of the actual gross revenue he represents. By this method all the meters are read in the usual way, and the amount registered is charged at so much per unit, but the meters register the whole or a fraction of the units actually consumed, according to the time when they are used, and if for any reason any consumer increases the peak of the load curve on any night because he is giving a dance or holding a prayer meeting, he pays for the privilege because his meter registers at the full rate. The disadvantage of the Norwich system lies in the method of its application. All the meters, which are of the periodic type, are controlled from a central clock in the supply station, which increases or decreases their period of inactivity according to the time of day. From some points of view periodic meters are not in themselves desirable, but the objection to the Norwich system lies in the fact that a third wire for controlling the meter has to be led into every consumer's premises, so that it would be a matter of considerable difficulty to introduce the system in any station except at the commencement of the undertaking, while the first mains are being laid. The expense of running a special main with a service to every consumer would appear to be prohibitive and impracticable in an established station.

During the time that the author was a central-station engineer he devoted some considerable attention to this subject from a perfectly disinterested point of view, and subsequently came to the conclusion that the maximum demand system was the best, but owing to some of the criticisms raised by those to whom he advocated its use he designed the automatic time-switch before you. This instrument is a modification of Mr. Kapp's, and has some claims to being considered an improvement. The switching-over arrangement is much simpler, more easily adjusted, and consequently much cheaper to make, besides which it is so constructed that both the commencement and the duration of both rates of charging can be varied and locked by means of one screw. The diagram (Fig. 3) shows the construction of the switch itself, which makes one complete revolution in 24 hours. Let us assume that the rates to be charged are 6d. and 3d. The duration of the 6d. rate is regulated by the position of the shield or quadrant, S, in relation to the periphery of the disc, D, and its commencement by loosening the disc on its shaft, and turning the hands of the clock till they show the time the 6d. rate should begin; the disc is then turned on the shaft till the spring, C, falls off the point, A, on to the shield, which is in turn adjusted in the same way, so that the spring, C, falls back again on to the disc at the time when the 3d. rate commences again. The apparatus is provided with an indicator, which serves to show the consumer the rate at which his consumption is being charged. The only serious objection that has been so far raised to this apparatus is that the clocks might stop. This is, of course, possible; but the probability has been reduced to a minimum.

(To be concluded.)

THE HAMPSTEAD ACCIDENT.

A jointer named Harry White, aged 35 years, employed by the Hampstead Vestry, while working in a transformer-chamber at Lyndhurst-gardens, Hampstead, on Saturday last, came in contact with some of the wires, receiving a shock which appears to have caused almost instantaneous death. At the inquest, held by Dr. G. Danford Thomas at the Hampstead Dispensary Hall on Wednesday, the first witness was Thomas Gill, a jointer engaged in similar work to that of the deceased. On Saturday morning it was part of their work to clean out the transformer-chamber of the sub-station in Lyndhurst-gardens. The deceased went down the ladder, and when he had nearly reached the bottom he put one foot on the transformer itself, the other foot being on the rung of the ladder. Suddenly he assumed a strained position, and almost immediately fell over the ladder. The witness did not go to his assistance, but went to the central station in Finchley-road, five minutes' distance from the spot, and told the engineer what had happened. Mr. Harold Woodall, assistant engineer, said that after switching the current off he went to the sub-station. The deceased was lying at the bottom of the chamber lifeless, and a hole had been burnt in one of his boots. An examination of the chamber showed that the insulation of one of the wires had broken down, but that did not account for the accident, because the "earth wire" was sufficient to carry off all the current from the transformer. In reply to a question from the Coroner, Mr. Woodall added that a new danger had arisen

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which would have to be met in some way. This was an unheard-of accident. Mr. Edward Sayer, another assistant, and Mr. Cottam also gave evidence. The latter said that the transformer-chamber was built in conformity with the regulations of the Board of Trade. Major Cardew had inspected the chamber since the accident, but could not say what was the cause of it. He had made certain suggestions which had since been carried out. No doubt the "earth-wire" failed. Dr. W. Heath Strange said that death must have been instantaneous, and a verdict of accidental death was returned.

PHYSICAL SOCIETY, Feb. 26.

Mr. SHELFORD BIDWELL (president) in the chair.

Mr. J. H. Vincent read a paper on **"The Photography of Ripples."** If mercury is used as the medium, all waves less than 1·3cm. long come under Lord Kelvin's definition of a ripple—that is to say, they are waves whose lengths are less than such as are propagated with minimum velocity. Vibrations in mercury of about 200 per second and upwards generate waves whose propagation is controlled almost entirely by surface tension, and these waves are therefore classed as "capillary ripples." Their speed of propagation is of the order of about 1ft. per second. They are invisible owing to their high frequency, and not in consequence of the velocity of their propagation. It is usual to examine them by some stroboscopic method. Mr. Vincent obtains photographs of the disturbed mercury surface by the sudden illumination of an electric spark. The spark is about ½cm. in length, and it lasts about one two-hundred-thousandth part of a second. Its brightness is increased by an auxiliary spark-gap. The optical arrangement consists of two lenses, one in the path of the incident light, and another to converge the reflected light from the mercury surface into a photographic camera. Ripples are set up in the mercury by a stylus attached to a tuning-fork. For this purpose it is generally sufficient to give a slight blow to the prongs, but when continuous vibration is required the tuning-fork can be connected by a thread to an electrically-driven fork, as suggested by Mr. Watson. By this means the analogues of many of the phenomena of the transmission of light can be shown, and the debate mostly turned upon how to obtain the others.

An interesting point was brought out by **Mr. Blakesley**, who asked why no reflections occurred from the sides of the mercury retainer.

Mr. Boys said the waves were lost at the edges of the meniscus. The mercury was kept in position by an annular ring of thin glass.

Mr. Elder then read a paper by **Mr. Beckit Burnie** on **"The Thermo-Electric Properties of Some Liquid Metals."** The investigation was made with a view to determining the effect of melting upon the thermo-electric properties of certain metals. The metal to be tested is contained in a W-shaped glass tube, of which one limb can be cooled and the other heated. Thus one limb can contain molten, and the other solid, metal. Copper wires are plunged, one into each limb, and through these connection is made with a galvanometer. The thermal junctions, therefore, are copper—hot metal, and copper—cold metal. The temperature is deduced from a separate thermal couple, calibrated by a mercurial thermometer. Curves are drawn co-ordinating temperature and E.M.F. It is found that their slope depends upon the rate of cooling or heating of the metals. This is particularly the case with bismuth. The effect is attributed to the variation in crystalline structure of the metal under test, at different rates of solidification. With tin the change is less marked, and with lead it is unnoticeable. At or about the melting points there is considerable change of slope in the curves. Here again the effect is smallest for lead; somewhat greater with tin; and remarkably large with bismuth, the latter changing from an exceedingly active thermo-electric metal to one resembling lead. A great change occurs also with mercury at the melting point, indicating a difference in the Peltier effect between solid and molten metals.

The next meeting is on March 12.

LEGAL INTELLIGENCE.

CHAMBERLAIN AND HOOKHAM v. JOHNSON AND PHILLIPS.

(Continued from page 309.)

In the Queen's Bench Division of the High Court of Justice, before Mr. Justice Wills, the above case was continued on Monday of last week. This is an action to restrain the defendants from manufacturing and selling the Perry meter, which is claimed to infringe a patent granted to Mr. George Hookham in 1887.

Mr. Moulton, Q.C., Mr. A. J. Walter,* and Mr. J. H. Gray appeared for the plaintiffs, and Mr. Bousfield, Q.C., M.P., Mr. J. C. Graham, and Mr. C. E. Jenkins for the defendants.

Mr. James Swinburne, in continuation of his cross-examination by **Mr. Bousfield**, said the relative motion of a disc and magnet gave a torque proportional to the velocity, and hence gave a suitable brake for a meter according to the statement in the Ayrton and Perry 1882 patent. Although it was obvious that the duplication of the magnets added to the power of the brake, he thought that Mr. Hookham in 1887 added to the knowledge of the world by describing how to make a brake that was both powerful and constant. The witness was then shown illustrations of the Wilde dynamo and of the hand Gramme dynamo (Fig. 8).

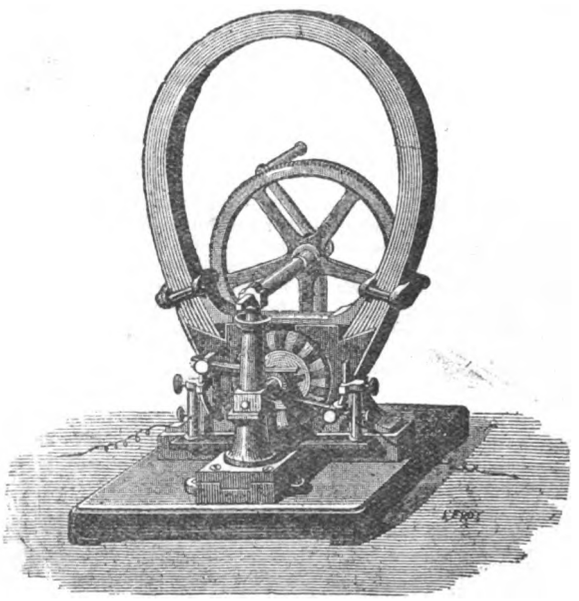

FIG. 8.—View of a Hand Gramme Dynamo, showing Permanent Magnets and Large Pole-pieces.

He said that the use of permanent magnets had been abandoned for such work, and that the arrangement shown did not give permanency. The counsel then showed Mr. Swinburne a model of three magnets grouped round a hollow cup, as in Fig. 9. Mr. Swinburne said the three magnets would give about three times

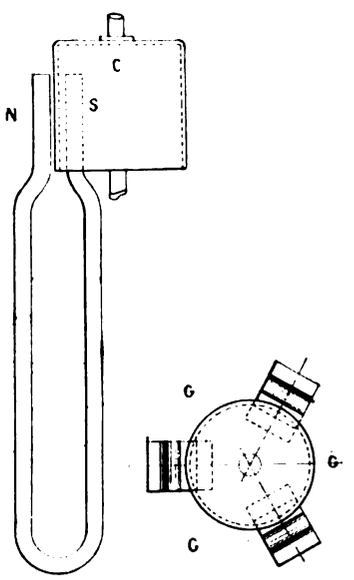

FIG. 9.—View Cup and Three Breaking Magnets, showing suggested Method of Development of the Perry Pole-pieces.

the braking effort of one. He could not say whether that arrangement filled in with plaster of Paris came within the plaintiff's specification. The difference between the plaintiff's grooves and those in the defendants' meter was that in the first case the grooves were only an advantage, while in the second they were essentials. The use of fluid contacts to reduce friction was known before 1887.

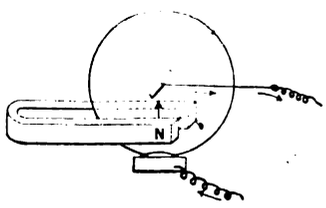

FIG. 10.—Sketch of "Barlow Wheel."

The method adopted in the Perry meter did away with the sparking due to commutation, and also gave little skin friction. The motor in the Perry meter was similar to the Edison 1883 motor (Fig. 4), except in that the cup was completely immersed. The question of the action of the Edison fluid brake (Fig. 5) was then gone into. The witness did not think it a practical arrangement. The Barlow wheel (Fig. 10) with a counter added, would be a bad

* We regret that this gentleman's name was given as "Walton" last week.

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meter. If it was improved by reducing friction and increasing the electrical forces, he considered it would come within the Hookham specification. He admitted that the D'Arsonval galvanometer was in use 15 years ago, but few people used it in a manner which required constancy of field. The revolving contacts described by Gray did not commutate the current, but distributed the current to the conductors as they turned Gray had an open-coil armature. He did not think the Gray arrangement of putting two spur gearings between the motor and brake practical for meter work.

Re-examined by **Mr. Moulton**, Mr. Swinburne said Gray's arrangement was not a commutator, as it never changed the direction of the current in the conductors. The action of the Edison fluid brake, shown in the drawing, did not agree with the letterpress. The paddles would require to be lifted out to reduce initial friction, whereas the opposite action was shown in the drawing. In his opinion, the motor used in the Perry meter was described in Hookham's 1887 specification of "a simple solid cylinder rotating between magnetic poles." Uniting the brake and armature in one was also described in the plaintiffs' specification. He did not think the Pacinotti ring construction as used in the old Perry motor would lead one to use it for meter purposes. The Foucault currents in this type of motor were considered a bugbear. There was nothing in the Ayrton and Perry 1882 specification to show them how to get a good range in the meter.

TUESDAY, MARCH 2.

Mr. Arthur Brumleigh Holmes, examined by **Mr. Gray**, said that when the Liverpool Electric Supply Company started in

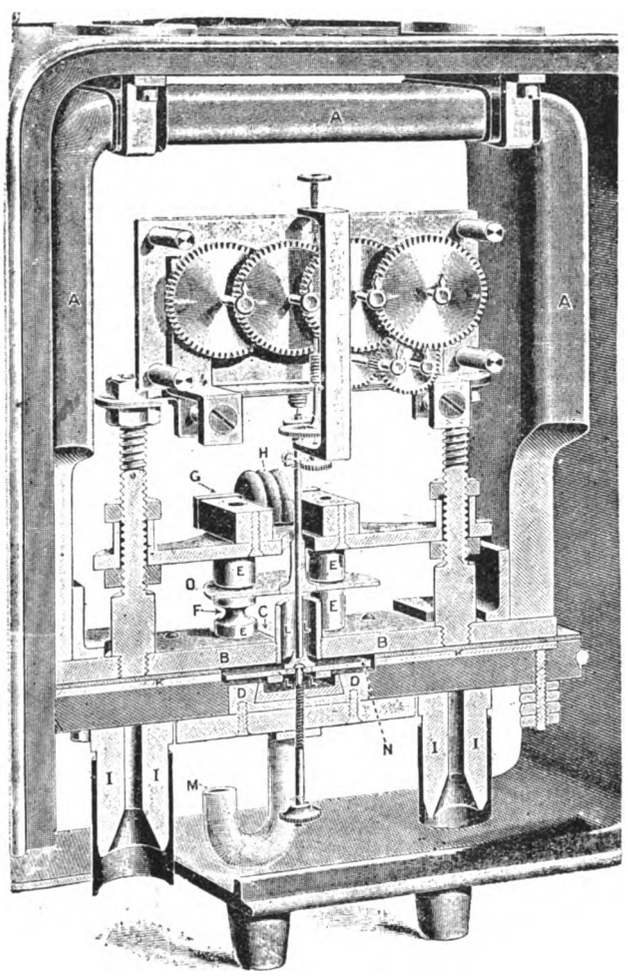

FIG. 11.—Sectional Elevation of the Present Form of Hookham Meter.

1883 there were no reliable meters to be had. They then charged by contract prices based on an estimate of what was used. He commenced to buy the Hookham meter in 1888, and had 80 of the first pattern and some 500 of the next type. They gave satisfaction at the time.

Cross-examined by **Mr. Bousfield**, Mr. Holmes said that the mercury contacts gave trouble owing to the mercury splashing. The cup needed attention every six or eight weeks. The two first types were ultimately replaced or converted to new meters at the cost of his company. The small Siemens machine, described in Mr. Holmes's book written in 1887, had permanent magnets attached to large pole-pieces. The air-gaps between them and the iron armature were small. It would be a good arrangement for permanency.

Mr. George Hookham, recalled and examined by **Mr. Moulton**, said that the price paid for the conversion of the early types was sufficient to pay for the cost of alteration. The experience in 1887 with magneto dynamos pointed to a want of permanency in the magnets. He did not think that Gray's meter would start. It was overrunning that caused the mercury to splash over.

Cross-examined by **Mr. Bousfield**, the witness said that the methods of getting permanency he used were not known in 1887. The article in the *Electrician* of December 29, 1893, was written from notes supplied by him, and he lent the block. Some parts of of it the writer would be responsible for.

Mr. Bousfield said that the article referred to improvements in the Hookham meter, and that his point was that the meter described in the 1887 specification was only fit for a museum.

Mr. Arthur Chamberlain was examined by **Mr. Moulton** as to the commercial success of the Hookham meter. He had sold £10,000 worth of the early types, which was a large order for a museum. They did not have more than 2½ per cent. of their meters returned. Splashing only occurred when the meter overran, due to a short-circuit, etc.

Cross-examined by **Mr. Graham**, witness said the falling off in sales in 1891 was due to better meters competing with them at that date. He might have received complaints from the Kensington and Knightsbridge Company, but three of their old types were still at work in that district.

Mr. Dugald Clerk, examined by **Mr. Moulton**, said that the plaintiffs' specification described a practical meter, and that the defendants' form of apparatus was included in the variants. The letterpress in Edison's patent would give a bad brake. He did not consider anyone could make a practical meter from Ayrton and Perry's specification. He thought that from the reference to Arago's disc meant that magnets would be revolved. The magnets would have to weigh some hundredweights to give the requisite braking force.

Cross-examined by **Mr. Bousfield**, the witness said he thought Foucault was the first to rotate a disc between the poles of a magnet. The letterpress of Edison's patent about the paddles of the brake was foolish, but he admitted that the arrangement in the drawing tended to a correct law.

Mr. Justice Wills said there was a doubt about the text, and he thought that a mechanic in such cases would turn to the drawings.

Mr. Clerk, continuing, said that there was nothing in Ayrton and Perry's specification to show what shape of magnet they proposed to use. He did not think they gave details enough to

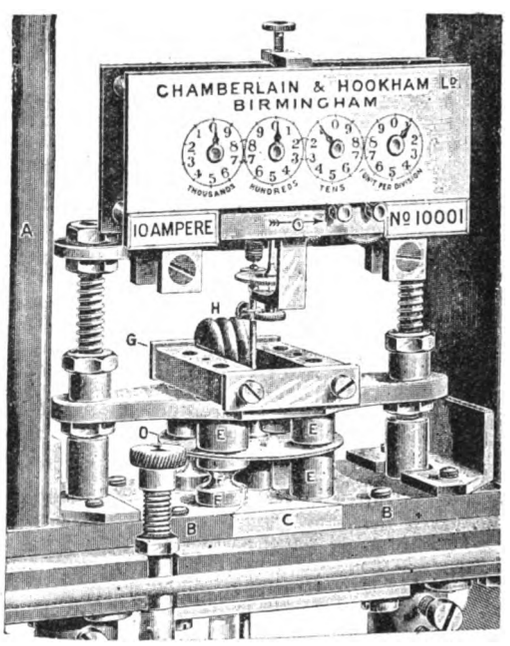

FIG. 12.—View of Poles, Armature, and Brake Wheel of the Present Form of the Hookham Meter.

enable anyone to manufacture a practical meter. The motor used by the defendants was substantially the same as that described by the plaintiff in his specification.

Mr. Vernon Boys, examined by **Mr. Moulton**, said he had given a good deal of attention to electricity meters. He agreed generally with evidence given about the plaintiff's specification, and considered the Hookham meter a practical one. From his personal knowledge in 1887 he should say that strong magnets were not permanent. He did not look on the Edison, Gray, or Munro meters as practical ones.

Cross-examined by **Mr. Bousfield**, the witness said that any meter under Ayrton and Perry's 1882 patent would be within the language used on page 5 of Hookham's specification, and hence the Hookham meter might be held to be an infringement if the patent were still in force. For the same reason things equally included would be an infringement of Hookham's patent. He considered that the plaintiff gave sufficient instructions to enable a practical meter to be made. The Edison meter was, in his opinion, a "faked" meter—that is, the vanes had to be so shaped as to correct for the defects in the law of the brake.

Re-examined by **Mr. Moulton**, Mr. Boys said that Edison's governor would not work at ordinary meter speed. He did not think an electrician would make a meter with a good range with only Ayrton and Perry's specification to guide him.

This concluded the plaintiff's case.

Mr. Bousfield complained of the lack of evidence with respect to the sixth claim, and asked if the claim was dropped.

Mr. Moulton said it was not, and in reply to Mr. Justice Wills promised to give exactly what he considered the patent to claim when the Court met next day.

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Mr. Bousfield then opened the case on behalf of the defendants. He said that the first claim of the plaintiff's patent was for an electricity meter "arranged substantially as described and illustrated." He held that this last phrase limited the plaintiff to the type described and illustrated. Ayrton and Perry in 1882 had described all that was required, and the plaintiffs could not there fore make a wider claim. The sixth claim was for grooved poles, which were not referred to in the provisional specification. He held that this was a claim to use grooves in the poles of the meter referred to in Claim 1.

Prof. John Perry, examined by **Mr. Graham**, gave evidence that in 1882 he had had practical experience in the design and carrying out of electrical engineering works. The 1882 meter was an energy meter, and became a current meter if used on a constant-potential circuit. Both types described in the 1882 patent had come into use. The Aron meter people acknowledged the patent by paying royalty. Mr. Elihu Thomson also acknowledged that his meter came within the patent. He explained that by the Arago disc he meant a disc revolving between magnets, as shown in Fig. 10. Permanent magnets were used for such apparatus before electromagnets.

WEDNESDAY.

Before the witness was recalled, **Mr. Moulton**, as asked by Mr. Justice Wills, stated his interpretation of the claims in the Hookham 1887 patent. The first claim he took to be for "an electricity meter which is a combination of two elements—first, a motor with a constant field, which field is arranged so as to give a large driving power"; secondly, "an effective electric brake which has a disc or its equivalent moving in a powerful and constant field, obtained in the case of electromagnets by saturation, and in permanent magnets by supplying form and arrangement." The same field may be applied for both armature and brake. As regards novelty, he put the second element in the first rank. He relied chiefly, however, for the elements in combination, and he read the phrase "substantially as hereinafter described" to mean arranged so as to exaggerate both the driving and braking forces. He considered the second element to be entirely new. The drawings were introduced by the words

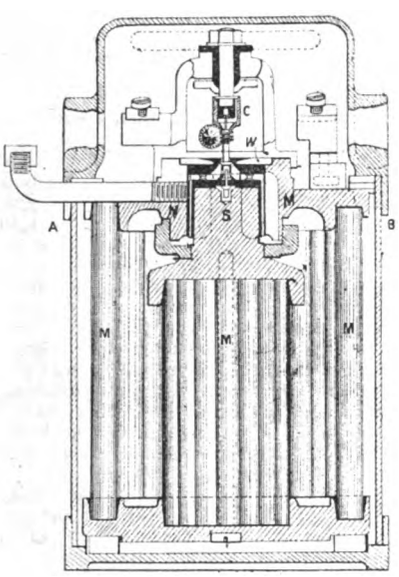

FIG. 13.—Section of the Perry Meter as now constructed.

"constructed according to one form of my invention," and other forms were repeatedly indicated so that the drawing illustrated a preferred type only. He relied on the combination of brake and field, and on the second element for the striking novelty. The other element must be made to suit that, and must be "arranged substantial" as hereinafter described.

Mr. Graham then continued his examination of **Prof Perry**, who said that in a magnetic brake it was immaterial which part revolved. It was well known in 1882 that grooved poles produced Foucault currents. In the patent of that date Prof. Ayrton and he had described three methods of getting a resistance proportional to speed—*i.e.*, fluid friction, magnet revolving in front of metallic plates, and metallic plates revolving in front of magnets. Friction and sparking at the commutator were the drawbacks at that date to the use of motors for meters. In 1882 he had made, or caused to be made, some thousands of permanent magnets which did not vary by 1 per cent. in several years. He also got powerful fields. The defect of the Edison 1883 meter was the quasi-solid friction at the surface of the mercury. His patent got over this by submerging the armature cup, and also it did away with the commutator trouble. He had also reduced solid friction, but did not use a large driving force. Nothing in the Hookham patent pointed, in his opinion, to the way he had got over the difficulties of the 1882 patent. Separate poles would be better than his grooving of the pole-pieces, but the connection between poles made a containing vessel for the mercury. It was otherwise a disadvantage.

Cross-examined by **Mr. Moulton**, Prof. Perry said he did not remember the article on his meter in the columns of the *Electrical Engineer* of June, 1893. The grooves in the Hookham poles were only similar to a small degree in effect to the gaps in his cylindrical pole-pieces. His magnet did not give such powerful fields as he would wish. They were magnetised *in situ* by flashing a large current through temporary coils. The Edison meter would be a very bad one, but it would measure over a limited range. He considered from the drawing (Fig. 4) that Edison's magnets were saturated. With 20 amperes he estimated the probable speed of the meter to be from 70 to 140 revolutions per minute. He considered the letterpress in Edison's patent agreed with the drawing. Putting the vanes right in would reduce the initial friction. He did not agree that from 1882 onwards the great importance of electricity meters was common talk of electricians.

Re-examined by **Mr. Bousfield**, the witness said that he and Prof. Ayrton advertised their clock meters in 1883, but only sold some 15. He knew the effect of eddy current with grooved poles from his motor experience in 1880.

Mr. Justice Wills here remarked that what had been a disadvantage to the motor in 1880 had been turned to practical purposes by Mr. Hookham.

The **Witness** had used some eight or nine poles at first, but found two or three to answer better. He estimated the plaintiff's grooving to increase the braking effort by some 10 per cent., while doubling the number of poles would have raised it 100 per cent. An excessive number of poles decreased the braking effort. The Edison 1883 meter might have a range of 10 to 20.

Prof. S. P. Thompson, examined by **Mr. Bousfield**, said that permanent magnets were only relatively permanent, but that Mr. Hookham had shown him personally how to increase the constancy of such magnets. Mr. Hookham, however, also used old and well-known methods of ageing the magnets. It was well known before 1887 that nearly closing the magnetic circuit and using large pole-pieces tended towards permanency and power. He referred to Mr. Jamin's researches, made from 1865 to 1875, to confirm this. The ratio between air-gap area of magnets and length given by Mr. Hookham were found in various other instrument previous to 1887. There was nothing in the specification of 1887 adding to the common knowledge about permanent and constant magnets. He had no difficulty in understanding the brake described in the Ayrton and Perry 1882 patent. The difficulty in making a meter to that patent would be that of proportionality. He had seen the magnetic brake used in an arc lamp before 1887. The lamp was made by Brache, of Paris. The peculiarities of the plaintiff's motor were entirely different from those of the defendant's motor. He understood Edison's 1883 patent, and considered the range of correct law would be small. It was essential to subdivide the poles in that meter if a braking action were required on the armature cup. The devices in Gray's and Hookham's specifications for reduced friction on the bearings were mechanically equivalent. There was nothing new in Hookham's magnetic shunt or in his mercury commutator. He showed a small motor with a vertical axis using such an arrangement.

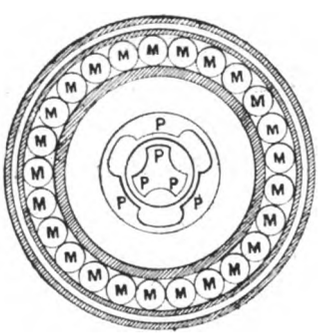

FIG. 14.—Section of Perry Meter through A B.

These motors were illustrated in all the old instrument makers' catalogues. He bought the model shown in 1883 second-hand.

Cross-examined by **Mr. Moulton**, Prof. Thompson said he could not off-hand refer to any book prior to 1887 giving details, as the plaintiff's specification did, of how to make powerful magnets permanent. He knew of no Foucault brakes working at speeds suitable for a meter except Barlow's wheel. The arc lamp he had mentioned he had not seen in England. In it exact proportionality was not required. He could give examples from Dredge's book of a Siemens armature with a mercury commutator. He estimated the torque on the Edison 1883 armature at $\frac{1}{10}$oz.

Re-examined by **Mr. Bousfield**, the witness said that three magnets grouped round the cup, as in Fig. 9, was equivalent to Prof. Perry's type of pole-piece. A fluid brake with oil instead of mercury, as in the Teague meter, would have a larger range.

THURSDAY.

Mr. John Imray, examined by **Mr. Jenkins**, said he had, as patent agent, acted for all the principal electricians at home and abroad for many years. He did not consider that Hookham's patent gave definite information as to the strength of magnets required. He considered the total immersion of the armature as in the defendant's specification a distinct advance in meter construction. The plaintiff's specification referred to a solid cylinder armature, where the defendant used a cup. The Barlow wheel would act as a meter if working gear was added. The grooving of the poles was not mentioned in the plaintiff's provisional specification, neither were permanent magnets mentioned in the provisional. Apart from Gray's specification, the plaintiff's bearings were common knowledge.

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Cross-examined by **Mr. Moulton**, Mr. Imray was taken through the differences he had pointed out between the two meters in dispute. The gaps in the poles of the defendant's meter differed from those in the poles of the plaintiff's meter chiefly in number. His remarks as to plaintiff's meter referred to Fig. 1 in the specification, as what was only hinted at was not described. Atwood's anti-frictional bearings were better than either Gray's or the plaintiff's.

Prof. Ayrton, examined by **Mr. Bousfield**, said the 1882 patent was dropped because they neglected to pay stamp duty when due. He and Prof. Perry had devoted their attention to the clock type of meter, and had not experimented much with the motor meter. The few meters they sold were to gentlemen who wished to know what they were doing—such as Edison, Siemens, etc. They had received royalties on the Aron meter. The speed of the Perry meter varied from one revolution in 17 seconds to one in three-quarters of a second. A speed of 200 revolutions a minute was too high. The Elihu Thomson meter at full load made one revolution in 1·8 second. At that speed fluid friction could be used, as in the Teague meter. The range of this latter meter was large. Experiments were then made with an oil brake to show that the resistance varied as the velocity. The Teague meter had a correction for temperature. He knew of a meter in which the magnets revolved and the brake disc was practically fixed. He had had experience of permanent magnets, and gave details of the permanency of those used for some D'Arsonval galvanometers in his laboratories. Variations of under 1 per cent. in eight or nine years had been observed. Powerful magnets were also in use before 1887. The Gramme dynamo (Fig. 8) was from his laboratory, and the arrangement in it would tend to constancy of power. The use of permanent magnets for measuring instruments had familiarised them to electricians. He described the Ayrton and Perry ammeter with the saturated spiral spring. The 1887 Hookham meter had many defects, such as skin friction at the surface of the mercury, sparking, etc. He had not seen grooves in the Hookham pole-pieces before the case. The grooves diminished the driving force, but increased the braking force. The mercury commutator was a very old arrangement. The action of the Pacinotti teeth had been explained before 1888.

Cross-examined by **Mr. Moulton**, Prof. Ayrton was referred to the meter he had mentioned which had revolving magnets. After a severe cross-examination, he had to admit that he was not familiar with the action of the meter in question, and that the current to be measured did not go through the motor driving the brake. The more viscous fluids such as the oils used in the Teague meters had to be corrected for a large temperature error or had to be kept at constant temperature. He was then taken to the Ayrton and Perry 1882 specification and asked to explain how they proposed to correct for friction by addition of a predetermined quantity. He said a certain amount would be added, depending on the revolutions the meter had made. He could show nothing other than the Jamin researches as to the method of making powerful and constant permanent magnets.

Prof. Perry, recalled by **Mr. Bousfield**, explained that fluid friction even with vanes up to a certain speed followed the simple law of giving a resistance proportional to speed. Over the critical speed the law suddenly changes.

Cross-examined by **Mr. Moulton** as to the correction for friction in the 1882 type, he thought it was intended for experimental work where the length of time the meter was running would be known.

Mr. L. J. Steel, examined by **Mr. Bousfield**, said he knew the Brillé meter, in which the magnet revolved in front of a metallic plate. In that meter the current to be measured did not pass through the motor, but that did not affect the use of the example as an illustration. He had cut the grooves of a Perry meter right through, and found it increased the braking power, reducing the speed 25 per cent. The metal was kept to retain the mercury. He had tested a Hookham meter of the first type, and found it had a speed of 330 revolutions per minute at 20 amperes. He then grooved the poles as shown in Hookham's specification, and found the speed was decreased some 10 per cent. At speeds over 200 revolutions per minute splashing took place. He did not think the meter would work for more than 10 days without attention.

Cross-examined by **Mr. Moulton**, the witness said in the Brillé meter the current to be measured did not pass through the motor. The meter could be driven by an independent supply of current. The brake was precisely the same as that in the Hookham meter. He read the following extract from the description of the Brillé meter: "The V-shaped magnets rotated by the motor produce eddy currents in the copper cylinder placed between the poles, and these eddy currents tend to drag the cylinder in the direction opposite to the displacement of the bobbin, B, under the influence of the current to be measured. The drag is rigorously proportional to the speed of rotation of the magnets."

FRIDAY, MARCH 5.

Mr. L. J. Steel, cross-examined by **Mr. Moulton**, said that in the Brillé meter the motor was controlled by cutting off the current when a certain speed was reached. The grooves he had made in the Hookham poles were proportioned as in the patent drawings. He considered the meter to be in fair working order when he received it, and remagnetising had made little difference to the readings.

This concluded the evidence called, and **Mr. Bousfield** then summed up the defence.

(To be continued.)

COMPANIES' MEETINGS AND REPORTS.

COUNTY OF LONDON AND BRUSH PROVINCIAL ELECTRIC LIGHTING COMPANY, LIMITED.

The third ordinary general meeting of this Company was held on Monday last at Winchester House, E.C., under the presidency of Lord Rathmore.

The **Chairman**, in moving the adoption of the report, stated that while in 1895 their gross revenue amounted to £5,635, last year it rose to £8,485, and the net profit in 1895 amounted to £2,714, while last year it was £5,904. Great satisfaction, he thought, might be drawn from this net increase, owing to the fact that a part of it—£1,145—was obtained from current actually supplied in their St. Luke's district. To meet their liabilities, on December 31 £38,330 still remained to be received on calls on the second issue of preference shares which they made last year. This brought down the liabilities to £49,813, which must be further reduced by £8,620, the amount of the sundry debtors, which had since been realised. A considerable reduction had taken place in the preliminary expenses, which now figured at only £11,409, as of the £20,000 received as premiums on the last issue of their preference shares, £12,169 had been applied to reducing these expenses. Their investments in shares of subsidiary companies remained the same as in 1895, but the loans to those companies on mortgages, debentures, and bills had increased to £103,573 against £77,488 last year. The larger portion of this amount was in relation to the Bournemouth and the Dover companies. These expenses had been unavoidable, but there was a good prospect of deriving adequate returns from those investments. The capital expenditure in those cases would in the future be much smaller, as they would be principally for extensions of mains and such additions to the plant in their generating stations as might be necessary from time to time. The expenditure incurred on "applications for provisional orders" now stood at £944, while the expenses incurred in connection with unsuccessful applications for provisional orders, amounting to £830, had been written off out of the premiums on shares. The item of "directors' remuneration, salaries and wages, rent, rates and taxes, etc.," was lower by about £440, while on the credit side the gross profits from "interest on investments, rents, discounts, and administration of associated companies" was £5,538 for 1896. There was also an item of £537 for commissions. That amount had been received in connection with the transfer of a contract for the electrical equipment of a tramway company to the British Electric Traction Company. Then the sum of £1,218 represented profits realised from the sale of certain investments, while the balance from the earnings of the North London station was £1,145, and a small amount for transfer fees made up the total revenue for the year to £8,485. With regard to the various stations, they had had to suffer both at their Wandsworth station and their station at St. Luke's and Clerkenwell from considerable delay in connection with the strikes last year in the London building trade. At Wandsworth the difficulty thus experienced was particularly aggravated, as they had to make large demands on the patience of their customers there who had been ready to take current from them. They were, however, met with great forbearance, and he was glad to say that this time of trial was now over. Since the beginning of January they had been supplying current in Putney, and from a later period they had been supplying current in Wandsworth and Streatham. They had applications for about 6,000 lights in the Wandsworth district, and half of that number had been attached to their mains, while the others would be attached as soon as the fittings of the houses were completed. He lived in the neighbourhood of Wandsworth, and he had very great confidence in the success of their station there. Several churches in the neighbourhood had applied for electric lighting. The building for their St. Luke's and Clerkenwell station was now almost entirely completed, and it was expected that by June they would have plant there capable of supplying 60,000 lights, and buildings which would be capable of accommodating plant to supply double that number. Moreover, whereas at present they had only the electric lighting to look to, it was confidently expected that they would derive income soon from the supply of motive power, for which they had already received a large number of applications from small manufacturers and traders. They had at present 16,000 lights connected to their mains in the St. Luke's district, and it was expected that the number by June next would be 20,000, and that by the end of the year this number would be more than doubled. Their indefatigable engineer, Mr. A. J. Lawson, also anticipated that within two years from now the whole of their present plant in the St. Luke's district would be taken up, while additional fields, in which they might hope to reap considerable profits, would be opened by extending their operations into their other North London areas. He hoped that before many years they would be able to rival the success achieved by their sister company—the City of London Electric Lighting Company. They hoped, for some years to come at any rate, to be able to supply current for those districts on the southern side of the river from the Wandsworth station, which was capable of accommodating plant which would supply 100,000 lights, while on the north side of the river they would also be able to make arrangements which would enable them to supply the more easterly districts with current from the St. Luke's and Clerkenwell stations. There were also pending some other applications to the Board of Trade. With regard to the provincial stations there was not anything very special in connection with the Bournemouth station, but the expenses, which had been pre-

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viously rather heavy in that station, had within the last year been considerably reduced, and especially in the item of fuel consumption and salaries. The fuel consumption had been reduced by about £200, although the output from the station had been increased by about 38,000 units, and there was no doubt that those economies and the reduction of expenditure would be carried further in the current year. As to Dover, he was glad to say that the amount of current actually sold last year had been more than treble the quantity sold in the previous year, and they still continued to receive very hopeful applications for additional lighting. Amongst the consumers connected last year was the well-known Lord Warden Hotel, which they had begun to light in July, and since then they had also added the Grand Hotel and the Metropole Hotel, and had reason to expect that a new and very large hotel—the Burlington—they would also have the lighting of, and this would require about 2,000 lamps alone. A very important and satisfactory contract had been concluded with the Corporation of Dover for supplying electric current to their municipal tramways. The Corporation of Dover guaranteed a minimum consumption of 160,000 units per annum, or more than their total output for 1896. This consumption would be taken principally during the hours of daylight, when there was an easy call on the machinery for lighting purposes. The returns for the Dover station for the present year ought, therefore to show a very handsome surplus. As to the Richmond station—which had always been a very satisfactory station—although the connections had not increased very much during the year, the consumption of current had been in excess of any previous experience. Important economies were also made in the working, and the result had been that nearly £1,200 had been made on working in the year 1896, as against a profit of only £230 in the previous year, while applications had recently been made for connection by some very large establishments, and there was no doubt that the revenue for the present year at Richmond would be considerably in excess of that in the year 1896.

Mr. B. H. Van Tromp seconded the adoption of the report, which was put and carried unanimously.

The **Chairman** next moved the re-election of the retiring directors (Mr. Emile Garcke and Mr. Francis E. Savory).

Mr. F. W. Reynolds, in seconding the motion, spoke in high terms of the services of those gentlemen.

The motion having been unanimously agreed to,

The **Chairman** moved the confirmation of the interim dividend for the half-year ended June 30 last at the rate of 6 per cent. per annum on the preference shares and the declaration of a further dividend to December 31, 1896, at the same rate upon the preference capital.

Mr. F. E. Savory seconded the motion, which was put and carried.

The retiring auditor (Mr. R. H. Marsh) having been reappointed, the proceedings closed with a vote of thanks passed to the chairman and directors on the motion of **Mr. Smart.**

BRUSH ELECTRICAL ENGINEERING COMPANY, LIMITED.

Interim report to the shareholders for half-year ended December 31, 1896:

The directors beg to submit a brief statement of the Company's operations for the six months ended December 31, 1896, in accordance with the wish expressed by the shareholders at the annual meeting of the Company in 1895. The works at Loughborough have been well employed, the volume of orders received during the half-year having been above the average of the past few years. The Company's "Universal" engine is steadily growing in favour with buyers. Numerous orders have been received during the six months under review, and the engine has been put to work in several important installations, among which may be mentioned the Wandsworth, Windermere, and Oswestry electric lighting central stations, Messrs. W. T. Glover and Co., Manchester, and elsewhere. The new alternating-current dynamo referred to in the last annual report has been completed, and the tests made have proved very satisfactory. The Company hold in Great Britain the patent rights for this type of dynamo, which is being largely and increasingly used on the Continent of Europe. Progress has been made with the settlement of outstanding accounts with the City of London Electric Lighting Company, and further payments on account have been received. The necessary initial steps have been taken to give effect to the resolution of the shareholders to write £1 per share off the ordinary shares of the Company. Mr. J. S. Raworth, lately joint manager and chief engineer of the Company, has resigned his position, and has been elected a director, and also consulting engineer of the Company. Mr. Percy Sellon has been appointed general manager, Mr. W. M. Mordey consulting electrician, and Mr. C. E. Hodgkin works manager at Loughborough. The requisite notice has been given by advertisement that £26,770 of the company's second debenture stock will be drawn for repayment on October 1 next. This will leave a balance of £50,000 second debenture stock outstanding. The directors do not propose to declare an interim dividend, preferring to await the result of the complete financial year.

BRITISH BLAHNIK ARC LIGHT COMPANY.

The statutory meeting of the British Blahnik Arc Light Company, Limited, was held at the offices of the Company, 28, Victoria-street, Westminster, on Saturday, Mr. A. C. Schonberg, A.M.I.C.E., in the chair.

The **Chairman** said the whole of the £50,000 capital had been allotted, and the Company had started with a working capital of £10,000. They had opened suitable premises at 50, Parliament-street as showrooms, and for warehousing and testing their lamps. In the case of the Blahnik every difficulty which other arc lamps had to contend with had been overcome, and they had in it simplicity, reliability, economy, steadiness, increased lighting power, and an absolutely steady arc. There was one important advantage possessed by the Blahnik lamp over any other lamp—namely, the power to increase or diminish the light. That would, without doubt, be of the greatest importance to railway companies, and more particularly for street-lighting, as it rendered an economy of current possible which did not exist in regard to any other arc lamp.

Mr. Henry Kisch enquired whether the economy of current referred to by the chairman was in proportion to the reduction of light.

The **Consulting Engineer** (Mr. W. Slade Oliver) replied that it was in a direct ratio.

The **Chairman** added that the light could be diminished without touching the lamps themselves.

A vote of thanks to the chairman closed the meeting.

MANX TRAMWAY AND ELECTRIC POWER COMPANY.

The annual meeting of the Isle of Man Tramway and Electric Power Company, Limited, was held in Douglas, on Monday, Mr. A. Bruce presiding,

The **Chairman** proposed the adoption of the report, recommending a dividend on ordinary shares equal to 8 per cent. for the whole year and 6 per cent. on the preference shares.

The report was adopted.

Mr. Bruce said an offer had been made to the Douglas Town Council to light the principal promenades and thoroughfares with electricity on condition of being allowed to supply private consumers along the line of route, run cars on the bay section with electricity, and construct a new quay section to the railway station, conceding 15 per cent. of the gross receipts from the quay line and 5 per cent. of the receipts from the supply to private consumers to the Town Council.

Mr. Brown said if the Council did not accept this magnificent offer they would be fit subjects for a lunatic asylum.

Mr. Bruce disclaimed any intention of injuring the gas company, and said they intended to construct an electric line from Laxey to Ramsey, keeping the capital of the Company distinct from that in existence, and working the line out of its own revenue.

CONTRACTS FOR ELECTRICAL SUPPLIES

CONTRACTS OPEN.

Charleroi (Belgium).—Tenders will shortly be wanted at the Charleroi station for the construction of a telephone building.

Ekaterinoslav (Russia).—The Municipal Authorities will receive tenders on 20th inst. for installing and working the electric light in the town.

Brussels.—Tenders will be wanted shortly (the date is not yet announced) at the Brussels Bourse for eight lots of various articles articles connected with electric lighting, for the Belgian State Railways.

Bristol.—The Electrical Committee of the Council are prepared to receive tenders for the supply, delivery, and erection of condensing plant, steam and exhaust piping, etc. Full particulars appear in our advertisement columns.

Lubeck.—Tenders are wanted for a telephone installation along the Elbe and Trave Canal. Particulars are obtainable for three marks (3s.) from the Canal Authorities (Kanalbaubureau, Kl. Bauhof 15), at Lübeck, and tenders must be in by March 27.

London, E.C.—The Directors of the Great Indian Peninsular Railway are prepared to receive tenders for, among other stores, telegraph materials and telegraph stay rods. Specifications can be obtained at the office, 48, Copthall-avenue, E.C. The date is March 15.

Braila (Roumania).—The Local Authorities are prepared to receive up to March 15 offers for a concession for the construction and working of a system of electric tramways. The aggregate length of line would be about 13 miles, and applications and enquiries should be addressed to the Mairie, at Braila.

Glasgow.—Tenders are invited for supplying and fixing in the Olympia, New City-road, during the month of April, a 25-h.p gas-engine, together with 20 arc lamps, each of 2,000 c.p., and a quantity of small incandescent lights, together with all the necessary wire cable, switches, etc. Address tenders to E. H. Postock, care of Lithgow and Son, printers, 76, West Howard-street, Glasgow.

Manchester.—The Manchester, Sheffield, and Lincolnshire Railway Company are prepared to receive tenders for the supply of electrical materials during the 12 months ending April 30, 1898. Patterns can be seen on application to Mr. A. W. Longden, storekeeper, at Junction street Mills, off Ducie-street, London-road, Manchester, and specifications, with forms of tender, may be obtained from Mr. Oliver S. Holt, secretary, London-road Station, Manchester. Sealed tenders to be in the hands of the Secretary by 10 a.m. on 16th inst.

Galatz.—The Secretary of State for Foreign Affairs has received a despatch from H.M. Consul-General at Galatz stating that tenders are invited for the construction and working of a system of electric tramways over a length of about 13 miles of the streets

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in the town of Braila. The concession is for a maximum period of 35 years. Tenders will be received up to 27th inst. at the office of the Mayor in Braila. Such further particulars as have been received may be seen at the Commercial Department of the Foreign Office any day between 11 a.m. and 6 p.m.

Tunbridge Wells.—The Corporation invite tenders for the supply and erection of a 350-kilowatt steam alternator with engine combined. Copies of the specification and further particulars can be obtained on application to the borough electrical engineer, Mr. H. L P. Boot, Town Hall, and on payment of £2. 2s, which will be returned on receipt of a bona fide tender. Tenders, endorsed "Steam Alternator," to be delivered at the office of Mr. W. C. Cripps, town clerk, Town Hall, Tunbridge Wells, by March 13. The person or firm whose tender is accepted will be required to enter into a contract and bond with two approved sureties for the performance of contract.

Wells (Somerset).—The Corporation require tenders for the supply and erection of the plant required for the complete equipment of an electric light station and for the underground conductors, etc. Copies of the specification may be obtained, and plans inspected, at the offices of the Town Clerk, Wells, Somerset; and of the engineer, Dr. John Hopkinson, F.R.S., 5, Victoria-street, Westminster, upon the payment of a cash deposit of £25, which will be returned on receipt of a bona fide tender. Tenders, sealed and marked "Tender for Electric Lighting," must be delivered to the Lighting Committee, Town Clerk's Office, Wells, Somerset, by 27th inst. Mr. Regd. L. Foster, town clerk.

Islington.—The Vestry are prepared to receive tenders for the supply and erection of a combined set, comprising 80-i.h.p. high-speed enclosed engine, 35 to 40 kw. alternator, having very low armature drop and reaction, and 20-kw. continuous-current dynamo, on combination bed-plate. Specification and plan of general arrangement of plant and steam-pipes included in the contract, with terms and conditions of tender and tender forms, may be obtained at the Offices of the Electricity Department, 50, Eden-grove, Holloway, London, N., on payment of a deposit of £1. 1s., which sum will be returned on receipt, and after consideration, of a bona fide tender in accordance with the specification. Tenders must be received at the Works, 50, Eden-grove, Holloway, N., on or before noon on 23rd inst., and must be addressed to the Electrical Engineer, endorsed "Tender for Combined Generating Set."

South Shields.—The Corporation are prepared to receive tenders for the supply of the following plant, and the carrying out of the work connected with the same: Section A—Supply of cast-iron pipes and boxes; Section B—Trenching and laying pipes; Section C—Rubber-covered cables and laying same; Section D—Low tension cables and laying same; Section E—Supply and erection of arc lamps, lamp-posts, switches, and transformers; Section F—Supply of high and low tension switches and transformers for placing underground; Section G—Supply of incandescent fittings for street lamps. Firms tendering are at liberty to tender for any section or sections, but not for part of a section. Copies of the specification, including conditions and form of tender, and also forms of contract, can be obtained from Mr. Joseph A. Jeckell, the borough electrical engineer, South Shields, on payment of £2. 2s., which sum will be returned on receipt of a bona fide tender. Tenders, on the form supplied, sealed and endorsed "Tenders for Electric Lighting," must be delivered at the office of the town clerk, Mr J. Moore Hayton, on or before 23rd inst.

Ashton-under-Lyne.—The Corporation are prepared to receive tenders for the supply and erection complete of the following apparatus and plant: Refuse destructors; multitubular and Lancashire boilers; economiser, tanks, pumps, steam-pipes, etc.; continuous-current steam dynamos, motor-generator, balancing transformer, switchboard, cables, street-boxes, etc.; arc lamps and columns, accumulators, overhead crane, station wiring, meters. Tenders may be sent in for any section or for the whole of the sections, but not for part of a section only. Plans of the district can be seen and copy of the general conditions, specification, and form of tender can be obtained on deposit of £5. 5s., which will be returned on receipt of a bona fide tender, at the Borough Comptroller's Office, Town Hall, Ashton-under-Lyne, or at the offices of the consulting engineers, Messrs Fawcus and Clirehugh, Temple-chambers, Brazennose-street, Manchester. Sealed tenders, which must be on the prescribed form, endorsed "Tender for Electric Lighting," to be delivered to Mr. John Neal, borough comptroller, Town Hall, Ashton-under-Lyne, not later than 12 o'clock noon on March 15.

Plymouth.—The Corporation are prepared to receive tenders for the following engineering works in connection with the electricity works of the borough—viz. (Contract No. 1) steam alternators (disc armatures) and dynamos, exciters, motor-generator, rectifiers, etc.; (2) Lancashire boilers with mechanical stokers, steam, exhaust, and other piping, ejector condensers, valves, electric pumps, water-tanks, economiser, etc.; (3) electric accumulators, etc.; (4) overhead travelling crane, jib wall crane, turntable, etc.; (5) switchboard (Ferranti type) and instruments; (6) high and low pressure mains, etc.; (7) stoneware conduits, etc.; (8) alternating-current transformers, sub-station switch-gear, etc.; (9) arc lamps for rectified currents, posts, etc. Contractors, who must in all cases be the actual manufacturers of the apparatus tendered for, are at liberty to tender for any of the contracts, but not for a part of any contract. Copies of the conditions, specifications, and forms of tender, bound up together, may be obtained from Mr. John H. Rider, borough electrical engineer, East-street, Plymouth, on deposit of a £5 Bank of England note for each copy, which will be returned on receipt of a bona fide tender upon the prescribed form and within the stated time. Should a contractor withdraw his tender, the amount of his deposit will be forfeited. In his application the contractor must state which contract or contracts he proposes to tender for, and copies of the drawings relating thereto will be forwarded with the specifications. Drawings must be returned undamaged with the tenders. Sealed tenders, endorsed "Engineering Contract, No. —," must be delivered to Mr. J H. Ellis, town clerk, Plymouth, by March 26. The acceptance of any tender will be subject to the contractor paying the standard rate of wages obtaining in the district where the work may be carried on.

RESULTS OF TENDERS.

Reading.—The Town Council have accepted the tender of the Brush Company, for £1,440. 7s. 6d., for an installation of wiring and fittings for lighting the new art gallery, municipal buildings, and town halls with electricity.

BUSINESS NOTES.

Kirkby-in-Ashfield.—It was reported at the District Council that the estimate for lighting the parish with electricity was not yet to hand.

Motorcar Exhibition.—An exhibition of motorcars, cycles, etc., will be held in the Royal Aquarium, London, from May 1 to May 22 next.

London Electric Omnibus Company.—The directors propose to make a new issue of 50,000 shares of £1 each, instead of calling up the balance of 10s. per share on the original issue.

Ramsgate.—The Town Council have decided to reconsider the whole question of the proposals submitted by the Isle of Thanet Light (Electric) Railway Company.

Personal.—At a meeting of the Ayr Town Council Mr. J. Arthur Fuller, interim electrical engineer, was appointed permanent engineer of the Corporation electricity works.

Keswick.—Letters were read at the Urban District Council meeting with regard to the electric light from Messrs. Hayton and Simpson, Cockermouth, and Messrs. Waugh and Musgrave.

The Newcastle Electrical Exhibition.—This exhibition continues to be as popular as ever, and owing to its success there is a probability that it will be extended to 10 weeks instead of eight as originally intended.

Pembroke.—The Township Commissioners have signed a petition to the Board of Trade for increased speed on the electric tramways between Haddington-road to Dalkey, from a maximum of eight miles an hour to 12 miles.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended March 7 amounted to £1,315, as compared with £1,040 in the corresponding week of the previous year, being an increase of £275.

Walmer.—The District Council are agitating for a decrease in the price of gas, and it was suggested at the last meeting that they should join with Deal Town Council, who are about to bring forward a scheme for electric light.

Bristol Tramways and Carriage Company, Limited.—The traffic returns for the week ended March 5 were £2.101. 18s. 1d., compared with £1,861. 11s. 7d. for the corresponding period of last year, being an increase of £240. 6s. 6d.

High Littleton.—The Parish Council have obtained an approximate estimate of the cost for the electric lighting of the parish, which would include cables, lamps, current, etc., amounting to £180. The matter was deferred to a parish meeting.

Govan.—The Hospital Board are considering the advisability of lighting the institution with electricity at a cost of about £1,700. The matter has been referred to the committee, so that Mr. A. B. Allan, burgh surveyor, might procure a definite offer.

Kensington.—A letter was read at the Vestry meeting from the Notting Hill Electric Lighting Company forwarding copy of their accounts for the year ended December 31, 1896, and stating that they are reducing their price per unit to 6d. for a 200-volt supply.

Winchester.—The Town Council have approved the draft transfer of the provisional order to the Winchester Electric Light and Power Company, Limited, and have instructed the town clerk to take the necessary steps to obtain the consent of the Board of Trade to the transfer.

Harrogate.—At the Town Council meeting, Colonel Thwaites, chairman of the Electric Lighting Committee, said it was anticipated that the electric light would be ready for use about the middle of April, and trials would be made with portions of the plant during the week.

City and South London Railway.—The returns for the week ended March 7 were £1,062, compared with £977 for the corresponding period of last year, being an increase of £85. The total receipts for the half-year 1897 were £10,775, compared with £9,837 last year, being an increase of £938.

Crosby.—A plan was produced at the Urban District Council meeting of the proposed route of the electric tramway as submitted by Mr. Holme, also a memorandum from Mr. Holme asking that the Council would give the proposed scheme general approval. Nothing definite in the matter was done.

Shoreditch.—The Finance Committee of the London County Council reported on Tuesday that they had received a report from

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the solicitor notifying the receipt of Treasury sanction to the period of 42 years proposed for repayment of the loan to the Shoreditch Vestry of £41,800 for electric lighting.

Ayr.—At a meeting of the Town Council a letter was submitted from the Under-Secretary for Scotland sanctioning the borrowing of a further sum of £15,000 for the purpose of capital expenditure under the Ayr burgh electric lighting order. The total sum now authorised to be borrowed amounts to £40,000.

Yarmouth.—A London syndicate has applied to the Town Council for permission to erect an Eiffel tower near the parade; and the plans provide for an open-work steel tower, with a circular railway running outside for the ascent and descent of passenger cars, the whole of which is to be lighted by electricity.

Western Counties Electric Railways and Tramways Company, Limited.—This Company has been registered, with a capital of £650 in £1 shares, 150 of which are founders', primarily to enter into certain agreements, the general objects being sufficiently indicated by the title. Registered office: 4, Strand, Torquay.

Teignmouth.—Mr. Headley, engineer of the St. Austell electric lighting works, on the suggestion of Mr. England, appeared before the District Council at the last meeting and gave details of the working of the low-tension system of installation, and how it could be applied to Teignmouth. Mr. Headley was thanked for his remarks.

Hastings.—At the Town Council meeting the reply of the electric light company to the resolution which the Council passed in January was read, stating that the company regretted that the Council should pass a resolution containing untrue and exaggerated statements without making due enquiry. The letter was entered on the minutes.

Mile End.—At the meeting of the Vestry it was decided, after a long discussion, that the application of the County of London and Brush Provincial Electric Lighting Company to the Board of Trade for a provisional order to light the hamlet should not be further opposed, the Vestry having a fortnight ago decided to oppose such application.

Belfast.—The Electric Committee have granted several applications for electric light beyond the area of supply on receiving the usual guarantee. A meeting of the Council in committee has been held for the purpose of considering the application of the tramway company for an Order in Council authorising the construction of suburban lines of tramway.

Douglas.—The Isle of Man Tramways and Electric Power Company, Limited, have under consideration the question of the lighting by electricity of the promenade from Derby Castle to the Victoria Pier, and of Victoria-street, Prospect-hill, Bucks road, and Woodburne-road as far as Earl-terrace. The company have decided to submit an offer to the Town Council.

Briton Ferry.—Great progress is being made with electricity at Briton Ferry. Recently, Messrs. Herbert Lewis and Fletcher, electrical engineers, of Cardiff and Briton Ferry, put down electric light and power plants at the Albion Steelworks and the Baglan Bay Tinplate Works, and on Saturday last the opening ceremony was performed in the presence of a large company.

Dewsbury.—The Town Council have decided to adopt the Brighton rebate system at the works from July 1, and that all electricity consumed exceeding an average of 1½ hours per day on the consumer's maximum demand be supplied at 3½d. per unit; 6d. being charged for all consumed below that average, and discount for prompt payment reduced to 2½ per cent.

Hull.—The preparations for the erection of the new electric lighting station in Sculcoates-lane are being pushed forward. The proposal is to supply Beverley-road, the Spring-bank, Anlaby-road, and Hessle-road districts. There is a large demand for the light in other districts where mains are not yet laid down, and provision will be made at the station for possible extensions.

New Swindon.—The debate on the question of establishing electric light installation works in Swindon was continued at the last meeting, and after long discussion it was decided to refer the question back to the committee until after the committee on amalgamation had reported, and to apply to the Local Government Board for an extension of time granted by the provisional order.

Leatherhead.—With reference to the objection to the application of the Leatherhead Electric Lighting Company, who sought powers to supply electricity at Leatherhead for lighting purposes, a letter was read at the Urban District Council meeting from the Board of Trade, stating that the order of the company would not be proceeded with. Dr. Davis observed that he was very glad to hear it.

Dundee.—The Gas Committee have adopted the report of Mr. W. H. Tittensor, the electrical engineer, recommending the following additions to the plant at the electric lighting station: boiler, seating, and connections, £950; engine, dynamo, and connections, £1,500; and accumulator battery and switching gear, £900, making a total of £3,350. Twenty-four additional street arc lamps are also to be erected.

Charing Cross and Strand Electricity Supply Corporation, Limited.—This Company offers for subscription 10,000 4½ per cent. preference shares of £5 each at £6. The dividend is cumulative, and the shares rank in respect of capital in priority to the ordinary shares. The net revenue of the Company shows a steady and satisfactory increase, and the preference shares are amply secured. At the issue price of £6 they pay 3¾ per cent.

Edison and Swan Company.—This Company are still keeping very busy in all their departments at their extensive works on the Lea. Among the contracts recently secured by this well-known firm are: supply of boxes, lampholders, and lamps for Blackwall Tunnel (London County Council), Islington Vestry, and Northern Polytechnic, besides numerous others. The high-voltage lamps of the Company are now in great demand.

Birmingham City Tramways Bill.—The Standing Orders Committee of the House of Commons have met to consider the non-compliance reported by the examiners in regard to the petition for the above Bill. After discussing the matter in private the Chairman informed the parliamentary agents that the committee had decided to allow the Standing Orders to be dispensed with, subject to certain consents being proved before the committee which will consider the Bill.

Folkestone.—A letter was read at the Town Council meeting from Mr. Hopkins, in which he said there were several points to settle before registering the company, otherwise it would have been done last week. He hoped to accomplish it and get it done some time this week, and then would communicate with the Council at once. The Town Clerk said his letter to Mr. Hopkins stated that he was prepared with the draft of the deed of transfer and the notice which had to be published.

Neston and Parkgate.—At the meeting of the District Council, Mr. Grenfell, referring to the probability of an electric lighting company being formed for the districts of Neston, Heswall, and Thornton Hough, suggested that the Council should pass a resolution to the effect that they would not oppose such a company when formed. The resolution could do no harm. Mr. Pugh said that at Brighton the electric light was being supplied at a price equivalent to gas at 6d. per thousand. The matter was deferred for the new Council.

Greenwich.—The District Board of Works have informed the Board of Trade that on the promoters of the Blackheath and Greenwich District Electric Lighting Order, 1897, giving an undertaking to lay mains in certain thoroughfares in Greenwich within two years the Board would be prepared to give their assent to the granting of the order. The District Board have given consent to an application of the London, Deptford, and Greenwich Tramways Company for permission to make experiments with Ribble's accumulator car, worked by electricity, on their line.

Irish Telephonic Communication.—The Duke of Norfolk has received a deputation from the South of Ireland at St. Martin's-le-Grand with reference to telephonic communication arrangements. The Post Office authorities are thinking of constructing a trunk telephone line from Dublin to Cork in a direction practically identical with the Great Southern and Western Railway, and the object of the deputation was to suggest the desirability of bringing the trunk line through the south east coast of Ireland, *vid* Arklow, Wicklow, Enniscorthy, Wexford, New Ross, Waterford, and Dungarvan.

Waterloo-with-Seaforth.—The Chairman announced at the Urban District Council meeting that the committee having the matter of the electric tramway in hand had met, and Mr. Holme was asked to confer with the members, but he was unable to attend. Another meeting, however, would be arranged for, when the committee would ascertain what were Mr. Holme's proposals. With reference to the Simplex electric tramway, a letter had been received from the secretary of the syndicate, in which he stated that there would be a trial of the system at Prescot on Tuesday, 9th inst., and asked if any member of the Council would attend on that occasion.

Electric Lighting in Inverness-shire.—Messrs. P. C. Middleton and Co., Aberdeen, are at present fulfilling a number of contracts to introduce the electric light into private residences in the counties of Inverness and Ross. Among the works completed is an installation by which Rossal and Carroll, two mansions in the suburbs of Inverness, are lighted. An 11-h.p. oil-engine supplies the motive power. Messrs. Middleton and Co. intend opening a branch office at Inverness, which will be managed by Mr. J. A. Linney, who had charge of the works described and an installation in progress at Gledfield House, Bonar Bridge, belonging to Sir Kenneth Matheson, Bart.

Eccles.—The South Manchester Electric Supply Company have applied to the Local Government Board for the revocation of the Town Council electric lighting provisional order (on account of the refusal of the Board to pass the necessary borrowing powers) and for the issue of a new order in favour of the company. A long discussion took place at the Town Council meeting in reference to this condition of affairs, and eventually a resolution was passed instructing the Electric Lighting Committee to reconsider their scheme and introduce one which only provided for lighting the main streets, other streets to be lighted at some future period as found desirable.

Stretford and Withington.—A deputation, consisting of Aldermen Gibson and Higginbottom, Mr. W. H. Talbot (town clerk of Manchester), and Mr C. H. Wordingham (the Manchester city electrical engineer), have had an interview on behalf of the Corporation of Manchester, in the presence of Sir Courtenay Boyle and other officials of the Board of Trade, with the representatives of the Urban District Councils of Stretford and Withington respecting the applications of these authorities for electric lighting powers. The result of the conference was that the Board of Trade decided to sanction the applications of Withington and Stretford to secure their own provisional orders for electric lighting purposes, leaving it with them to open negotiations with Manchester at their discretion.

Hammersmith.—The Electric Lighting Committee reported at the Vestry meeting that they had further considered the request from 48 residents of Uxbridge road, west of Percy-road, that the electric lighting of the main road may be continued to the boundary

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of the parish, and recommended that they be informed that under the electric lighting order the compulsory area is limited in Uxbridge-road to the portion east of Percy-road, and that the Vestry is unable to consider any extension of that area at present, but they contemplate extending the mains for both public and private lighting to the parish boundary so soon as the demand for private lighting will justify the expenditure. Mr. Searle, replying to Mr. Payne, said he had no doubt that the light would ultimately be extended if the committee found that the demand for the light would be sufficient to meet the additional expenditure.

Bury (Lancs.).—At the meeting of the Town Council there was a warm discussion on the minutes of the Electric Lighting Committee coming up for confirmation. Mr. Ashworth, the chairman of the committee, said that there had been a considerable amount of criticism as to the points at which the new lamps had been erected, especially those at the corner of Bolton-street and in the Market-place. As to the latter, the committee would have been glad to have retained the new lamp could they have done so at a reasonable cost. Mr. Alderman Meadowcroft enquired how it was that an order was given to take down the lamp when a committee meeting was held to sanction the work, but no answer was made to the enquiry. There was a strong complaint as to the obstruction caused by the lamp at the corner of Bolton street.

Lobbstown (Demarara).—The half-yearly meeting of the British Guiana Electric Lighting and Power Company, Limited, was held last month, and from the chairman's statement we gather that during the past half-year the number of lights installed by the company amounted to 848 lamps, and the total number of lights in circuit were equal to 5,663 16-c.p. lamps. During the past half-year the total revenue amounted to 25,770·31dol., as against 24,677·76dol. for the previous half-year, or an increase of 1,092·55dol. The average monthly increase from private lighting amounted to 278·94dol. The working expenditure during the past half-year amounted to 13,748·94dol., as against 14,276·83dol. during the previous half-year, showing a decrease of 527·89dol. The profit for the half-year amounted to 12,021·37dol. A dividend at the rate of 7 per cent. was declared.

Kingstown (Dublin).—At a preliminary meeting in connection with the electric tram service, it was resolved to prepare a petition for presentation to Mr. Ritchie President of the Board of Trade, and the prayer of the petition is as follows: "We, the undersigned residents and travellers along the electric line of tramway from Dalkey to Haddington-road, beg that the speed now limited to eight miles an hour may be increased to 12 miles an hour. This is already provided for in Belfast and elsewhere, and we vouch that it can be accomplished with perfect safety, both as regards the width of roadway and the absence of any traffic that would necessarily interfere with it." Then follow the signatures. A good deal of feeling has been excited along the line of tramway with regard to the recent decision, and it is expected that the petition will be largely and influentially signed.

Edinburgh.—The Electric Lighting Committee of the Town Council have resolved to recommend that a sum of £4,050 be voted out of the current year's receipts as the beginning of the electric lighting reserve fund. The above sum was arrived at by setting aside certain percentages on the electric lighting plant, apart from the percentages provided for under sinking fund. On engines, boilers, etc., estimated to last 20 years, and costing £61,000, an additional 2 per cent. was set aside, absorbing £1,220; on batteries, arc lamps, meters, etc., on which £6,500 has been expended, and which are calculated to last 10 years, an additional 7 per cent. was laid aside, representing £455; while upon transformers, rectifiers, etc., estimated to last 15 years, and costing £8,400, it was resolved to set aside an additional 4 per cent., representing £336—making £3,011 in all. To this was added £1,040 as the amount which should have been laid aside last year.

Accumulator Cars on Tramways.—The Highways Committee of the London County Council submitted the following report at the meeting on Tuesday: "The London, Deptford, and Greenwich Tramways Company has applied, under the provisions of Section 43 of the Southwark and Deptford Tramways Act, 1889, for the Council's consent to the experimental use of Ribbe's accumulator car, worked by electricity, on a portion of the company's line in Rotherhithe New-road, between Raymouth-road and the canal bridge, Old Kent-road. We see no objection to the experiment being made, and we recommend that the consent of the Council be given to the use by the London, Deptford, and Greenwich Tramways Company of mechanical traction, other than steam, for the period of one year, upon the portions of the company's line in Rotherhithe New-road, between Raymouth-road and the canal bridge, Old Kent-road, and that the Board of Trade be informed that such consent has been given."

Bangor.—The City Council have decided, upon the recommendation of the Lighting Committee, to pay the sum of £150 to the town clerk on account of his costs and out-of-pocket expenses in connection with the application to the Board of Trade for a license to put up electric lighting works. The Mayor said they had received several letters from the town clerk asking to be paid his account so as to enable him to meet the out-of-pocket expenses incurred in this matter. The committee were anxious not to pay at present only the amounts they were obliged to, so that they might at a future date obtain, if possible, a loan to meet the expenditure. In reply to Mr. Thomas Lewis, the Mayor said the bill altogether amounted to between £300 and £400. The account had not been gone into for the simple reason that it could not be paid without the Council obtaining power to borrow the money. The account had nothing to do with the present electric light provisional order which the Council were seeking.

Commercial Cable Company.—The report of the Board of the Commercial Cable Company for the year ending December 31 states that the gross earnings, including interest from investments, amounted to 2,019,255dol., being an increase of 9,517dol. over 1895. The expenses amounted to 842,690dol., an increase of 48,349dol., which was principally due to cable repairs, eight repairs having been made during 1896, as compared with five in the previous year. The balance of earnings over expenses amounted to 1,176,565dol., out of which have been declared dividends of 1¾ per cent. for the quarters ending March 31, June 30, September 30, and December 31, together with a bonus of 1 per cent., making total dividends of 8 per cent., which have absorbed 800,000dol., a balance being left of 376,565dol. This sum has been added to the amount standing to the credit of profit and loss account for the previous year, making the undivided profits carried forward 846,678dol. The reserve fund has been increased by a further amount of 250,000dol., which has been invested in first mortgage bonds of the Commercial Cable Building Company, secured by valuable real estate in New York City. The amount now standing to the credit of the reserve fund is 2,042,820dol.

Cork.—At the meeting of the Improvement Department, Sir John Scott asked the town clerk if he had any further information with regard to the electric tramways in the city. The Town Clerk said he had enquired into the cause of the delay, and had received the following letter from the Privy Council Office at Dublin Castle: "Sir,—I have to acknowledge the receipt of your letter of the 1st in reference to the Cork electric tramways order, and to acquaint you, in reply, that the order in question is a complicated and difficult one, upon whose construction various important legal questions arose, which would have had to be carefully considered by the law officers, as this order is the first of the kind which the Privy Council have had to deal with. I am informed that the order is now practically settled, and as soon as it has been received in this office it will be submitted to the different bodies interested for their observations, previous to its being laid before his Excellency in Council.—J. B. DOUGHERTY." Sir John Scott said he was glad to know that the project was not likely to fall through. The Town Clerk said the company were prepared to go on with it directly the order was issued. They were only too anxious to commence, for in addition to that they had the order for the electric lighting, and the two things must go concurrently.

West Ham.—The question of electric lighting, at a cost of some £20,000, came before the District Council recently. The tender of the Electric Construction Company, Limited, was rejected, and a higher tender was accepted. The company then alleged that they had been previously approached by the representative of one of the members of the Council, and that certain private offers were made by this representative. The company stated that they declined to listen to these overtures. They demanded an investigation. The Council pointed out that the company had not named the persons against whom they brought this serious charge, but ultimately it was arranged that the Council should apply for a Local Government Board enquiry, and the company thereupon undertook to reveal all the facts at this enquiry. In the House of Commons Mr. Chaplin last week stated that the Local Government Board had no power to order an enquiry into this matter, but the firm might prosecute or communicate with the Public Prosecutor. Mr. Henry F. Joel, of the firm of Messrs. Henry F. Joel and Co., has now written to the local Press stating that his company also are not satisfied as to the fairness of West Ham Council in the matter of electric lighting contracts, and stating that in 1893 and again in 1894 Messrs. Joel tendered at £1,045 for electrically lighting the public hall and free library at Canning Town, but a higher tender was accepted.

Newport.—At a meeting of the County Council recently, Alderman Moses brought up a report of the Electricity Committee, the members of which had been on tour so as to gain further experience to guide them in the extension of the works at Newport. They had visited Portsmouth, Reading, Islington, Liverpool, St. Helens, Halifax, Leeds, and Sheffield, and now recommend that the extension of the Newport works take place on the following lines: two slow-speed compound-condensing horizontal engines, with flywheel alternators each of 300 kilowatt capacity, the alternators of the stationary armature type made to run with the least possible noise, and the condensers to be in combination with the engines, Lancashire boilers to be used; the switchboard, extended and improved, to be of the Lowrie-Hall pattern, mounted on iron or steel framing; and that Mr. Hammond be reappointed consulting engineer, subject to satisfactory terms being arranged. The terms which the committee found Mr. Hammond would require were 5 per cent. on the outlay, which was estimated at £30,000, in addition to the sums already spent. This valuation would enable the Corporation to extend the supply of current to Maindee, where he understood it was very much wanted. The Electrical Committee recommended that the new municipal buildings at Maindee should be lit with electric light, and he believed that they would get plenty of customers in that district. Alderman Parnall said that the committee on their tour had only seen one station to equal that at Newport for simplicity and efficiency, and if the Newport works progressed as they had in the past, and the necessary extensions were made, the light would be a paying concern. The committee's report was adopted.

Canterbury.—The following report of the Lighting Committee was read at the Town Council meeting: "The committee recommend that the town clerk be instructed to engage counsel to conduct the case for the Corporation in the Local Government

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Board enquiry for the loan for electric lighting. A letter was read from Messrs. Edmundsons, Limited, offering to take over the electric lighting powers and to let the Corporation repurchase the works at any time upon payment of the capital expended plus 15 per cent., and also offering to deposit a sum of £500 as a guarantee that the work should be carried out, the money being returned as soon as the electric station was in course of construction. The committee recommend that a reply be forwarded to the effect that the offer could not be entertained, as the Corporation had decided to proceed with the undertaking themselves. The Town Clerk reported that the Board of Trade had notified their approval of the system of the electric lighting proposed to be installed in the city. In reply to the letter of the gas company of the 13th ult., the town clerk was instructed to write that the Council will welcome their suggestion to improve the street-lighting by the introduction of incandescent burners, and that, in order to recoup the company for the necessary outlay, they will be prepared to enter into a contract for two or three years (certainly not more), but, before they can consider entering into any agreement, there must be a very considerable reduction in the price charged per lamp, the Welsbach burner, bulb pattern, in approved and suitable lanterns being used and, where necessary, existing lanterns being removed or altered to suit the burners." Councillor Dean moved as an amendment that the first paragraph of the report be eliminated, and after a long discussion it was agreed that the first paragraph be struck out, the second referred back, and the remainder adopted.

Newington.—The Board of Trade having invited the attendance of four representatives of the Vestry to meet an equal number of representatives from the objecting ratepayers to the granting of the electric lighting order, for the purpose of discussing the questions at issue, the Vestry appointed Messrs. Cole, Mather, Edwards, and Newman (members of the Electric Lighting Committee) to represent them. The chairman of the Vestry (Rev. J. W. Horsley, J.P.) introduced this deputation to Sir Courtenay Boyle last week. Mr. Dunham (vestry clerk) explained that the Vestry had again complied with all the rules and regulations of the Board to entitle them to the order. Since the last local enquiry, although there had been another election of vestrymen, at which the question of electric lighting had been fully discussed and brought under the notice of the ratepayers, the representation of the parish remained practically as before, in favour of the municipal scheme for lighting the parish by electricity. Mr. Wheeler, Q.C., addressed the Board on behalf of the objecting ratepayers, and Mr. Cole (chairman of the Electric Lighting Committee) having replied, Sir Courtenay Boyle said that although the Vestry's case might appear to be weak on the compulsory area selected, he could but consider that Mr. Wheeler's case was even more so in asking the Board to ignore the wishes of the elected representatives of the inhabitants of the parish. The Board had, as the result of the last enquiry, withheld their consent, because it was not clear that the views of the Vestry were in accord with the majority of the ratepayers; but it appeared to him that as the ratepayers had not materially changed the position of matters at the last elections, and the Vestry had again renewed their application, the Board would seriously consider the objections that had now been raised to the granting of this order. He promised that the decision of the Board should in due course be communicated to both parties.

Sheffield.—At the half-yearly meeting of the Sheffield Gas Company on Monday, Sir Frederick Mappin, the chairman, said he had seen some correspondence lately in the local Press in reference to electric lamps of 2,000 c.p., and he had no hesitation in saying that there were no lamps that gave anything like 2,000 c.p. of light. He was supported in that opinion by Mr. W. A. Anthony, who, at the general meeting of the American Institute of Electrical Engineers at Philadelphia, entered his protest against the assumption that the so-called 1,200-c.p. and 2,000-c.p. arc lamps were anything of the kind. He said, "There is no 450-watt arc lamp in use that will measure 2,000 candles, when measured as other sources of light are measured, and there is no 450-watt lamp that will give, when surrounded by a plain glass globe, 500 candles." When, therefore, electric light companies claimed for their arc lamps 1,200 c.p. and 2,000 c.p., they might be pretty well satisfied that such was not the case. He was also supported in that contention by Mr. Dibdin, superintendent and gas examiner to the London County Council. It had also been stated in the local newspapers that in the streets of Edinburgh there were 350 to 400 electric lamps, for which the Corporation have to pay £7,000 to £8,000 per year. The whole cost of public lighting in Sheffield for the year ended March, 1896—including the lighting of 6,800 lamps, the cost of the lighters' wages, uniforms, etc.—was £19,486, and it would, he had no doubt, be less for the present year, as gas was now 2d. less per 1,000 cubic feet. He was firmly of opinion that they were still not at the end of improvements in the manufacture of gas, and he did not think that company was likely to be superseded to any great extent by their competitors with the electric light.—Preparatory to the work of converting the horse traction system into the overhead electric traction system, the committee have passed the following resolution: "That schemes be invited for the electrical work necessary in the conversion of the Nether Edge and Attercliffe sections to the overhead electric system, and that the following firms be asked to submit schemes and statement of cost—viz., the British Thomson-Houston Company, Limited, London; Messrs. Siemens and Halske, Berlin; Messrs. Siemens Bros. and Co., Limited, Woolwich; Messrs. Dick, Kerr, and Co., London; Messrs. Laing, Wharton, and Down, Limited, London; Messrs. Davy Bros., Limited, Sheffield; the Electric Construction Company, Limited, Wolverhampton; the Brush Electrical Engineering Company, London; and the British Electric Traction Company, London.

Cardiff.—A discussion took place at the Corporation meeting on the minutes of the Electrical Tramways Committee with regard to the number of the deputation which visited Manchester and other towns in reference to electric lighting and traction, and the terms upon which the committee was appointed. Mr. Evans proposed that the recommendations of the Lighting Committee for lighting Cathedral-road with electricity should be referred back for consideration. The cost was greater than he anticipated, and he thought the Council were not justified in adopting the scheme. Alderman Carey said he had no objection to the matter being considered in committee. In reply to Mr. Veall, Alderman Carey said the mains were being laid in Cathedral-road, and private consumers would be able to obtain electric light. At a meeting of the Health Committee held recently, under the chairmanship of Alderman T. W. Jacobs, Councillor T. Andrews moved a resolution, notice of which he had given, to the following effect: "That in consideration of the large and continually increasing amounts paid by that committee for the maintenance of horses, and with a view to facilitate scavenging and watering and cleansing the streets, a small sub-committee be appointed to report (1) as to the practicability and possible economy of employing carts and vans driven by electric, steam, or other automatic motors; (2) as to the advisability of fitting suitable motors to the water-carts and other vehicles; and (3) as to the advisability of the purchase by the Council for experimental purposes of a motor-van of the most approved pattern, designed for the collection of refuse and scavenging, and that the sub-committee be authorised to obtain the necessary estimates, plans, and all information." Councillor Andrews considered the time had arrived when they should move in the matter in the same way that other towns had done, and argued that there would be no expense in altering the wagons if several were drawn by one motor. He understood the committee spent £800 a year in horses, whilst feed and harness cost another £5,000 per annum. If the matter was taken up in a proper spirit they would save £5,000 a year. Councillor Ward seconded the resolution, which received the approval of the entire committee, several members agreeing with Councillor Andrews that the matter was one well worth going thoroughly into. At a meeting of the County Borough Council a recommendation was received from the Tramways Committee to the effect that it was desirable, in the interest of the Corporation and the public, that the purchase of the tramways should be effected subject to the terms meeting the approval of the Corporation. An amendment was carried to the effect that the question should be deferred until the expiration of the present term, and that six months' notice of purchase should be given.

Bradford.—At a meeting of the County Council, the Mayor, who is chairman of the Gas and Electricity Committee, made the half-yearly statement regarding the gas and electricity departments. Turning to the electricity department, he stated that he had no doubt the accounts of that department would please the members of the Council. The new works were rapidly approaching completion, and it was hoped they would be ready in either July or August. All consumers were now supplied at a pressure of 230 volts, and as a consequence of the change they were able to carry twice as many lamps as was possible at 115 volts, and they had been able to increase the area of supply from 1½ square miles to nine square miles. The Corporation had commenced the practice of supplying free incandescent lamps to their customers, and the system they adopted, he considered, protected them from fraud. In order to encourage the use of electricity in the daytime, they had decided to let certain classes of motors out on hire. That scheme had been in operation only three months, and they had had applications for 26 motors and 22 arc lamps, and the price for the electricity for motors had been reduced from 3½d. per unit to 2½d. per unit. During the year they had laid 10½ miles of cable, which was equal to 3½ miles on one side of a street length. The total income during the half-year ending December 31, 1896, had been £9,570. 13s. 2d., which was an increase of £1,911. 1s. 7d. on the corresponding period of the year previous. The total expenditure, including interest and sinking fund, had been £5,570. 4s. 1d., as against £5,566. 12s. 6d. in 1895. The profit for the half-year, therefore, was £4,000. 9s. 1½d., as against £2,292. 19s. 11½d. in the corresponding half of 1895; and, after charging those profits with depreciation of plant and machinery, there was a clear sum of £3,007. 4s. 8d., as against £1,506. 2s. 7d. The number of consumers was 470, or an increase of 28 per cent., and the total units consumed was 477,342, as against 373,372, thus showing that the average consumption had been steadily increasing. The total profits since the opening of the works in September, 1889, had been £12,168. 8s. 5d., of which £4,622. 18s. 2d. had been written off for depreciation, leaving the sum of £7,545. 10s. 3d. to be appropriated as the Council might direct. The trading profit—viz., taking into account interest and sinking fund was 6·26 per cent., as against 6·38 in 1895; and the net profit, after allowing for interest and sinking fund and depreciation, was 2·88 per cent., as against 2·14 in 1895. Taking the December and the June half-years together—the darker and the lighter—the trading profit showed over 10 per cent. per annum on the capital outlay, which in January, 1896, was £84,351, and now stood at £104,325. The mortgage debt in December, 1896, was £74,152, and the total amount borrowed £84,202. Since then they had borrowed other money, bringing the total up to £104,335. The number of units consumed had been 477,343, and the cost of production had been 3·269d., as against 3·928d. in 1895, or a reduction of ·659d.

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PROVISIONAL PATENTS, 1897.

MARCH 1.

5383. **Improvements in primary galvanic batteries.** Sydney Ferris Walker, Cardiff Electrical Works, Severn-road, Cardiff.

5410. **Improvements in hydrometers.** Charles William Scott Crawley and Alfred Soames, 16, Red Lion-street, Clerkenwell, London. (Alexander Pelham Trotter, Cape Colony).

5420. **Improvements in or relating to electric lamps suitable for carriages and for other purposes.** Albert Henry John Heard, 111, Hatton-garden, London.

5429. **Improvements in electric arc lamps specially suitable for projectors.** William Morris Mordey, 46, Lincoln's-inn-fields, London.

5430. **Improvements in speed-regulating governors specially suitable for electric light and other high-speed engines.** James Thompson Marshall, 46, Lincoln's-inn-fields, London.

MARCH 2.

5477. **Improvements in and relating to arc lamps.** William George Heys, 70, Market-street, Manchester. (The Puritan Electric Company, United States.) (Complete specification.)

5479. **Improvements in and connected with dynamo-electric machines.** Charles Henry Wade, James Moores, and Henry Oliver Farrell, 70, Market-street, Manchester.

5493. **Improvements in plug contacts for electrical apparatus.** Cambridge Scientific Instrument Company, Limited, and William Pye, Carlyle-road, Cambridge.

5507. **Signalling electrically between ships or between ships and the land without wires.** Herbert Watson Sullivan, 19, Great Winchester-street, London.

5569. **Improved construction of asynchronous motor for single or polyphase alternating electrical currents in combination with an auxiliary synchronous motor.** Charles Denton Abel, 28, Southampton-buildings, Chancery-lane, London. (La Société Anonyme pour la transmission de la force par L'electricité, France.)

MARCH 3.

5687. **Improvements in electric batteries.** Michael Martin Bair, 45, Southampton-buildings, Chancery-lane, London.

5706. **Safety differential device for electric installations.** Henry Harrington Leigh, 22, Southampton-buildings, Chancery-lane, London. (Edmond Desroziers, France).

MARCH 4.

5714. **Improved system of fitting up electric bells.** Henry William Johnston, 154, St. Vincent-street, Glasgow.

5723. **Electric light adjustable extension fitting.** Robert Hurry and Malcolm Graham Yooll, 15, Rosefield-avenue, Portobello, Midlothian.

5794. **Improvements in electrically-operated clocks.** Richard Burk, of the Württembergische Uhrenfabrik Schwenningen, 6, Lord-street, Liverpool. (Complete specification.)

5805. **Improvements in and in the manufacture of elements for secondary batteries.** Desmond Gerald FitzGerald, 53, Chancery-lane, London.

MARCH 5.

5826. **Improvements in the active material of secondary batteries.** Alexander Schanschieff, 7, Acacia-grove, West Dulwich, London.

5859. **Improvements in electrical switches.** Charles Mark Dorman and Reginald Arthur Smith, Ordsal Electrical Works, Salford, Manchester. (Complete specification.)

5885. **Improvements in or relating to the driving of vehicles by electromotors.** Charles James Hall and Robert Henry Fowler, 37, Essex-street, Strand, London.

MARCH 6.

5948. **Improvements in means and apparatus for discharging, neutralising, or removing electrical charges from paper and other fabrics during and after the process of manufacture.** Henry John Rogers and William Morris Mordey, Lavington, Watford.

5957. **An improved method of increasing the surface insulation between connections on electrical switches and fuses.** Frederick William Heaton and Harry Smith, Salford Switch Works, Sidney-street, Salford, Manchester.

5993. **Improvements in or connected with telephone transmitters.** Anthony Boiston, 33, Chancery-lane, London. David Noble Rowan, United States, and Charles Herbert Wilkinson, Canada.)

5998. **Improvements in switchboards and controllers for electric circuits.** Leo Linder, 39, Essex-street, Strand, London.

SPECIFICATIONS PUBLISHED.

1892.

13395.* **Electric signalling apparatus.** Mercier. (Amended.)

1896.

355. **Electric regulator for regulating arc lamps and for other purposes.** Davis.

2772. **Method and apparatus for effecting the connection in parallel of alternate-current and polyphase dynamos and motors.** Siemens Bros. and Co., Limited. (Siemens and Halske.)

3083. **Ceiling rose and attachment therefor, chiefly applicable for electrical purposes.** Braham.

3092. **Controllers for electric motors.** Devonshire. (Potter.)

3481. **Dynamo-electric machines.** De Ferranti.

4709. **Method of and electrical apparatus for automatically reducing and cutting off the steam from and thus preventing the racing of marine engines.** Folk and Ellis.

4761. **Device for facilitating the fixing, adjustment, and removal of electric incandescent lamps.** Coulson.

4773. **Electric traction.** Claret and Vuilleumier.

5616. **Electrolytic processes and apparatus.** Peyrusson.

5673. **Apparatus for refining metals by electrolysis.** Elmore (Elmore.)

6732. **Advertising devices operated by an electric current.** Collings.

7694. **Electric traction.** Esmond. (Date applied for under International Convention, September 11, 1895.)

7789. **Electric arc lamps.** Brockie.

8269. **System of running and insulating concentric electrical conductors and appliances in connection therewith.** Wilkinson.

23663. **Apparatus for the production of oxygen and hydrogen by electrolysis.** Garuti and Pompili.

24233. **Electric switches.** Storey, Storey, and Parkinson.

25903. **Controlling electric arcs.** The British Thomson-Houston Company, Limited. (Thomson.)

28196. **Dynamo-electric machines with motors for driving the same.** Fischer and Held.

29614. **Electromagnetic contact makers for electric traction with underground feed.** Haddan. (Piquet.)

29907. **Manufacture and production of elements or plates for electrical storage batteries.** Brault.

29919. **Electric arc lamps.** The British Thomson-Houston Company. (Thomson.)

1897.

130. **Multiplex telegraphy.** Barr.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	9¼-9¾
Brush Company, Ordinary	3	¾ ¾
—— Non. Cum., 6 per cent. Pref.	2	1¼-1½
—— 4½ per cent. Debenture Stock	100	107-111
—— 4½ per cent. 2nd Debenture Stock	100	95 99
Callender's Cable Company, Debentures	100	104-109
Central London Railway, Ordinary	10	9¼-10
——	6	5¼-5¾
Charing Cross and Strand	5	10¾-11¼
Chelsea Electricity Company	5	9¼-10
—— 4½ per cent. Debentures	100	113-115
City of London, Ordinary	10	18¼-19¼
—— 6 per cent. Cumulative Pref.	10	16¼-17¼
—— 5 per cent. Debenture Stock	100	132-136
City and South London Railway, Consolidated Ordinary	100	59 61
—— 4 per cent. Debenture Stock	100	139-141
—— 5 per cent. Pref. Shares	10	15¼-16
County of London and Brush Provincial Co., Ordinary	10	10¾-11¼
—— 6 per cent. Cum. Pref.	10	14¾-15¼
—— 4½ per cent. 2nd Debenture Stock	10	14¼-14¾
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	1¾ 2¼
—— 5 per cent. Debentures	—	96 98
Edison and Swan United Ordinary	3	1¾-2¼
—— 5 per cent. Debentures	5	3-4
—— 4½ per cent. Debentures	100	105-110
Electric Construction, Limited	2	1¼-1¾
—— 7 per cent. Cumulative Pref.	2	2¼-3
Elmore's Copper Depositing	1	¾-1¼
Elmore's Wire Company	2	⅜ ⅝
W. T. Henley's Telegraph Works, Ordinary	10	19¼ 20¼
—— 7 per cent. Preference	10	18¾-19¼
—— 4½ per cent. Debentures	100	107-112
House-to-House Company, Ordinary	5	6 6¼
—— 7 per cent. Preference	5	8¾-9¼ xd
India Rubber and Gutta Percha Works	10	20¾-21¼ xd
—— 4½ per cent. Debentures	100	106-109
Kensington and Knightsbridge Ordinary	5	11-11¼ xd
—— 6 per cent. Pref.	5	8-8¼
London Electric Supply	5	1¼-1¾
Metropolitan Electric Supply	10	14¼-15¼
—— 4½ per cent. First Mortgage Debenture Stock	100	120-124
National Telephone, Ordinary	5	6¾-7¼
—— 6 per cent. Cum. First Pref.	10	16-18
—— 6 per cent. Cum. Second Pref.	10	16-18
—— 5 per cent. Non. Cum. Third Pref.	5	6-6¼
—— 3½ per cent. Deb. Stock	100	102-105
Notting Hill Company	10	12-13
Oriental, Limited, £1 shares	1	1¼-2
—— £5 Shares	5	8¼-9
—— £4½ shares	4½	7¾-8
Oriental Telephone and Electric Company	1	¾-1
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	103-105
St. James's and Pall Mall, Ordinary	5	14-15
—— 7 per cent. Pref.	5	9-10
Telegraph Construction and Maintenance	12	39-42
—— 5 per cent. Bonds	100	103-106
Waterloo and City Railway, Ordinary	8	10¾-11¼
Westminster Electric Supply, Ordinary	5	12¾-13¼
Yorkshire House-to-House	5	7-7¼

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NOTES.

Society of Arts.—Mr. W. B. Esson's paper on "The Transmission of Power by Alternating Electric Currents" is to be read at the Society of Arts on Wednesday, March 24.

New Book.—We have received from Messrs. Grevel and Co., King-street, Covent Garden, Mr. Pattison Muir's translation of "The Elements of Electro-Chemistry," by Dr. Robert Lüpke, which we hope to notice further in due course.

The Civil Engineers.—The subject of the James Forrest lecture fixed for yesterday (Thursday) evening is "Bacteriology," and the lecturer Dr. G. Sims Woodhead. The lecture will be repeated on the afternoon of the 24th if it should be necessary and desirable.

The Royal Society.—Among the papers on Thursday were one by Mr. S. A. Sworn on "The Conditions which render Absolute the Readings of the Mercurial Thermometer," and another by Prof. Hartley on "Experiments on the Flame Spectrum of Carbon Monoxide."

South Kensington Museum.—The Chancellor of the Exchequer has stated in the House of Commons that in view of the great cost of the erection of public offices in London which have recently been sanctioned, the Government cannot undertake to proceed with the extension or completion of the buildings at South Kensington.

The "Engineer" Motorcart Competition.—Intending competitors should remember that the time for making entries for the *Engineer* motorcart prizes will expire on the 31st inst. It is hoped that no intending competitor will neglect to enter within the time fixed. The list of entries will not be published until the time comes for delivery of the vehicles at the Crystal Palace.

Electricity from the Nile.—A Reuter's telegram states that the Egyptian Council of Ministers has approved of the appointment of Prof. Forbes to examine and report upon the Nile cataracts regarding the best method of utilising the water power available for generating electricity. Prof. Forbes will commence his work in the autumn, and it is expected that the results will be of high importance to Upper Egypt and the Soudan.

Students' Visit.—The Institution of Electrical Engineers announce that the next students' visit will be to the Islington central station on Thursday, March 25. The party will meet at 50, Eden-grove, Holloway, N., at 4.15 p.m. Those desiring to join should at once give notice to the secretary of the Students' Committee (Mr. W. Bunn, 23, Oxford-road, Stroud Green, N.), and as the number will have to be limited applications will be dealt with in order of receipt.

Electric Railway Working.—A fair trial on a full scale will be given to the electrically-worked railway if it is correct, as stated in the *Western Electrician*, that the new standard-gauge railway 60 miles long between Detroit and Port Huron, in Michigan, is to be constructed as an electric line. It is proposed to have the power-house about one-third of the way along the line. There is no waterfall in the business, but steam-engines will drive three-phase dynamos, and the current be converted to continuous by rotary transformers at four sub-stations. It will be an overhead trolley line.

Crystal Palace Lecture.—Last week's Crystal Palace lecture was by Prof. Silvanus Thompson on the "Electrical Discoveries and Inventions during the Queen's Reign." Though electricity was known to Galvani, Volta, and Franklin, the age of electricity really began in the year of her Majesty's accession. Soon after the first telegraph was established between Paddington and Slough, it was seen that it was absolutely necessary to the safe conduct of railway traffic. Cables followed land lines, and to-day the length of submerged cable exceeds 162,000 miles. Then came the telephone, electricity as applied to the arts and manufactures, and engineering.

Technological Examinations.—The City and Guilds of London Institute's examinations in technology will be held on April 24, May 1, 3, 4, 5, 6, 7, and 8. All applications for examination in technology must be forwarded to the institute on or before March 29. Only in exceptional cases, and by payment of an additional fee, can applications be received from local secretaries after that date. Applications from individual candidates for examination at the offices of the institute should be made not later than April 17, addressed City Guilds Institute, Examinations Department, Exhibition-road, S.W., and should be accompanied by a postal order for the amount of the fee.

The Telephone Service in London.—Mr. Bartley has been asking the Secretary to the Treasury whether his attention had been called to the inefficient service of the Telephone Company in London and Westminster, and of its inability to supply persons with telephones, and Mr. Hanbury replied that the attention of the Postmaster-General had not recently been called to any inefficiency. He understood that the company were making every effort to place the service on a satisfactory basis, and that the work of reconstructing the system on the metallic-circuit principle was now nearly completed. Mr. Bartley gave notice that he would call attention to the subject on the Post Office vote.

Fire.—Between six and seven o'clock last Friday night, a fire occurred in the Queen-street Station of the North British Railway at Glasgow. The outbreak took place on the top floor of a two-storey wooden erection used as a power generating house for the electric light installation. The lamps in the station went out for a time. The officials, however, worked energetically to overcome the flames, and with the aid of the fire brigade the damage was confined to the floor where the fire originally began. The old gas lamps in the station were lit, and the traffic was enabled to be carried on without interruption. The loss will amount to about £500, principally to machinery, and that mostly due to water damage. The fire is believed to have been caused by the contact of two electric wires. (It always is so believed, and usually on no particular evidence.) Anyhow, soon after the fire was out the majority of the electric lamps in the station were again in use.

Technical Education in London.—At last Tuesday's meeting of the London County Council Mr. N. W. Hubbard moved: "That, whereas the Council is now allocating nearly the whole of the revenues (estimated this year at £172,000) derived from the Exchequer contributions in respect of the wine and spirit duties to the purposes of technical education, which revenues might, and doubtless would, have gone in aid of the county rate had the recommendation of the Royal Commission of 1884 on the City Companies been carried out; and further, as it is evident that the said Exchequer contributions will in the near future fail to meet the growing needs of the Technical Education Board, the Council do petition her Majesty's Government to take the necessary measures for putting into operation the recommendations of the Royal Commission—viz., 'The application of the (City Companies) funds to objects of acknowledged public utility'—technical education being specially mentioned as one of such objects." Dr. Cooper seconded the resolution, which was, after dis-

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cussion, carried by a majority of four. But, then, there are people capable of saying that it is as much dislike of the City as love of technical education which is making the County Council so anxious to find more (of other people's money) for its needs. In this wicked world it is so difficult to get all the credit that is due to one.

The Midland Engineers.—A general meeting of the Chesterfield and Midland Counties Institution of Engineers will be held in Tamworth on Saturday, April 3, at 3.15 p.m., and the attendance of all members of the two Staffordshire (North and South) Mining Engineers' Institutes is invited. All visitors are desired to communicate their names to the secretary not later than Saturday, March 27, as the accommodation is limited, and only those applying can be provided for. After an excursion to the Kettlebrook Paper Mills, and thence to the Kingsbury sinking of the Hockley Hall and Whateley Colliery Company, Limited, there will be a general meeting at the Assembly Rooms, Tamworth, when among the papers to be read, or taken as read, is one on auxiliary haulage at Netherseal Colliery, by Mr. G. J. Binns. Among the papers open for discussion are: "Electric Machinery for Mines," by Mr. Rankin Kennedy; "The Use of Petroleum in Safety-Lamps," by Mr. E. B. Wain; "Secondary (Auxiliary) Haulage," by Mr. W. Galloway; and "Electric Haulage at Pleasley Colliery," by Mr. J. Piggford. Afterwards there will be dinner at the Peel Arms.

Etruscan Vases.—Dr. G. Folgheraiter's observations on the traces of magnetisation in Etruscan vases have been noted here more than once. Obviously it at once suggests itself that the magnetisation may have undergone some modification during the many centuries that have elapsed since the vases were baked. In a recent contribution to the *Atti dei Lincei*, Dr. Folgheraiter settles any doubts on the matter by his observations on some vases which were pieced together from scattered fragments, discovered in excavations at Arezzo. If the magnetisation of the baked clay had in any way altered since the vases were broken, it is clear that the different portions falling and lying anyhow would have been differently affected, and when the bits were pieced together again the mended vases would have shown irregular magnetisation. But they were found to be as regularly magnetised as those which had been excavated entire, the opposite poles at the mouth and base being exactly 180deg. apart. The uncertainty of course remains as to what was the position of the vases in the kiln. Dr. Folgheraiter hopes that further excavations may lead to the discovery of potteries of the Etruscan epoch containing vases *in situ*. It is of course permissible to hope, but it seems improbable. But then a little while ago the antecedent improbability of our being able to get any information at all as to the elements of terrestrial magnetism somewhere about the time of the Tarquins would have seemed very great indeed.

Royalty Payments to the Telephone Company. In the House of Commons on Tuesday Mr. Henniker Heaton asked the Secretary to the Treasury, as representing the Postmaster-General, what was the amount of money paid as royalty by the National Telephone Company for each of the following years—1893, 1894, 1895, and 1896; and whether he was aware that no particulars of these receipts were specifically given to Parliament in the Postmaster-General's annual report or in any other public document. Mr. Hanbury replied that the amount for the year 1895-6 was £81,530. The information asked by the hon. member in regard to previous years was given in reply to a question asked by him on March 20, 1896. The answer then was that the royalty was 10 per cent., and the amount received during the past five financial years were: 1890-1, £44,007; 1891-2, £50,403; 1892-3, £57,620; 1893-4, £65,443; 1894-5, £72,693. The Postmaster-General was aware that no particulars of these receipts were specifically given to Parliament in his annual report or in any other public document, and he did not think it necessary to select this particular item for separate publication. But then those are just the sort of items that Mr. Henniker Heaton and some other people think it desirable at any rate, if not necessary, should be published. So they drag them out of the Minister by a question in the House, and what would otherwise be never seen unless someone looked for it gets brought before everyone's attention in a special paragraph.

The Institution.—Last Thursday Mr. H. Benest took two cable breaks down to the Institution of Electrical Engineers and asked how they happened. That is practically what the paper comes to. There were quite a quantity of lantern slides by way of illustration to the paper. Electrical and telegraphic engineers are not, unless by accident, also geologists, and therefore it may be remarked that the theory of earthquakes being caused by "sea-water filtering through the bed of the ocean" and coming in contact with "intensely heated regions below" is now discredited. The thing does really happen with fresh water in special cases, but the result is not an earthquake, indeed not even a volcano, but only a geyser. This of course in no way militates against the suggestion that a submarine volcanic disturbance would be exceedingly bad for a cable lying near it. It is true that all the submarine volcanic action that we know of has been confined to quite shallow water, but the reason of that may be an exceedingly obvious one. "The late Prof. Charles Darwin, F.R.S.," is a curiously elaborate way of citing a very famous name indeed. The discussion of Mr. Benest's paper is yet to come, and it would be almost an offence against etiquette to in any way anticipate it. But it is a quite harmless remark that if there had been at St. Louis one of those earthquake-recording instruments which Prof. Milne would like to see set up in a great many submarine telegraph stations, it would have given an answer one way or the other to a very possible suggestion of what was the cause of the enigmatical breaks described by Mr. Benest.

A Mathematician.—The death is announced of Prof. James Joseph Sylvester, F.R.S., the Savilian Professor of Geometry in the University of Oxford. He represented essentially "pure" mathematics, and the region in which he worked is so remote from popular knowledge that only specialists can understand the contributions made by him and Prof. Cayley to a branch of science that some of the people who deal with the more practical problems on the mixed side would be hardly sorry to believe was worked out. Sylvester was born in London in 1814. From the Royal Institution, Liverpool, he went to St. John's, Cambridge, the Inner Temple, University College, and thence to the University of Virginia. Though it is by no means always the case that a great mathematician is "good at figures" (some are very good and many are quite the reverse), Sylvester returned to England, gave up mathematics for a time, and was on the point of taking up the profession of an accountant when he was made professor of the Royal Military Academy, Woolwich. In 1877, on the foundation of Johns Hopkins University, Baltimore, he went back to America; and in 1883 he was elected Savilian Professor of Pure Geometry in Oxford. On the failure of his eyesight and general health in 1893 he retired from active duty to London. Throughout his life learned societies at home and abroad agreed in doing him honour, so that he could put more letters after his

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name than perhaps any other Englishman. When not writing mathematics he wrote verse (English or Latin). His verses were good verses, as his equations were good equations, but of course it was not poetry.

National Telephone Company.—The fourth annual staff dinner of the National Telephone Company, Limited, took place last week at the Empire Room of the Trocadero Restaurant. Mr. W. E. L. Gaine, the general manager, presided, and amongst those present were Mr. James Staats Forbes, Lord Harris, Sir A. K. Rollit, Mr. W. H. Preece, Sir H. Mance, Prof. Hughes, Mr. W. C. Quilter, M.P., and Mr. Dane Sinclair. In proposing the toast of the National Telephone Company and its board of directors, the Chairman stated that the company had not been inactive during the past year. Their customers had in the previous year increased by over 9,000 people, but in the present year there had been an increase of about 13,000. They opened in the previous year 50 new exchanges throughout the country, but in the past year they had opened 69. Last year they were only sending 313,000,000 messages, but this year they were sending over 350,000,000, about half the number of inland telegrams. He was somewhat surprised that in the transfer of the trunk lines to the State there had been so little friction and dislocation. Negotiations were proceeding with the authorities in London which he hoped would result in a better arrangement being made which would enable them to put the telephone wires underground. Among other toasts was that of "Telephony," proposed by Mr. W. H. Preece, who mentioned that he was the first to bring over to this country from the United States a pair of telephones, and that he was then met—it was 20 years ago—with incredulity, and the feeling that it was only another form of swindling. They now had more trunk wires in operation in England than in the whole of Europe. The toast was responded to by Sir H. Mance and Mr. D. Sinclair.

Animal Electricity.—On Tuesday Dr. Waller, in commencing the third part of his sessional course of lectures, said that after having treated empirically the phenomena of nerve and muscle this would bring him back to nerve again. The general conclusion which he hoped to show that the phenomena would lead to was the importance of the polarisation effect, and that excitation meant electrolysis. It might be what was called incipient electrolysis, but it came to this, that, to use a nomenclature that was invented at the Royal Institution, the action was due to the ions liberated by the current. Dr. Waller referred to the experiment exhibited by Lord Rayleigh on the previous Saturday as showing that, though in a circuit the nominal E.M.F. might seem too small to bring about electrolysis, yet it was possible to obtain a certain amount of it by the induction current of the make and break. A curious effect obtained was that when an alternating current was taken through a nerve or muscle and a galvanometer, instead of the instrument showing no indication, there was a deflection in the direction of the breaking current, which was produced by an inequality in the back E.M.F.'s of the polarisation. A fuller elucidation of this was promised. (It must, of course, in some way be due to the difference of voltage in the currents of make and of break, owing to the time periods being different.) One remark of Dr. Waller's in the course of his lecture is also worth note, and that was that Du Bois Reymond, in his book on the subject, coming to a difficulty in the year 1849, stopped short in the middle of a sentence. That particular difficulty was not so removed that the sentence was completed until the year 1884. That interval of 35 years might give some notion of the patience and perseverance that had been devoted behind the scenes to the investigation of these phenomena.

The Physical Society.—At last week's meeting of the Physical Society, Mr. Shelford Bidwell presiding, Mr. William Barlow read a paper on "A Mechanical Cause of Homogeneity of Structure and Symmetry, Geometrically Investigated, with Special Application to Crystals and to Chemical Combination," illustrated by models. Mr. Barlow assumed an equilibrium arrangement of assemblages of mutually repellent particles, and showed that these mechanical systems of particles exhibit characteristics entirely analogous to certain crystalline and other properties of matter. The fundamental concept was a number of different kinds of mutually repellent particles dispersed through space, the amount of this repulsion being some inverse function of the distance between the particles concerned. The particles are destitute of polarity, and the difference in kind consists only in a difference in the degree of mutual repulsion which two particles exercise, according to the kinds taken. As was subsequently remarked by Mr. Fletcher, the paper, with its 188 pages of MS., represented a vast amount of clear thinking and many years of admirable work, and it certainly excited considerable interest among the members of the society. But without Mr. Barlow's models it would be hardly possible to render the detailed results arrived at intelligible, and to what has been said above it would be useless to add much beyond that as a state of equilibrium Mr. Barlow gets the arrangement of "close packing," and extends it to explain solution, diffusion, and stereo-chemical problems. It was objected, in a communication from Prof. Miers, that this view of crystal structure failed to explain why crystals should have faces, and gave no hint as to the controlling forces which kept mutually-repelling particles together. At the invitation of Dr. S. P. Thompson, the society will, on 26th inst., meet at the Technical College, Leonard-street, Finsbury.

Paris Tramways.—A curious kind of official tangle appears to have arisen in connection with the electric tramway which is, or, rather, was, so recently as Friday last being constructed across the Champs Elysées at the Rond Point. The work has been suspended for the time by order of the Minister of Public Works. Why no one precisely knows, but there appears to be some misunderstanding between the authorities. The Champs Elysées does not form part of the Government roads over which the Ministry has direct control, but is a simple communal road depending entirely on the local authority. It so happens that the line of tramway from St. Philippe du Roule, in the Faubourg St. Honoré, to the Porte d'Orléans, crossing the Champs Elysées at the Rond Point, is one of a network of five lines which were declared to be of public utility by a decree of the Bourgeois Ministry, dated March 12, 1896. The initiative of those tramways was taken by the Paris Municipal Council so long ago as 1892, and a public enquiry was, as usual, instituted. It took place in June, 1894, and there was not a single protest against the line now in question crossing the Champs Elysées. Indeed, the complete absence of any sort of opposition to the tramway crossing the Champs Elysées was noted in the report of the Official Inspector to the General Council of the Ponts et Chaussées, which consequently adopted the project without remark. The affair, following the usual course, was approved by the Council of State before the decree of public utility concerning it was issued by the Bourgeois Cabinet. To complicate the matter more, it happens to be the case that the Municipal Council made the construction of the five new tramway lines, of which the Champs Elysées tramway is one, a condition to its subvention of 20,000,000fr. to the

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Great Exhibition of 1900. The Paris Municipal Council, like our London County Council, has ways of its own (the municipal councils of all capital cities seem liable to the disease), but the French Government has more effective means of keeping it in order than our Government possesses in the case of a local authority with ideas.

Our Submarine Cables.—Mr. Hanbury, replying to Mr. Henniker Heaton in the House of Commons on Monday, said that the Postmaster-General had from time to time received representations on the subject of the charge for cablegrams to India, and had endeavoured to bring about a reduction, but without success. The charge to Japan by the cheapest route was 8s. and to British Guiana 10s. per word. Mr. Hanbury added that he was not aware of any general feeling of discontent, and did not think any useful purpose would be served by an enquiry into cable facilities and charges. The Postmaster-General did not know what amount was paid for telegrams by merchants engaged in the Anglo-Australian trade, and it was not within his province to state what the expenditure of the Government was on telegrams to and from places abroad. (Why not?) The Postmaster-General had not had before him any calculations as to the cost of constructing and maintaining a set of cables to take the place of those already in existence, and he had no reason to suppose that cable communication to all parts of the empire could be given for a tenth of the present rate. (Who said a tenth?) Mr. Hanbury thought it entirely contrary to sound policy for the State to attempt to acquire the existing cables. They were landed at a great many points in foreign territory, and foreign countries would not acquiesce in the working of such cables by the British Government, although they were ready to come to terms with British companies. (That is just the trouble. Our own cables are under the control of foreign Governments.) At the Telegraph Conference in Budapest arrangements were made for very considerable reductions in the charges to various parts of the world. Some of these reductions were already in force, and the rest would be brought into operation on July 1 next. These arrangements could not have been made without the cordial co-operation of the British cable companies. In reference to one part of this, it has been stated by the *Birmingham Daily Post* that it is computed that upon the present tariff the merchants engaged in Anglo-Australian trade and the public generally have to pay £412,000 a year, and the Government at least £100,000 a year in communicating with the Colonies and foreign Governments and with its naval and military officers. That is decidedly a good revenue to start on.

The Royal Institution.—Last Friday there was a very full audience to hear Prof. Arthur Smithells on the "Source of Light in Flames." Mr. Smithells has a marvellous way of separating the two parts of the flame—the upper, or bright part, and the lower, or blue part (say)—and making them burn several inches apart. It is exceedingly simple when one comes to see it, but it may safely be said that it did not succeed right off the first time it was tried. The way in which Mr. Smithells was able to burn—and occasionally for some moments fail to burn—such things as carbonic oxide, acetylene, and cyanogen filled one with admiration for the ventilating capacities of the theatre. He also showed flames which were very hot and almost invisible (pure hydrogen in pure oxygen), and, as a contrast, a flame that was quite bright, but which you could hold your finger in (vapour of phosphorus carried by a current of carbonic acid burning in air). Antimony hydride was promised for those who wished to stay for it, but the end was a beautiful concoction in which the basis was nothing more than ordinary air and coal gas, but the flavouring was copper, lithium, and chloroform to taste. As to the theory, Mr. Smithells does not agree with Dr. Frankland. The latter is believed to be still unconvinced. It may be a comfort to those of us who are still discussing what happens in the arc to see that the gas flame is not settled yet. Afterwards in the library, or rather beyond, Siemens Bros. and Co. had sent an electric deck drill for exhibition. There was also a McEvoy's submarine detector—in it the balance between the induction of two coils is upset by the proximity of a mass of metal, and the result is detected in a telephone—and various other things. Mr. G. F. Edwards showed a quantity of structures built up of regular tetrahedrons. The possible forms appear to show some remarkable analogies to the periodic law of the chemical elements. Among other properties, valency, for instance comes out, but in a rather unsatisfactory way. There was not time to examine into it completely. "Improved" incandescent lamps, ripple photographs, and the Electric Engraving Company's work covered the tables and walls. To-night is "Palæography," next Friday Sir W. Turner on "Early Man in Scotland," and during the week (Thursday afternoon) Prof. Boyd Dawkins starts a new course of lectures on "The Relation of Geology to History."

Lord Rayleigh at Albemarle-street. — Lord Rayleigh's second lecture on electricity at the Royal Institution on Saturday dealt mainly with current induction. The fundamental law was, that with two adjacent circuits the making or stopping of a current in either one of them (called the primary) produced a current in the other (called the secondary circuit) in such a sense as would make the least change in the electromagnetic energy contained in the medium surrounding the two circuits—that is, the energy of the magnetic field. If the starting or stopping of the primary current was practically instantaneous the secondary current had at starting a very high value, which proceeded to fall off according to the law of compound interest, until speedily the induced current ceased altogether. This was because the secondary circuit necessarily had resistance, and the given quantity of energy supplied at the beginning was frittered away in heat. And so forth. Treating of the self-induction of the secondary circuit on which the value of the initial current depended, Lord Rayleigh showed the difference in the effect when the number of turns was varied by means of the magnetisation communicated to small needles as shown by the difference in their period of vibration in the earth's field. With a coil fed from the alternating current of the Metropolitan Company, it was shown that the electromagnetic induction was propagated through air and non-conductors and stopped by copper and conductors (the copper sheet translated a portion of the energy into sound-waves in the most beautiful manner), and the behaviour of a conducting ring dropped over the coil under the action of the currents induced in it was also exhibited. There was also a show of vacuum tubes. Lastly, Lord Rayleigh called attention to an experiment which, though by no means new, had been a great deal overlooked, and an explanation of which had never been fully given. The principle of it was that in the immediate neighbourhood of a flame the air seemed to lose its insulating properties, and the effect might possibly be correlated with a similar result which was produced under the influence of the Röntgen radiations. Lord Rayleigh showed with a Bunsen flame an electrophorus and a gold-leaf electroscope that there was a considerable divergence of the leaves when the Bunsen flame and the electrophorus plate were brought near. The last experiment illustrated the fact that a Daniell cell which

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normally had not sufficient E.M.F. to decompose water became able to do so, owing to the E.M.F. of self-induction, when a make-and-break was introduced into the circuit in shunt between the terminals of the decomposition cell.

Burning Gas.—By the courtesy of the author, for which he has our best acknowledgments, we have received a copy of a paper on the use of "Gaseous Fuel as a Means of Cheapening Electricity," which was read before the North-Western Electrical Association at Milwaukee by Mr. Nelson W. Perry. The subject is an interesting one, and it is quite possible that if in the beginning the gas companies had adopted a different policy towards the electric light it would have been in the end the better for them. That is, however, past, and the only possible question now is the substitution of the gas-producer for the boiler and the gas-engine for the steam-engine, and if it is done how best to do it. It was intended to give Mr. Perry's paper in full, but pressure of other material has resulted in its postponement, and it will be better to give its substance here than to hold it over indefinitely. Mr. Perry makes a great point of the much lower cost at which gas can be conveyed in pipes than current in copper conductors, and his proposition amounts practically to substituting gas-pipes for the high-tension feeders, and sub-stations for the transforming stations. The feasibility of this novel way of doing things he supports by a considerable amount of figures, some of which may possibly be referred to at a future date. What he suggests is to "locate a gas generating plant with regard to economy of land and fuel, and instal there a large gasholder, so that every dollar of investment at that point would have a maximum earning capacity." Taking advantage of the greater economy of gas over electrical transmission, Mr. Perry would transmit this gas to local centres of distribution. At these points smaller gasholders would be erected so as to enable the gas-mains to be used to their maximum capacity. Gas-engines would take the place of steam boilers and engines; less space would be required, and stand-by losses entirely avoided. If the load line were such as to warrant the introduction of storage batteries, these would supplant the local gas storage, and the land necessary would be saved, and dynamos, engines, and labour would all be employed continuously to their best advantage. "In fact, every dollar of investment from the gas generating plant to the electrical plant at the local distributing centre, including the gas-mains, would be employed to its best advantage, leaving only the electrical distributing mains to be employed under a a low-load factor." The economies in investment and in operating expenses thus accomplished would make it possible to reduce the radii of distribution, and thus to give the same service with less copper, and to reach unsupplied territory which is neither accessible nor profitable by present methods. Part of the cost of illuminating gas is due to the refinements of manufacture rendered necessary for the service it supplies, but gas sufficiently clean for fuel purposes, without high illuminating properties, but of nearly equal calorific power, could be manufactured for considerably less than illuminating gas, and it could be distributed at higher pressures. It would pay to generate such gas as had a high calorific power if it has to be transmitted far. If to be generated locally and used on the spot, a low grade, such as the Dowson gas, having a calorific power of about one quarter that of ordinary 16-c.p. gas, would be the most economical; but by reason of the greater volume required, and for other reasons, such a gas would be less economical where long transmissions are involved than the richer and lighter gas produced at somewhat higher first cost.

The Chambers of Commerce.—At the annual meeting of the Association of Chambers of Commerce last week, Sir S. Northcote, M.P., in the chair, a resolution was carried urging on the Government the reintroduction of last year's Bill for the legalisation of the metric system of weights and measures. There was some difference of opinion as to the precise form of the resolution. In the course of the discussion Mr. Kenric B. Murray (secretary of the London Chamber of Commerce) said that at the present moment it was absolutely illegal to use the metric weights and measures, and merchants in the city of London had had their weights and measures seized by the officers of the London County Council, and the County Council only stayed their hand when they were shown a copy of Mr. Ritchie's Bill. Mr. H. P. March (Sheffield), while fully agreeing with the last speaker as to the illegality of the use of metric weights and measures, said it was the custom in his district to have those weights and measures in their works, and they had never found any difficulty with the authorities, who winked at the practice. They could not possibly conduct their foreign business without the metric measures. They sent their goods away without the transposing operation, for the transformation of English weights and measures into metrical weights and measures inevitably led to mistakes. They had recourse in Sheffield to the foreign method, and he found that their workmen understood it thoroughly. The following resolution from the Sheffield Chamber, which was to have been moved by Mr. H. Marsh, was only withdrawn at the suggestion of Mr. Ritchie: "That this association, being fully convinced of the great advantages to British trade which would follow the adoption of a decimal system of currency throughout the British Empire, desire to urge upon Her Majesty's Government the importance of the subject, and calls for an exhaustive enquiry into the matter by Royal Commission or otherwise as may seem most expedient." A resolution was also carried opposing any alteration of the existing law whereby an employer would be made liable to pay compensation to an injured workman, except where the employer or any servant of his shall be guilty of neglect or default, and the injured workman has not been guilty of contributory negligence. The annual dinner of the association took place in the evening, and Lord Salisbury was present, and responded to the toast of "Her Majesty's Ministers." On the following day, on the subject of telegraph rates, a resolution was carried in favour of the telegraph rates between Great Britain and France being reduced to 1d. per word. Afterwards, a large and influential deputation of delegates waited upon the Postmaster-General for the purpose of presenting a memorial on the subject of the present telephone service in several large North of England towns and districts, and of urging the necessity for increased facilities. Leeds, Bradford, Halifax, Dewsbury, Cleckheaton, Heckmondwike, Keighley, Morley, Wakefield, and other centres were represented. Mr. T. Sutcliffe (Halifax) said the chief complaint was in regard to the inter-town service, which was less efficient under the Post Office than it had been under the National Telephone Company. Mr. Ellis (Dewsbury) said that he did not think the increased demand was responsible for the difficulties, but that difficulty did undoubtedly become greater after the Government took over the lines. Mr. Billson, M.P., remarked that in Liverpool they had not found any improvement so far as the trunk lines were concerned. The Postmaster-General (the Duke of Norfolk), quoting from a statement handed him by one of the officials of the Department, hinted that something had been done in the way of improvement since the memorial was drawn up, and hoped more would be done.

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THE MECHANICAL CONSTRUCTION OF ELECTRICAL MACHINERY.

BY F. M. WEYMOUTH.

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THE DYNAMO.

(Continued from page 328.)

Combination Bed-plates (continued).—In Figs. 100 to 102 is shown another example wherein a Z section is used at the dynamo end. This is a method apparently adopted in a further type of machine designed by Messrs. G. E. Belliss and Co. for lighting yachts and destroyers, of whose light-weight designs we have already shown one. In the last case (Fig. 89) the casting was entirely in gunmetal, whereby brackets for the magnets were avoided: but in this present case we have cast iron, and gunmetal brackets or shoes for the magnets are consequently necessary. The section in question will be observed on the line, *cd*, and is shown in Fig. 102. Where the weight of the magnets comes, however, a table is cast across the top, strengthened underneath by two ribs, *v v*, as shown in section on *e f*. In Fig. 102 the part lettered *s* will be noted as not being a rib, but merely the end of the casting, as indicated by the same letter in Fig. 101. Outer ribs are also added, as shown at *u u*. It will thus be seen that this example comes much nearer the general type, as indicated in Fig. 84, than did that shown in Fig. 88. In the latter there were no webs or ribs. The twisting effect indicated by the arrows in Fig. 84 is here obviated by the union of the two sides, and by the ribs *v v*. Though these ribs will themselves of course take metal, it may perhaps be safe to say that with their use the casting as a whole need have only half the thickness of metal that would be required were they absent. With their adoption, therefore, a much lighter casting may be produced to take the same load and strains. The end, A, is the base of a pedestal, shown broken off, which rises to take the engine on its top.

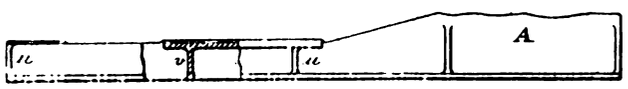

FIG. 100.—Elevation with Section on *a b*.

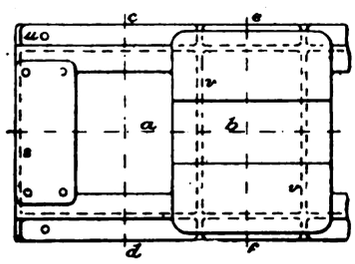

FIG. 101.—Part Plan.

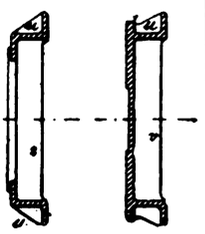

FIG. 102.—Sections.

We now come to the consideration of bed-plates the design of which is based on the use of channel sections placed with their open side downwards, as was shown (Fig. 80). This combination we intimated was the best for the attainment of a maximum "all round" strength. It is to be noted, however, that in our method of procedure we shall be taking a somewhat extreme view of the subject, and the design we now approach is probably heavier and of greater general strength than what is usual in practice. Contrariwise, however, we propose later on to touch on some that are far too weak.

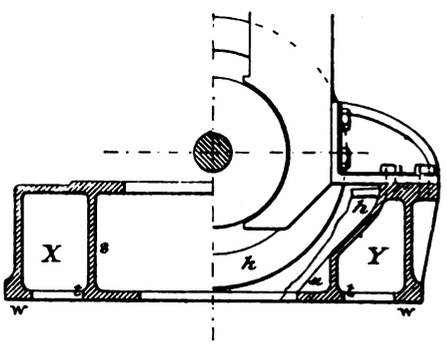

FIG. 105.—Section on *c d*.

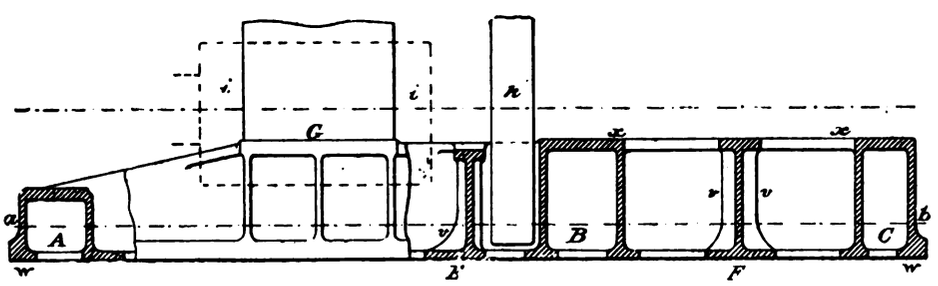

FIG. 103.—Section on *e f* and Part Elevation.

On a previous page we pointed out that when a channel section was strengthened by being webbed across at intervals

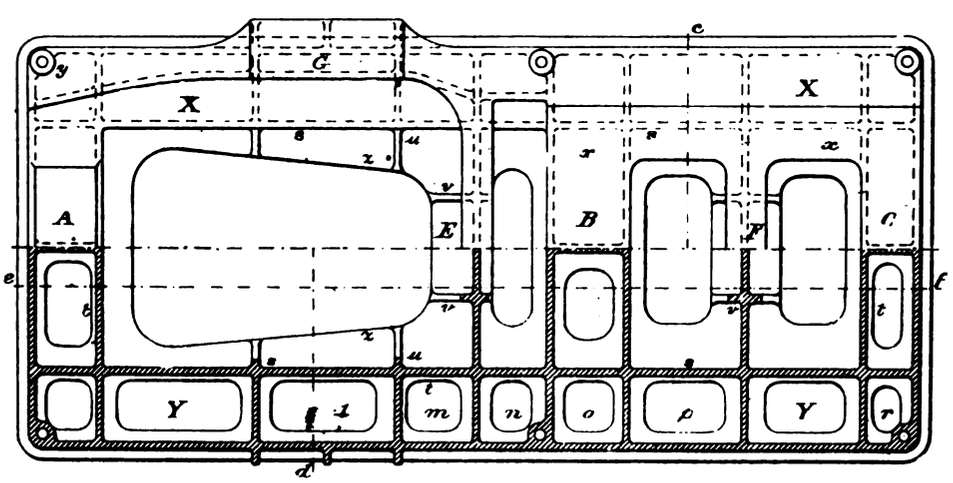

FIG. 104.—Half Plan and Half Section on *a b*.

inside, and all the edges flanged, its construction might then be described as cellular, and it formed the nearest convenient approximation to a tube. We thus find on now turning to Figs. 103 to 105 that we have here a design of

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bed-plate based on the inverted channel principle, and the channels so subdivided that they form a series of cells. It is thus a cellular bed-plate; and it may be considered as practically the strongest method of construction to suit the conditions, these being the same as heretofore, with the addition that this present design is also made very strong laterally. Beyond this last-named addition, a further difference is, that as compared with Figs. 92 and 97, the shaft centre is raised a few inches above the bed-plate top, instead of being level therewith. For with the added strength due to the interior walls (*s s*, Figs. 104 and 105) a great depth is not so necessary.

To consider now the *raison d'être* of this casting, and the "placing" of the metal therein, we may first remark on the precise strains to be met. Of these, one set of strains will be those due to the bed-plate, with dynamo and engine complete, resting on two diagonally opposite corners only, instead of being evenly supported throughout. Another positive strain will be that which might be caused by a blow sideways on a corner, say at the dynamo end; or any lateral pressure tending to crush the bed-plate between the ends, or the sides, or diagonally.

We may now look more closely at the design itself, which, it may be noted, is in outside appearance generally similar to one by Messrs. J. P. Hall and Co., Oldham. It will thus be observed to be composed of two cellular longitudinal side members, X X and Y Y, and these are joined across by three other cellular members, lettered respectively A, B, and C, and also by two other members of girder section, E and F. Of these latter, the member E coming between the flywheel, *k*, and the armature, *i i* (shown dotted), is not usual, and is added here, inasmuch as it forms an additional source of strength, which is our immediate object. The member F is not made cellular on account of its narrowness, and also to avoid a greater multiplicity of cells: for if cast cellular, the two sides continued the longitudinals X and Y would divide these into an unnecessary amount. The subdivision of the side members, it will be noted, is largely due to the continuation thereinto of the transverse members.

As regards the distribution of the load, we observe that the engine, which is assumed as of some two-crank open type, will stand on a facing generally indicated at *x x*; and its three bearings will come respectively on B, F, and C, the two wells between which will therefore form crankpits. The dynamo bearing will stand on A, which latter member is low enough to allow the armature to be withdrawn over it. But the principal weight will be that of the magnets resting with their brackets on facings, G; and a not inconsiderable load will be that on the bearing on B, due to part of the weight of the armature and shaft, and practically the whole weight of the flywheel. The member E will not carry direct weight, but contrariwise, must be dropped a little at the top so as to clear the shaft coupling, as shown in Fig. 103, and at *h*, Fig. 105, which latter shows part of this member broken away to disclose the flywheel. As before mentioned in connection with the diagrammatic Fig. 78, the member B is made of extra width, so as to permit a longer bearing here than elsewhere in order to suit the additional load due to the flywheel and armature. As we shall see, however, it is opportune generally to have this member of ample section.

We may now consider the effect of this load, together with the weight of the bed-plate itself, when the latter is supported only on two diagonally opposite corners. Now a good way to obtain a magnified view of such an effect, so that it may be observed not only in general conception, but in detail, is simply to curve the paper on which the plan (Fig. 104) is drawn, doing so on one of the diagonals, so as to make two diagonally opposite corners, say *r* and *y*, come higher than the other two corners. The first immediate effect that is thus clearly brought to view, is that the bed-plate becomes twisted. In detail we observe that each longitudinal side member, X and Y, becomes not only bent to suit the curve of the paper, but is also twisted; and the same applies to each cross member. The effect of the bending, moreover, with a possible exception to be mentioned later, is to throw the whole of the bottom of the bed-plate into tension.

As regards hence the meeting of, or resistance to, these strains, it might seem as though obviously the right thing to do would be to work into the design a rib, or ribs, diagonally between the corners, as from *r* to *y*. But this is obviously impossible under the conditions. Diagonal strips or flanges, corresponding to the lower flanges of diagonal girders cast in, might be proposed; but this assistance would be somewhat fictitious without a straight upper flange to take the compression: and in any case a flywheel, slightly larger than here shown, would project through the bottom, and thus destroy even this method of adding strength. We thus find that under the conditions we must take the individual members and "place" the metal in each one so that it may be used to the best advantage to meet the strains that are imposed. To meet the twisting strains, therefore, as has been already pointed out, each member must be made cellular: and in order to attain as much as possible to the strength of a tube, the bottom edges of all ribs, walls, and webs must be flanged as shown.

There is, however, a double reason for this bottom flanging: for under the load, the upper side of each member is in compression, and the lower edges are in tension, due to the bending action. Thus, without these flanges, there would not be a proper balance of metal between the top and the bottom. The top might be amply strong to withstand the compression, while the bare lower edges would be tearing open. Moreover, as cast iron is much weaker in tension than in compression, it is to be noted that, as a matter of fact, there should, if anything, be more metal below than above. Thus we find that for this further reason, beside that relating to torsion, the bottom flanges are desirable; and to secure a proper balance of metal they might be made both broader and thicker even than shown in the drawings (Figs. 103 to 105). It is for the reason of this bending action, moreover, that the members, instead of having a section approaching that of a square tube, which next to a circular section would be the most economical to resist torsion, require to have an extra depth given to them, so that they become rectangular, as shown B, C, and X (Figs. 103 and 105).

The members, E and F, are not so well suited to resist torsion. They serve, however, to withstand the bending action, and to this end, as may be observed, the lower flanges being in tension, are made more or less proportionately heavier in section than the top flanges. Ribs, *v v*, serve to stiffen the flanges and keep them in their proper line of strain, more especially as regards their outer edges.

The weakest part of the casting is doubtless the dynamo end. Usually the dynamo well extends from A to B, and it is to shorten this well that the girder member E is here introduced. This member might of course be objected to in respect of its promoting magnetic leakage. But this is a matter for decision. In ordinary cases the flywheel would be nearly as close to the magnets, and so offer the same objection in greater or less degree. Bearing in mind that we are still supposing the bed-plate to be resting on the corners *r* and *y*, we note that the end member A projecting as a cantilever from X, is comparatively weak by reason of its want of depth. Its effect, however, is to tend to raise the end of Y, and also to twist the latter, as may be observed on inspection. But Y carries a magnet, and A carries one end of the armature. It is thus a question whether the lifting effort of A is sufficient to sustain these two loads. If not, then we may suppose the outer end of A to spring downwards under these weights; and the end of Y being then unsupported by the member A, its bottom flanges will be in compression instead of tension, and the arm Y may simply be looked upon as a cantilever projecting from the main body of the casting.

But it must be observed that—the bed-plate as a whole being regarded as a girder resting at the points *y* and *r*—while the one half is of complex form between E and C, the other half is simply the arm X in its extent from E to *y*; and the bottom flange of this latter will be in tension. Hence, as cast iron in tension must have ample section, and also on the principle that obtains with girders—namely, that their section must increase toward the middle of their length—it will be observed that the bottom flanges are widened toward E, as shown, *z z*; and to keep these widened flanges more in one with the side members, ribs *u u* are added, projecting from

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the ends of the internal cross webs (forming the cell, *l*), as shown.

It is here, also, that we may perceive the value of the large section of the transverse member, B, and the assistance thereto of the added member, E. For these being in the middle of the bed-plate impart the strength to it that it there needs when viewed as a girder resting in the points, *y* and *r*. Owing, also, to the weight especially of the magnet on the arm Y, combined with the weakness of the end member A, severe torsion will be set up in the transverse members, E and B, jointly, which forms a still further reason for the presence of the member E and the increased width of B.

Having regard to lateral strains, such as might be set up by a blow, acting horizontally on the corner at *y*, it will be noted that of course owing to their cellular construction, and the presence of the walls, *s s*, and to the fact that double bends would have to be set up, as was dilated on in connection with Fig. 95, the side members, X and Y, are very strong to withstand any such tendency to distortion. In reference to lateral crushing strains (such as might arise if the plant were slung in a crane) it will be obvious that the transverse members have compatibly great strength as struts.

In respect of patternmaking, it will be seen that the pattern will be composed almost entirely of straight boards, the only special work being required at the dynamo ends to obtain due magnetic clearance between the cast iron and the magnets, as shown in section at Y (Fig. 105). For the sake of symmetry the foot, *w*, of the outside wall is carried the same all round. In order to facilitate the casting, and to allow as much room as feasible for removing the cores after casting, from the small cells especially, such as *m*, *n*, and *o*, the flange of the wall *s* is moved so that it is very small on the inside, as shown at *t t*. For the same reason the cross flange is moved from *m* toward *l*, the latter cell having ample space. The transverse members, A, B, and C, are subdivided by webs on the main centre line; though the girder members, E and F, have two ribs, *v v*, instead.

This bed-plate may be considered as being about 8ft. long, and the metal about $\frac{5}{8}$in. thick, excepting the bottom flanges, which may be $\frac{3}{4}$in. or $\frac{7}{8}$in. thick; and the bosses for the holding-down bolts, shown six in number, are incorporated in corners—though these latter would seem to presuppose a proper foundation. As intimated, however, this design of bed-plate is conceived with the idea of its resting on rough ground, without being bolted down, the total weight affording sufficient steadiment: and though used herewith as a subject in the discussion of strength, as an example, this design is stronger than what usually obtains in practice, this latter tending toward what is lighter and less expensive both in amount of metal and in patternmaking.

(To be continued.)

THE LOCAL DISTRIBUTION OF ELECTRIC POWER IN WORKSHOPS, ETC.

BY ERNEST KILBURN SCOTT.

PART I.

(Continued from page 268.)

The conditions of driving in textile factories where a number of machines are exactly alike, and, what is more important still, are all run together continuously, are very different to those which hold in an engineering works. In such cases it is doubtful whether it would be wise to abolish shafting altogether, except perhaps for the heavy ground-floor machinery, such as calenders, washing machines, fulling machines, etc. The shafting in the upper floors generally works under good conditions: it is light because the load is uniform, there is no dust or grit, and the bearings are always under observation by the "tuners" or machine attendants. It is probable, therefore, that economy would be best met by having, say, only two motors to each floor or room. Of course making motors part and parcel of small machines which run steadily on a constant load, such as some textile machines do, would have the effect of lowering the all-round efficiency and increasing first costs. At the same time, a mill at St. Etienne, in France, has been fitted throughout with a motor on each machine (some as small as $\frac{1}{4}$ h.p.), and the latest accounts are to the effect that the results are quite satisfactory.

Abnormal conditions such as are common in engineering works are sometimes met with. Thus, for example, the beetling-rooms of a bleach works are, whenever possible, laid off from the main buildings on account of the noise. Dye-houses and rooms where there is a quantity of steam and moisture in the air are also very hard on driving belts, and are places where the introduction of enclosed electric motors (airtight) would be beneficial. Hot drying rooms are also cases in point. When shafting is required in dye-houses and laundries, a good plan is to mount the motor on the wall and gear direct into the shaft through a two or three thread worm-gear, thus dispensing altogether with belting. Dye-winches and hydro-extractors are especially suitable for the application of electric motors direct, because of the clouds of condensed steam in the first case and of the high speed of the second.

TABLE VI.—Horse-Power Required for Woollen-Mill Machinery (Hartig).

Description.	Ordinary speed in revs. per minute.	Horse-power. Empty.	Horse-power. At work.	Efficiency of the machines.
	Revs.	H.P.	H.P.	per cent.
Washing machine, two cylinders	35	—	·223	—
Centrifugal pump for this machine	300	—	·77	—
Hydro-extractor	1,000 to 1,200	·75	1·20	39
Burring machine	350 to 500	1·47	1·77	17
Scutcher, continuous feed	300	·47	·66	29
Opening machine	350 to 450	·42	·95	55
Scribbler card, 40in. wide	110	·34	·58	40
Intermediate card, 40in. wide		·27	·43	36
Finishing card, 40in. wide		—	—	—
One spindle, spinning	2,500	—	·0027	—
One spindle, doubling	1,100	·005	·006	13
Sizing and warping machine (without ventilator)	17	—	·071	—
Loom, 7·45ft. wide	40 to 45	—	·113	—
Scouring machine, for two pieces	40	·13	·50	74
Fulling mill, one cylinder, for *nouveautés*	100	·19	2·54	93
Fulling mill, three cylinders, for cloth	45	·17	1 59	89
Fulling mill, three cylinders, for cloth	110	·71	2·74	73
Double fulling mill, for *nouveautés*	100	·30	3·40	91
Double fulling mill, for cloth	45	·16	3 26	95
Single fulling stock, two stamps (Dobbs)	blows 125	·53	1·64	78
Double fulling stock, two stamps (Spranger's)	116	·43	1·99	74
Gig (Laineur) single, without spreader	revs. 90	·19	·73	74
Gig (Laineur) double	100	·20	1·38	86
Machine for dressing the reverse side, with cylinders	100	·11	2·03	94
Machine for dressing the reverse side, with eccentrics.	100	·17	2·45	93
Wringing machine, lengthwise	650	·52	·61	14
Wringing machine, across	1,000	·25	·31	22
Brushing machine, one cylinder	250	—	—	—
Brushing machine, two cylinders	250	·37	1·03	64

TABLE VII.—Horse-Power Required to Drive the Machines of a Flax Mill (Cugnot).

Description.	Horse-power. Empty.	Horse-power. At work.	Efficiency of the machines.
	H.P.	H.P.	per cent.
Flax card	1·42	2 1	32
Drawing frame of 156 slivers, per sliver	·0794	·0934	15
Combing machine	·151	·555	75
Roving frame, 330 spindles, per 100 spindles	2·434	2·627	7·3
Spinning frame, dry, 1,480 spindles, per 100 spindles	2·515	3·21	21·6
Spinning frame, wet, 2,080 spindles, per 100 spindles	1 613	2·24	19

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The adoption of electricity for machine driving gives great facilities for ascertaining the power required for different operations, because it will not only measure the total horse-power required, the readings in which case have merely to be read off on an ammeter and voltmeter, but it will also measure to a degree of exactness unattainable by any other means the total amount of energy expended in any given time, the reading in this case being of course registered in some form of wattmeter.

Actual experience has shown that when large quantities of current are required for a short time—such, for instance, as for punching and shearing machines—it is important to have motors compound wound, and also, if possible, coupled to their work through some form of friction clutch, and the following are some particulars of tests carried out at Pencoyd Ironworks, United States of America, bearing on this point. A punching machine coupled direct to a 10-h.p. shunt-wound motor required 1½ h.p. to turn the machine when running light. At starting, the current rose to 45 amperes, which at the potential of 218 volts gave 13 h.p, whilst on punching 1⅝in. holes through 1in. plate the enormous flow of 150 amperes was registered, corresponding to over 43 h.p. The motor, thus enormously overtaxed, broke down after punching 200 holes.

A pair of cropping shears cutting hot steel 1in. square was then tested, the motor being shunt wound, of 1 h.p., and coupled to its work through a friction clutch. The potential was 228 volts, and when running light the machine took 2 amperes, which, in cutting, was increased to 9½ amperes, corresponding to an output of nearly 3 h.p. As the motor was evidently overtaxed, the field winding was compounded, with the result of reducing the amperes when cutting to 5½, equivalent to 1¾ h.p.

A scrap shears driven by a 15-h.p. motor, also coupled to its work through a friction clutch, when working at 220 volts, took 10 amperes running light. The following figures show the amperes at starting and when doing work with the two forms of field winding:

—	Current with shunt winding.	H.P., shunt winding.	Current with compound winding.	H.P., compound winding.
Running light	10	2¾	10	2¾
Starting	70	18¾	50	13½
Shearing steel rails, 3in. by 2¾ base, and 1¼in. thread	54	14	42	11¼
Shearing 2½in. round steel bars	73	19½	50	13½

To show the beneficial effect of a friction clutch, the following test was made: a shearing machine which took 38 amperes at 220 volts on shearing 8in. by ⅝in. plate without friction clutch took only 35 amperes to shear 8in. by 1in. plates with the friction clutch. Tests were also made showing that the power required is not merely proportional to the area sheared, but depends greatly on the form of the bar. Thus, a 2½ round bar having an area of nearly 5 square inches took 14¾ h.p. to shear it, whilst an 11in. by ¾in. plate, having an area of 8¼ square inches, took only 13⅓ h.p.

An important point to remember in deciding on the size of a motor, especially for work to which it is geared direct, and subjected to shocks, is to have it *amply large* for the maximum load that may come upon it. Unlike other motors, such as steam and gas engines, which, when overloaded, will run slow or stop altogether, the continuous current motor will attempt any duty that may be put upon it, and would certainly overtax itself if not prevented by a safety fuse or magnetic cut-out switch. In the case of a machine driven by belting, when the belt gets too much work to do, it tends to throw itself off the pulley, and there is an end of it, except that it will sometimes do a great deal of damage by wrapping round shafts, etc. In any case, replacing a fuse or resetting a magnetic cut-out switch, especially the latter, is a much more simple matter than starting an engine or replacing a belt on a pair of pulleys.

The size of the fuse or the springs of the cut-out switch are adjusted from 10 to 60 per cent. above the full working power of the motor, according as to whether the load is a steady one or one subjected to shocks—as, for instance, in lifting heavy weights by an electric crane or hoist. In such cases it is sometimes advisable to provide some form of slipping or friction clutch. Fig. 13 shows a form of cone friction clutch, designed by Mr. Thomas Meacock, of Birmingham, in which the end thrust common to nearly all other forms is got rid of, and it has also the added advantage that it can be adjusted to a sensitive degree to slip at any desired load with certainty. Referring to Fig. 13, A is the driving or motor shaft, and B the driven shaft, which is subjected to shocks or excessive variation of load, C is the conical clutch box, the cone surface being marked G. The leading feature of the clutch is the adoption of a series of springs (say six in a clutch of the size shown), mounted on pins, K, having lock nuts, L, for adjustment. As will be seen, the object of these springs is to put the cone surface, G, into contact. They can be conveniently adjusted, and whatever they are once set to, cannot increase. The thrust of the cone surface, G, is counteracted against the surface H, so that no end thrust is transmitted to the shafts, A or B. When it is remembered that with an ordinary clutch for, say, a 3in. shaft, this end thrust may amount to nearly 3,000lb., it will be seen that there is room for improvement. When the clutch is withdrawn by the notch lock, M, the shaft, B, is at rest, and the clutch may be lubricated through one of the tubes, N.

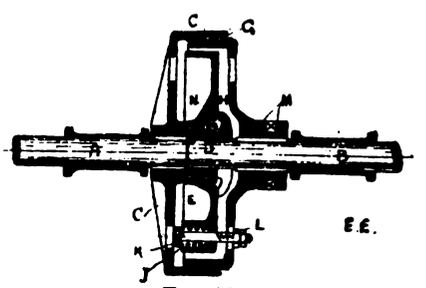

FIG. 13.

It is interesting to note that quite a number of machine-makers and general engineers have added an *electrical department* to their works, and are pushing special combinations of machines with electric motors directly attached amongst their own particular customers. This extensive application of electricity to all kinds of machinery is thus likely to become one of extreme importance, both from an economical as well as an engineering standpoint, and will undoubtedly mark an epoch in the history of engineering.

By means of electricity meters, it is possible for a large works carrying out various processes to debit each department with its annual consumption of power. In the same way also power may be rented off to tenants, as is now done in many of the West Riding cloth mills, only that with electricity meters the charges can be made on an exact basis, and not by mere guesswork, as is the case at present with mechanical transmission. In such cases as these, however, it is well to remember that the statement, that the consumption of energy ceases as soon as the machine (to which a motor is coupled) stops, needs some qualifying. It does not include the energy being consumed in overcoming the internal and frictional losses of the generating plant, as these of course go on whether the motor is running or not: in fixing the price for power therefore this should be borne in mind.

When it becomes necessary to lay down more power in a factory already supplied with electric energy, all that is required is to install another generating unit, and put up more cables. The cables may be run wherever they are most out of the way, it being generally sufficient to simply support them at intervals of 10ft. or 20ft. by wooden cleats or porcelain insulators. Sharp bends are not at all objectionable, as is the case with piping, and they can therefore be made as often as may be necessary, without thought of giving extra trouble in the future. With mechanical transmission, the question of extension either means that the shafting, etc., must be put in too large in the first instance, or else the still more costly way of replacing it with a larger diameter of shafting and bearings. Steam transmission is even more troublesome, because an extra large pipe to allow for extensions means large first cost and a disproportionate amount of condensation and leakage, until such time as the

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piping is doing its full amount of work. Seeing that almost all businesses call for extension at some time or another, the above is important.

Concentric cables, lead covered or armoured, are undoubtedly the best cables for use in a factory, the copper being tinned, so that joints can be readily made without the temptation to use (that bugbear of the electric wire man) so-called killed hydrochloric acid. The resistance of the outer conductor should be as near as possible the same as the inner, and care should be taken to see that the insulating material is uniform in thickness. It is not much use specifying pure rubber and other substances to be used in the insulation, because the cable manufacturer knows best what materials are most non-hygroscopic as well as durable, and he will simply use his own particular compounds. Probably the best test for the cables, from the layman's point of view, is to subject them to bending round a drum about 15 times the outside diameter of the cable, and then after straightening to test for insulation resistance, for many cables which will show high insulation resistance in the laboratory are very liable to break down when subjected to mechanical stresses such as are met with in actual practice.

Fortunately for users, the competition in electrical cables is high, and consequently prices are cut fine. The difference in price between the best and the cheapest is not very great in any case, and as so much depends on the cable, it is advisable to lay out money liberally on this item.

(To be continued.)

THE CHEVALET FEED-WATER HEATER AND DETARTARISER.

These feed-water heaters and purifiers are being introduced into this country by Mr. William Boby, of 16, Union-court. This gentleman kindly gave us facilities for inspecting the plant installed in the Brompton electric light station on Tuesday last. The time was fixed so that one of the heaters would be seen in the process of cleaning. Mr. Bowden, the energetic engineer of the House-to-House Company, was also there to receive us, and readily answered all questions as to the improved working of the boilers since the heaters have been introduced.

There are now four heaters in use in the station, two of which are placed in each boiler-house. Fig. 1 shows one set, which heats and purifies the feed-water from the further boiler-house. A typical general arrangement of the plant is shown in Fig. 2, while the working of the apparatus can be best seen from the section, Fig. 3. Referring to this last figure, the exhaust steam enters at B, and passes, as shown by the arrows, up through the series of six rings. The baffle, E, acts as a separator, and takes the major part of the oil from the exhaust steam. The cold water enters at the top of the heater, as can be seen in Fig. 2, and runs by gravity from each section into the one below. In the heater we saw in pieces there were some half a dozen steam inlets in the base of each section, and some three water-overflow tubes. The steam thus enters at the lower end of the heater, and passes up through the water in each section.

The purifying action of the "Chevalet" heater-detartariser depends on the fact that by boiling water for a sufficient length of time the carbonic acid dissolved in the water is driven off, and the lime which by its means had been held in the water in a state of solution is precipitated. The boiling is effected by steam which, as seen from the illustration, is brought into active contact with the whole of the water as it passes through the apparatus. The steam is, in fact, blown through the water, but in such a manner as to cause very little friction. The back pressure from this cause is found to be equal to about 10in. of head of water—say, $\frac{1}{3}$lb. per square inch. As the steam comes in contact with the water a certain proportion of it is condensed, and the temperature of the water in immediate contact with the steam is raised to boiling temperature. Cast-iron hoods or bonnets are placed over all the steam inlets and water outlet, so that an intimate contact between the steam and water is obtained. The edges of the bonnet dip into the water, and the steam blows under these edges and through the water in its upward course. This prolonged boiling action deposits the carbonate of lime over the whole of the surfaces with which the water comes in contact, but the sulphate of lime, which is usually also

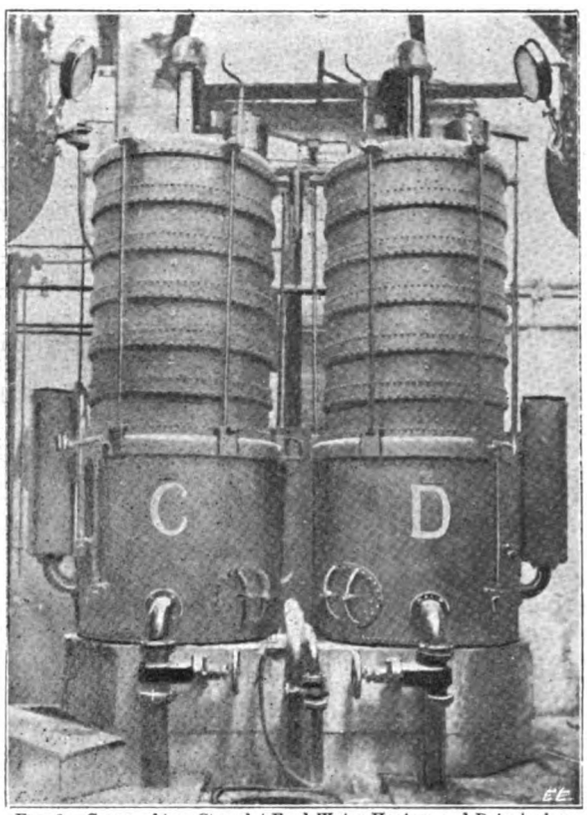

FIG. 1.—Group of two Chevalet Feed-Water Heaters and Detartarisers.

present in all calcareous water, cannot, as is well known, be precipitated by the action of boiling at 212deg. The sulphate, however, is the substance which forms hard scale, and it must be got rid of.

In the "Chevalet" heater the sulphate is eliminated by means of a solution of carbonate of soda, which is introduced at the same time as the crude feed-water at the top

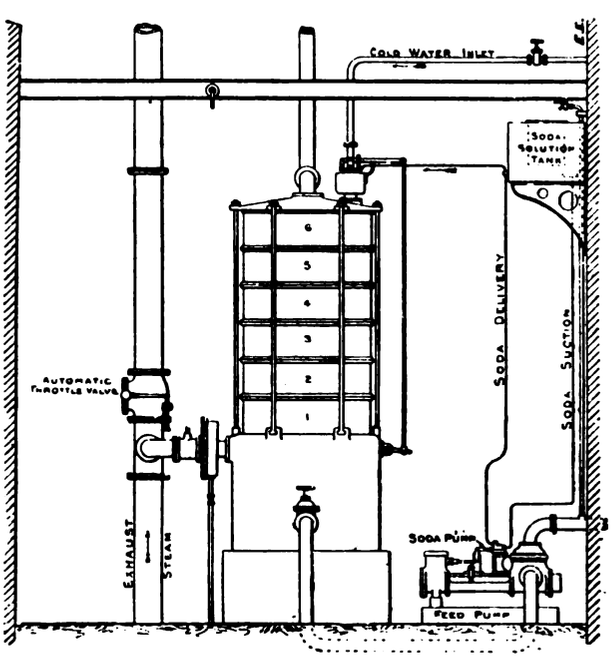

FIG. 2.—General Arrangement of Plant.

of the machine by means of a separate pipe discharging into the same funnel which receives the cold feed-water, but not mingling with this cold water till just as the two enter the machine (Fig. 2) The solution is supplied in a quantity exactly proportioned to the water drawn from the apparatus by the feed pump by means of a small pump actuated from some moving part of the feed pump itself. The solution is thus thoroughly mixed with the inflowing water, and both

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are heated together in the apparatus, with the result that the carbonate of soda combines with the lime, and the soda itself combines with the sulphate radical of the sulphate of lime; the carbonate is then precipitated, and the sulphate of soda remains permanently soluble in the water. This is the theory of the apparatus, but it is rather to the practical working of the softening process that one has to look. Many softening processes which give good results in skilled hands cannot be relied on in practice owing to the labour necessarily employed. The Chevalet apparatus at the Brompton station has now been in use for about a year, and Mr. Bowden has found a marked difference in the condition of the boilers. The heaters

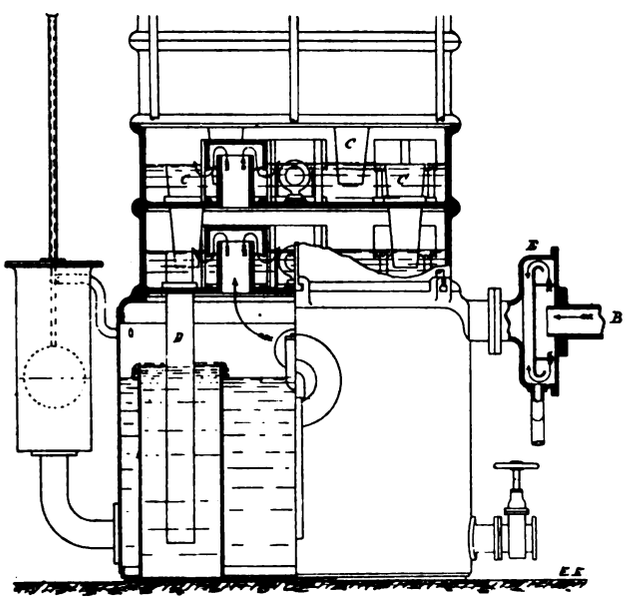

FIG. 3.—Cross-Section of the Chevalet Feed-Heater.

require to be cleaned every six or eight weeks in the winter, and the great quantity of the deposit shows how much the boiler cleaning has been saved. The character of this deposit renders the cleaning process easy. It is very soft and friable, owing, we believe, to the fact that the heat used to boil the water is not transmitted from the surfaces on which the deposits are laid. This heating up of the lime deposits in other feeder heaters tends to lower the efficiency of the apparatus, while the present method of mixing the exhaust steam with the feed-water shows no such falling off in efficiency. The Babcock boilers at West Brompton have not been cleaned all the winter, while previously they had to receive frequent

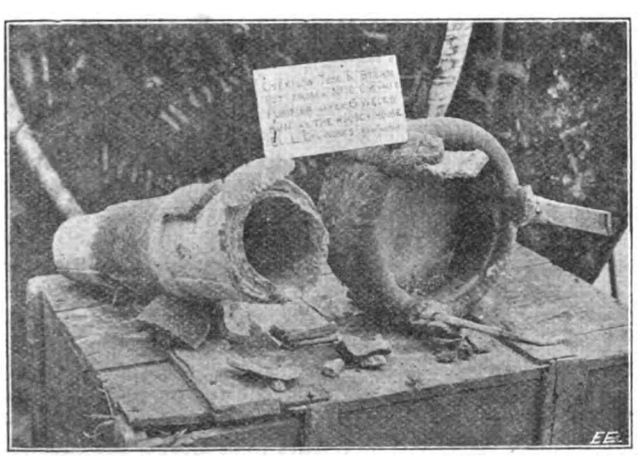

FIG 4.—Incrustations after Six Weeks' Use.

attention owing to the formation of a hard scale. The boilers have thus been kept in a more efficient state, and some of the reduced cost of fuel per unit may with justice be attributed to this. In 1895 the cost per unit for fuel was 1·66d., and this has fallen for the year 1896 to ·99d., with an increased output of only 15 per cent.

The other feature of the Chevalet apparatus yet to be referred to is the mechanical construction. The section comes easily to pieces, and hence a number of men can be put on the work. Thus the heater we saw being cleaned was taken down by men, commencing at 6 a.m., and was practically ready to go together again when we left the station about 11 a.m. In fact, any heater can always be cleaned and ready for working in the period between the heavy load of two working days. The oil has up to the present not shown itself by ill-effects in the boiler, and we could see no signs that such a fault was likely to occur. The greater proportion of this oil is separated out at E, and the deposit in the heater seems to take away what little dust gets through. As regards the quantity of steam required, about one-fifth of the total exhaust steam is used, and the supply is so regulated by a by-pass that the upper section of the heater is practically at boiling temperature. Thus the greater quantity of deposit occurs in the upper sections. The valve letting water into the top of the heater is controlled by a float in the hot-well below.

SHEFFIELD.

REPORT ON TRAMWAY TRACTION.

(Continued from page 335.)

BERLIN.—Population 1,750,000.

In Berlin the deputation had interviews with the secretary of the British Embassy; the deputy engineer to the Municipality; Herr von Siemens, of the Siemens and Halske Company; a director and the engineer of the Union Electric Company; and the director of the tramway company.

The streets along which the tramways run are generally of a good width, and there are very few steep gradients. The sharpest gradient is 1 in 24, and the quickest curves have radii of about 49ft. 2in. In exceptional cases, however, there are radii of about 41ft. The width of the carriageway of the narrowest road with tramways is about 24ft. 6in. Granite and asphalte are very extensively used in Berlin. The latter costs about 11s. 6d. per square yard, including foundation. It appears to be popular, and, the streets being flat, is a suitable paving. Where tramlines are laid in the asphalte pavement there is generally a row of setts on each side of the rails and asphalte in the middle, but sometimes the latter goes right across. The rails are of the Phœnix girder pattern. Where there was asphalte between the setts it was frequently very hollow, and the setts on the outer edges of the rails were much worn. The deputation were informed that these setts are very difficult to repair, and are constantly shaking loose under electric traction. Where the Municipality lay a new good pavement they do the work themselves and charge the cost to the company. Otherwise they leave the work to the company and their contractors. The total width of the tramway track is about 18ft. The length of the tramways is about 176 miles. The gauge is 4ft. 8½in. The tramways in Berlin are chiefly in the hands of the Great Berlin Tramway Company. Messrs. Siemens and Halske, however, have the concession for one line. This company are the owners, and not the Municipality.

The systems at present in use in Berlin are: (1) horses, (2) steam, (3) electric overhead, (4) electric conduit. The Great Berlin Company have one accumulator car for trial purposes. The concession is until the year 1911, but it is expected that an extension for a further period of eight years will be granted. The Municipality take from 4 to 10 per cent. of gross earnings, according to the amount of the latter. If the tramway company adopt accumulator cars the Municipality, in order to assist them, will not increase the percentage. The company do the repairs or repay the Municipality for doing them. The area repaired extends in the case of horse traction for 2ft. beyond the rails The horse cars are both single and double, with one and two storeys. There are also open cars for the summer season, and the seats are of the "toast-rack" pattern. The steam cars only run on the outskirts of the city. They will probably soon be replaced by electric cars.

The electric system, although at present in its infancy

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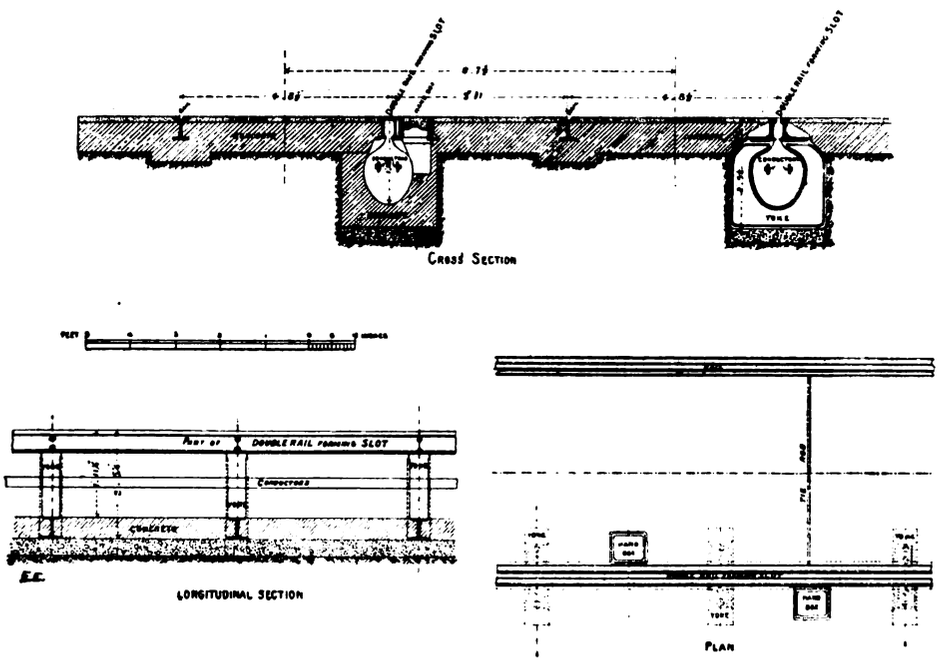
in Berlin, will in all probability very soon be rapidly developed. Horse and electric cars at present run on the same lines for some distance, but on account of the unequal speeds the horse cars will soon have to be abolished for electricity or some other mechanical traction. The electric cars have only been running since May, 1896. The lines at present constructed have been sanctioned as an experiment. The length of the overhead system is about eight miles, and that of the conduit 5¼ miles. The overhead electric lines, however, are eventually to extend to more than 150 miles. At present the municipal authorities do not consider the system of electric traction—either overhead or underground—to be fully developed, and would prefer some other form of electric traction which would cause less interference with and inconvenience in the streets, if such could be devised. Until two years ago the Municipality were altogether opposed to the introduction of electric traction, but as the opening of the new exhibition rendered it necessary to provide some better means of transit for the large number of visitors expected, overhead electricity was sanctioned. The sanction at present is for two years only, but it is considered very improbable that an extension will be refused. Although overhead traction is allowed in several streets of the city, the police authorities still object to it in the centre, and, therefore, to meet the objection the company is adopting the conduit system in those streets where the overhead apparatus is objected to. Meanwhile, it has been decided to adopt accumulators in such streets. Neither the police, the engineer's department, nor the tramway companies like the conduit system. The police object on the ground of the danger and inconvenience caused by the slot; the engineer's department on account of the serious and prolonged interference with the streets both during construction and repairs; and the company on account of the cost, both of construction and maintenance. From what the deputation could gather, the engineer's department have decided not to allow the construction of any extension of this system, and, therefore, in the centre of the city, where the police object to the overhead system, accumulators will have to be used. There are conduits on three routes, mostly constructed by Siemens and Halske, the Union Company only having laid a small portion. The former firm say their conduit line is working well, and they contemplate extensions. The system (overhead system) is of the usual type, fully described in the Hamburg report, and illustrated by one of the accompanying views, the wires being chiefly attached to poles. Between the poles there is a considerable distance, the wires between being also supported by guy wires. As a rule, there is no objection on the part of householders to give permission for rosettes. If they do at first object, they generally wish to change after the pole is fixed, and in that case the company require the householder to pay the cost of the change. Up to the present the overhead apparatus has not been used in connection with the electric lighting of the streets. The diagrams of the conduit system and photo of the line during construction, given herewith, explain the construction of the conduit better than a printed description can. In the conduit system (Siemens and Halske) one inner and one outer rail are double, with a slot between, through which the collector passes, touching the continuous conductor, carried in a conduit beneath the rail. This conduit is about 2ft. to 2ft. 6in. deep. It is drained into the sewer, and there are frequent manholes, giving access for purposes of cleaning and repairs. On the conduit lines of the Great Berlin Tramway Company both the inner rails are double. This (the combined conduit and overhead system) is simply a combination of the two systems just mentioned, the conduit being used in the centre of the city and the overhead in the remainder. The change from one to the other is made while the cars are in motion without any interruption, and is scarcely perceptible. It is stated by the company that the cost per mile of overhead line is about £2,400 as against about £6,450 for underground This is not including concrete work. The working cost per car mile cannot be given. Power is supplied to the tram company by another company, who have a concession from the Municipality on conditions somewhat similar to those in Hamburg, the price being about 1d. per unit. The voltage permitted is 500, and the current is direct. The cars are well constructed and lighted. The lighting of the electric cars is far more brilliant than that of the horse cars, which are lighted with oil. Each electric car has two motors of 25 h.p. There are 50 motor-cars, weighing about seven tons each empty and 9¾ tons full, and the cost is about £630 per car. The cars carry about 34 passengers, and are not divided into classes. The fares range from 1d. for from 1½ to 2 miles to 3½d. for about seven miles, and are collected on the ticket system, as in Sheffield. Stopping places are provided.



Berlin Tramways—Plans and Sections of Electric Conduit Lines (Siemens and Halske).

The lines are divided into sections of about 330 yards, any one of which can be cut off in case of accident or breakdown without interfering with any other section, but so far there has been no stoppage caused by a breakdown of machinery. The manholes provided at short intervals on the conduit lines enable repairs to be more easily effected than would otherwise be the case, but even with this aid the process is a very tedious one. It is stated that on the whole tramway system of Berlin during the year 1895, six fatal accidents occurred, 61 persons were badly injured, and 499 were slightly injured. What is known as electrical disturbance seems to have caused considerable discussion in Berlin, and it is possible that the Post Office will commence an action against the company for interference with the telegraphs and telephones. Two scientific institutes have also objected to the electric tramways on the ground

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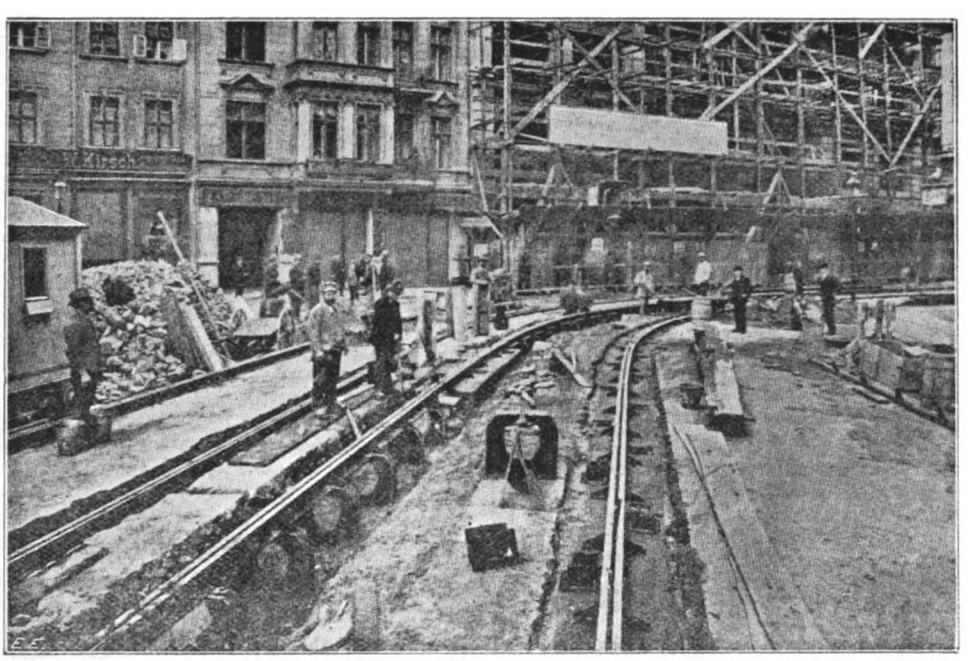
that their researches are interfered with. In laying the conduits for the underground system care has to be taken to avoid the water-mains, etc., which may have to be removed. The maximum speed is stated to be about 12½ miles per hour, and the service varies from four to ten minutes. As previously stated, the Municipality were at first opposed altogether to electric traction, and, from what the deputation could learn, do not like it now in its present form—viz., overhead and conduit—but hope for something more satisfactory in the shape of accumulators. The engineer's department would not express any opinion as to the superiority of either of the installations at present in use (Siemens and Halske or Thomson-Houston). The tramway company are quite satisfied with the result of the overhead electricity, and intend as far as permitted to convert all their lines to this system. Where overhead is not permitted, they hope to arrive at some solution of the accumulator difficulty and so do away with the conduit system, which they find very troublesome and expensive. The gravest objections of the company to the conduit system are: (1) the cost, which is stated to be three or four times as much as that of overhead; (2) the great length of time occupied in construction and in effecting necessary repairs; (3) the interference with the working and insulation through dirt and moisture getting through the slot.

The company object to the accumulator system at present, because of: (1) the dead-weight of the accumulators on each car which has to be overcome, thus necessitating more horse-power than would otherwise be necessary; (2) the smell of the acids and their liability to damage clothing, etc.; (3) liability of the accumulator to get out of repair; (4) great cost of maintenance (wear and tear); (5) waste of electricity in transferring from line to accumulators.

The company regard the overhead as the best from a commercial point of view.

The deputation had an interview with Herr von Siemens, the head of the firm of Siemens and Halske, who have very large works in Berlin, and who have supplied large electric installations to many European cities on both the overhead and underground systems. Herr von Siemens and his company preferred the overhead to the underground as the cheaper. He estimated the difference at about £4,000 to £5,000 per mile of double line. This form of traction, he said, was the more popular with promoters, but the public

Berlin—View of Overhead Electric Tramways (Siemens and Halske).



Berlin Electric Tramways—View showing Conduit (Siemens and Halske) in course of Construction.

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and the authorities generally preferred the conduit. In his opinion the conduit did not take longer in construction, and the authorities had raised no objection. He did not think there was much difference in maintenance, and there was no difficulty in cleansing after snow or otherwise, proper appliances having been devised for this work. Like the tramway company, this company have at present a concession for two years only, but expect a further concession for 25 years.

The deputation learnt from the officials of the Union Company that Berlin is their headquarters, and that, like Messrs. Siemens and Halske, they have supplied numerous installations of electric tramways, generally on the overhead system. They, too, strongly prefer the overhead system. They say the cost of the conduit system is four times that of the overhead; that it is also more costly to work, and very difficult to repair in case of breakdown, though some of these difficulties have now been got over. If there is a very quick service the conduit system might be a commercial success, but the representatives of the Union Company did not think there was any city in Germany with sufficient traffic to make it financially successful. The company say there is a tendency to use cars with a seating capacity of about 28 instead of the cars formerly used, which seated 20. These cars, however, are single-storeyed, and are preferred to the larger ones on account of the saving in time in loading and unloading. Their opinion seemed to be that, in view of the refusal of the city authorities to allow other systems in certain streets of Berlin, accumulators, which could be charged while running, would have to be used in the centre of the city, and that these could be made sufficiently powerful, but the company would not use this system on its merits. There are no accumulator cars in Berlin at present excepting the one trial car mentioned.

IMPROVED ELECTRICAL FITTINGS.

We have received samples of various improved electrical fittings from Mr. A. P. Lundberg, electrical engineer, Bradbury Electrical Works, London, N. Fig. 1 shows the "Improved

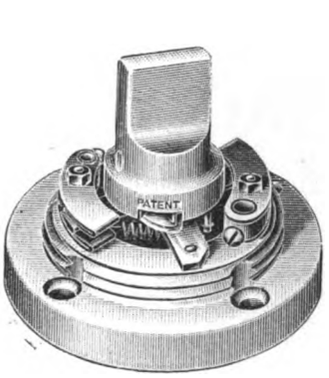

FIG. 1.

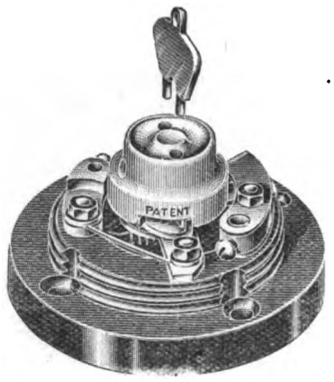

FIG. 2.

Pioneer" switch. It is essentially a quick double-break spring contact switch, and, we understand, was the earliest switch in the market dependent on a spiral spring for its quick-break action, a principle which has since become very popular on account of its simplicity and reliability, and has been largely used by the trade generally in the construction of switch mechanisms of various descriptions. This pattern has been found very suitable for high-voltage requirements on account of the long break which it possesses. The independent-break spring in the key, with which it is provided, dispenses with any objectionable "loose motion" (which generally is the cause of the rickety feeling so noticeable when actuating the ordinary types of loose-key switches) in turning the switch on or off, and is the means of preventing the key from working through more than a right-angle movement, so that the switch represents either on or off, when the thumb-piece is horizontal or vertical (depending on how the switch is fixed). The independent-break spring in the key also assists the spiral spring in breaking the circuit more rapidly. The spiral-actuating springs, being of plated steel, are practically unaffected by moisture. These switches are made in two sizes—5 and 10 amperes—and in several types other than that described above. Fig. 2 shows the switch arranged for a single-break action with terminals for a fuse, while Fig. 3 shows a two-way switch for staircases, corridors, etc. Either of these types can be supplied fitted with a removable key if required, so that the switch may be locked, as it were. In Fig. 4 is shown a combined switch and two-pin wall socket and plug fitted with a single-break

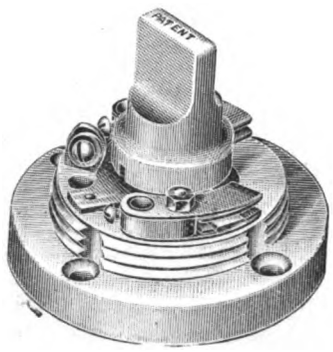

FIG. 3

action and terminals to carry a fuse. Porcelain and brass are the materials used in their construction. Fig. 5 shows the "Meteor" table socket and plug. The socket portion is of brass and porcelain, while the plug is of hardwood or ivory, and provided with steel contact pins for penetrating the table-cloth. It forms an effective fitting for table decoration, since

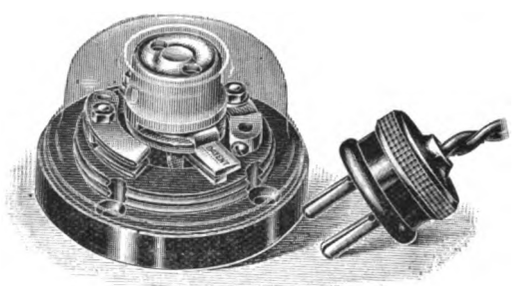

FIG. 4.

the face of socket can always be made to come flush with surface of table, and the part in view is only ⅞in. diameter. Fig. 6 shows the "Advance" floor or flush socket and plug made to suit the "Dot" two-pin plugs of hardwood or porce-

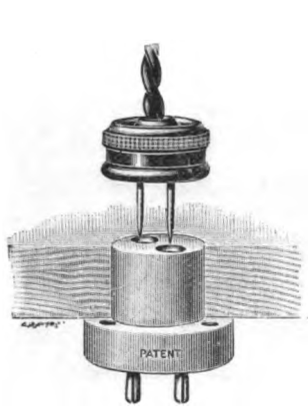

FIG. 5.

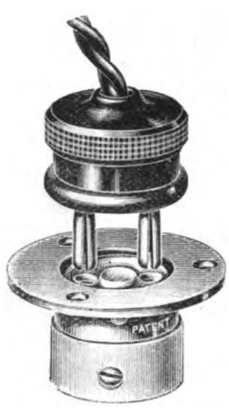

FIG. 6.

lain, the socket part being constructed of brass and porcelain. The diameter of the brass screwing-down face is $1\,^{9}/_{16}$in. The "Improved Centric" wall socket and plug is shown in Fig. 7. The chief improvement in this fitting is the keyhole slot, now

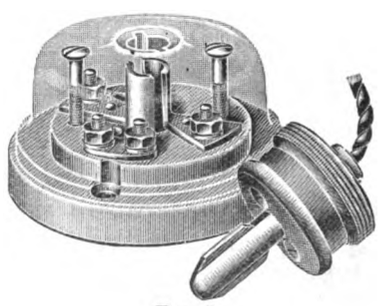

FIG. 7.

formed in the cover, enabling the separate porcelain centre-piece previously used to be dispensed with. The other fittings submitted for our inspection comprise a double-pole circular cut-out providing a long fuse in the minimum of space; a

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bayonet plug adapter in which the porcelain parts are protected by a hardwood cap of neat appearance ; a bayonet plug adapter arranged to take wall-socket plugs ; a lengthening socket plug for temporarily extending flexibles connected with portable standards ; and a twin socket plug for use where two branches are required from the same wall socket. These several fittings are strongly made, and are, moreover, exceedingly neat in design.

BEDFORD ELECTRICITY WORKS.

The accounts of the Bedford electricity supply station, under the Bedford electric lighting order, for the year ended December 31, 1896, have just been published. The total expenditure on capital account to date has been £39,019. 17s. 6d. We give herewith the revenue account, balance-sheet, and statement of electricity generated, sold, etc.

Dr. Revenue Account.	£	s.	d.
Coal, and other fuel	887	19	5
Oil, waste, water, and engine-room stores	103	10	3
Wages at generating station	562	3	10
Repairs, etc., of dynamos and other machinery	77	16	2
	1,631	9	8
Wages of linesmen, fitters, and labourers	48	0	0
Attending public lamps, £47; renewals, £51. 19s. 4d.	98	19	4
Rents payable, £45; rates and taxes, £76. 11s. 9d.	121	11	9
Salaries—engineer's department, £172. 10s.; printing and stationery, £17. 11s. 9d.; establishment charges, £10. 17s. 7d.	200	19	4
Insurances, etc.	63	7	4
	2,164	7	5
Amount carried to net revenue account	842	7	6
	£3,006	14	11

Cr.	£	s.	d.
Sale of current at 6d. per B.T.U.	2,132	12	0
Sale under contracts	5	10	0
Public lighting	800	16	8
	£2,938	18	8
Rents of meters and other apparatus	66	17	3
Sale of incandescent lamps	0	10	0
Miscellaneous receipts	0	9	0
	£3,006	14	11

Dr. General Balance-Sheet.	£	s.	d.
Capital account—amount received	39,019	17	6
Sundry creditors	285	11	4
Balance due to treasurer, £1,942. 4s. 5d. ; less cash in hand, £25	1,917	4	5
	£41,222	13	3

Cr.	£	s.	d.
Capital account—amount expended for works	38,676	1	5
Stores in hand—coal, £190. 12s. 6d. ; oils, waste, etc., £21 ; general, £30	241	12	6
Sundry debtors for current supplied	1,352	1	7
Other debtors for meter rents	38	11	3
Net revenue account—balance at debit thereof	914	6	6
	£41,222	13	3

Statement of Electricity Generated, Sold, etc.

Quantity generated in B. T. units			208,106
Quantity sold	Public lamps	72,282	158,238
	By contract	220	
	Private consumers	85,736	
Quantity used on works			11,040
Total quantity accounted for			169,278
Quantity not accounted for			38,828
Number of public lamps			201
Total maximum supply demanded (kilowatts)			200

INSTITUTION OF CIVIL ENGINEERS.

At the ordinary meeting on Tuesday, the 16th inst., Mr. John Wolfe Barry, C.B., F.R.S., the president, in the chair, the paper was read on "The Mond Gas-Producer Plant and its Application," by Mr. H. A. Humphrey, A.M.I.C.E.

The advantages of gaseous over solid fuel has led to an increasing demand for gas-producers to convert the solid fuel into the gaseous state. Gas-producers had hitherto been constructed to make gas with little regard to by-products, and none had been made to give good results with cheap slack coal, and where the use of gas for gas-engines was concerned only expensive fuel, such as anthracite or coke, had been found available. The Mond producer and recovery plant described not only employed cheap bituminous fuel, but recovered from it 90lb. of sulphate of ammonia per ton, and yielded a gas eminently suitable for use in gas-engines and applicable to all cases of furnace work. The difficulties to be overcome before bituminous slack could be utilised in producers were mentioned, and the author showed how Dr. Ludwig Mond, F.R.S., had not only succeeded in overcoming these difficulties, but had advanced the subject another stage by recovering as ammonia 70 per cent. of the original nitrogen contained in the fuel. The author was able to give the actual figures obtained at Winnington, where Mond gas had been applied to the following purposes : (1) furnace and boiler heating ; (2) the manufacture of steel ; (3) motive power. In each case great economy arose from its use. In a Babcock-Wilcox boiler the gas from one ton of fuel evaporated over seven tons of water at 100deg. C. In 1894 the author carried out the first experiments in the application of Mond gas to the generation of mechanical power. The trial of a 25-n.h.p. Otto-Crossley gas-engine gave most satisfactory results, 2,166 indicated horse-power hours being obtained per ton of fuel in the producers, the thermal efficiency of the engine being 23·8 per cent. A much larger engine was being erected to drive a dynamo with an output of 75,000 watts. In order to better realise what might be accomplished in the way of cheap power supply, the case of a 10,000-h.p. central station was considered to show the design of the gas producers and recovery plant suitable for providing the necessary gas for this power. A summary of the advantages to be derived from central power stations on the lines indicated concluded the paper.

FORTHCOMING EVENTS.

The following are some of the announcements for the forthcoming week :

To-day (Friday).—Royal Institution (Sir E. Maunde Thompson K.C.B., on Greek and Latin Palæography), 9 p.m.—Meteorological Society's Exhibition of Instruments (at the Civil Engineers', Great George-street).—And at Paris, meeting of the Civil Engineers of France.

To-morrow (Saturday).—Royal Institution, Lord Rayleigh's third lecture.—Institution of Electrical Engineers, students' visit to the Electric Welding Company's Works, Pimlico.

Monday, March 22.—Society of Arts, John-street, Adelphi (Cantor lecture on "Alloys," by Prof. W. Chandler Roberts-Austen, C.B., F.R.S.), 4.30 p.m.

Tuesday, March 23.—Institution of Civil Engineers (Discussion of paper on "The Mond Gas-Producer Plant and its Application"). Royal Institution (Prof. A. D. Waller on Animal Electricity, Lecture X.), 3 p.m.—London Chamber of Commerce, Eastcheap (Mr. D. Ferguson on the Indo-Ceylon Railway), 2.30 p.m.—And at Glasgow, Scottish Engineers' Meeting.

Wednesday, March 24.—Society of Arts ("The Transmission of Power by Alternating Electric Currents," by W. B. Esson. Mr. Alexander Siemens will preside), 8 p.m.—"James Forrest" Lecture (repetition) at the Civil Engineers', 4 p.m.—Crystal Palace Lecture.

Thursday, March 25.—Institution of Electrical Engineers (at the Civil Engineers', Discussion of Mr. Benest's paper on Cable Breakages), 8 p.m.—Institution of Electrical Engineers Students' visit to Islington central station.—Richmond Electric Lighting Company's meeting (at Moorgate-court), 2 p.m.—Chemical Society (Pasteur memorial lecture by Dr. Frankland, Burlington House), 8 p.m.—Society of Arts (Rhea Fibre, by Mr. Barraclough, at the Imperial Institute), 8 p.m.—Royal Institution (Prof. W. Boyd Dawkins on "The Relation of Geology to History : Lecture I., The Incoming of Man"), 3 p.m.

Friday, March 26.—Civil Engineers' students' meeting ("The Resignalling of the Liverpool-street Terminus of the Great Eastern Railway," by Mr. W. J. Griffiths), 8 p.m.—Electro-Harmonic Concert.—Royal Institution (Sir William Turner on "Early Man in Scotland"), 9 p.m.

Saturday, March 27.—Royal Institution (Lord Rayleigh on "Electricity and Electrical Vibrations," Lecture IV.), 3 p.m.

Contracts Open.—The Vestry of St. Pancras require tenders for the supply of bare copper strip conductors in culverts, and laying earthenware conduits. Particulars may be obtained at the Electricity Department Offices, 57, Pratt-street, N.W., on payment of £1. 1s., and tenders are to be sent to Mr. C. H. F. Barrett, vestry clerk, by 12 noon on 25th inst.—The Portsmouth Corporation invite tenders for the supply and erection of three motor-generators and switchboard arrangements and a battery of accumulators with stands. Particulars may be obtained of Mr. A. Hellard, town clerk, Town Hall, Portsmouth, to whom tenders are to be sent by 5 p.m. on April 2.—The Hull Town Council require tenders for the supply and erection of electrical plant, comprising boilers, engines, dynamos, batteries, etc., according to specification to be obtained of Mr. A. S. Barnard, borough electrical engineer, Dagger-lane, Hull. Tenders to the Electric Lighting Committee by 12 noon on April 8. Details of the above contracts appear in our advertisements on page xii.

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All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C Anonymous communications will not be noticed.*

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THE CART BEFORE THE HORSE.

As we have continually, though perhaps ineffectively, pointed out in these columns, it is not the right way to set about installing electrical works of any kind for an authority to invite tenders or schemes from contracting firms in order to choose what may be the cheapest, though not necessarily the best. With the usual perverseness of human nature, however, this course of action is adopted in probably seven cases out of ten: and the ordinary consequence is that on receipt of the tenders or schemes the committee in charge of the matter gets utterly bewildered over their "variousness," and in despair at length is obliged to confess its ignorance and ineptitude by calling in skilled advice to recommend the best or any tender.

Time and again we have seen this, and have safely prophesied the unerring results as soon as the early stages of this self-confidence are manifested: only the other week an important electric lighting installation came to our notice where several firms of equal standing had tendered on their own schemes, with the result that the amounts differed by hundreds of pounds. A consulting engineer was called in, and, being a man of strong character, at once threw the tenders metaphorically into the waste-paper basket, drew up a proper specification of what was really required, and the same firms were asked to tender on this: the new amounts did not differ more than fifty pounds in all, whilst the clients got much more useful plant at, comparatively speaking, less cost.

It is not of course every engineer who is strong enough in his own skill to take a bold line of action under such circumstances: some would doubtless be inclined to accept the lowest tender, botch it up, and pad it out, in order to get as near as possible to the best scheme from the client's point of view, rather than that of the contracting firm. But this would probably mean a greater outlay and no satisfaction to anybody. It is much better to start afresh, and let the competing firms know exactly what they have to supply and do.

These remarks do not merely apply to electric lighting; they are just as usefully pondered in connection with electric traction, and as a matter of fact, indeed, they have been evoked by the action of the Sheffield Tramways Committee in calling for tenders and schemes from nine well-known electrical firms and companies for the equipment of two short sections of line in that city.

Now, no one would say for a minute that any one of these respective firms is unable to instal a really good and satisfactory system of electric tramways, but surely something more than this is required! The Tramways Committee may perhaps decide to adopt Smith, Brown, and Co.'s tender or scheme as being the cheapest, or apparently the best so far as they are able to decide, but how do they know that Smith, Brown, and Co. will instal the type of boiler, of engine, of generator, of rail bond, of feeder arrangement, overhead work, car body or truck, each in its particular way best and most suitable for the purpose? We should be very much surprised indeed if Smith, Brown, and Co. regulated their supplies and design of apparatus, etc., by any such

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criterion; they are pretty sure to put in the plant that will pay them best, provided, of course, that it is good and worth the money asked. Moreover, how can the successful firm introduce into its tender voluntarily the specialities of a rival firm which are intrinsically and absolutely better, and ought therefore to be adopted from the Sheffield ratepayer's point of view?

These considerations are of no small weight, and they deserve all the prominence we can give them. Even as it is, however, we expect to see the Sheffield Tramways Committee follow the course now adopted, until such time as the tenders have to receive detailed examination. A betting man might find an opening for business then in laying odds on their taking refuge in the advice of a consulting engineer; the later the stage, the more it is found necessary.

We might, perhaps, add a word of advice assuming this to be the case. Inasmuch as the tenders to be sent in must represent an enormous amount of time, trouble, and expense, the committee should have no right to expect them to be drawn up afresh, or materially altered, according to the specifications which the consulting engineer would like to frame if he got the chance. Moreover, the committee need not engage for such services any one of the highly-paid engineers at the top of the tree, already overcrowded with work, and, therefore, probably unable to throw his heart into the task. They can find plenty of experienced men ready and willing to give a full measure of time and attention to the work. It is a good thing sometimes to make matters a little more even in this life.

ROYAL METEOROLOGICAL SOCIETY.

This society has for many years past held an exhibition annually which has been devoted to some special class of meteorological instruments. This year the society has arranged an exhibition of meteorological instruments in use in 1837 and 1897 in commemoration of the Diamond Jubilee of H.M. the Queen. The exhibition, which was opened on Tuesday, the 16th inst., is held in the large library of the Institution of Civil Engineers, Great George-street, Westminster, S.W. The instruments which were in use in 1837, as might be supposed, are not very numerous, but many of them are somewhat quaint and of great interest. Sir E. H. Verney, Bart., showed an old barometer with a large spirit thermometer, which latter has an arbitrary scale decreasing as the temperature increases: "extream cold" being 90deg. and "extream hot" 0deg. The instruments in use during 1897 are, however, very numerous, and comprise various forms of barometers, thermometers, hygrometers, rain-gauges, anemometers, nephoscopes, sunshine recorders, actinometers, aneroids, electrical and miscellaneous instruments. Many of the instruments are self-recording, and are shown in action. The most interesting exhibit is a railed off enclosure about 12ft. square, covered with green baize, representing a typical climatological station of the Royal Meteorological Society. The exhibition will be open to-day (Friday), the 19th inst.

In connection with the exhibition of instruments a lecture was delivered on Wednesday by Mr. G. J. Symons, F.R.S., on "Meteorological Observations in 1837 and 1897." After describing some of the instruments in use at the commencement of the Queen's reign, the lecturer stated that he had collected all the known records of rainfall for the year 1837. Mr. Birt Acres showed on the screen by means of his cinematoscope some very interesting studies of clouds, and also of waves at Dover during the storm on the 3rd inst.

THE GEOGRAPHICAL.—On Wednesday Mr. E. A. Reeves read a paper at the Royal Geographical Society on "Terrestrial Magnetism and the Position of the Magnetic Poles." Mr. Reeves's conclusions are somewhat revolutionary, and we have not space to deal with them properly this week.

ON THE DIELECTRIC CONSTANT OF LIQUID OXYGEN AND LIQUID AIR.*

BY J. A. FLEMING, M.A., D.SC., F.R.S., AND JAMES DEWAR, M.A., LL.D., F.R.S.

The exceedingly high insulating properties of liquid oxygen and liquid air indicate that these bodies are dielectrics, and possess a dielectric constant or specific inductive capacity which it is necessary to determine. We have, therefore, lately made some measurements which have enabled us to assign a number representing, in all probability, a close approximation to these constants. The remarkable non-conducting quality of these liquid gases for electricity enabled us to employ a method which, generally speaking, is not applicable to liquids other than those of a very high specific resistance or insulating power.

The method used by us in these experiments consists in the employment of a small condenser composed of metal plates which can be plunged beneath the surface of the liquid gas, and the capacity of this condenser measured when the dielectric between the plates is first gaseous air at ordinary temperature and pressure, and is next replaced by the liquid oxygen or liquid air. In order to determine the capacity of this condenser, which is necessarily small and of the order of 0·001 microfarad, we adopted the well-known device of charging the small condenser with a high potential (100 volts), and then discharging it into a much larger, well-insulated mica condenser, having a capacity of about 0·5 microfarad. This process was repeated 10 times, and the larger condenser was then discharged through a standardised ballistic galvanometer. A specially constructed and highly insulated key was employed to charge the small condenser by means of a battery of 50 small lithanode secondary cells, and then to discharge it into the larger condenser. The success of this method depends entirely on the absence of sensible leakage in the condensers, and it is essential to show that the small condenser loses no sensible portion of its charge by leakage or conduction during the interval which elapses between disconnecting it from the battery and connecting it to the large condenser, which acts as a reservoir.

In these experiments the small condenser consisted of 17 plates of carefully flattened aluminium, about 1mm. in thickness, each plate being 5cm. wide by 15cm. long. In order to separate the plates, small distance-pieces of crown glass were employed, each fragment being about 3mm. square and 1mm. thick. Four of these fragments were affixed to each metal plate with a touch of shellac at the four corners, and one fixed in the middle. The 17 plates were then piled one on the other, the glass fragments acting as separators, and the alternate plates were connected together by wires soldered to each series. A metal clamp kept all the plates in position. The condenser so formed consisted of 17 plates, eight being the positive and nine the negative surfaces. The glass distance-pieces had a total surface of very nearly 1 per cent. of the total opposed surface of the plates. The condenser so formed had a capacity of 0·001031 of a microfarad when gaseous air at 15deg. C. and normal pressure formed the dielectric.

If such a condenser having a capacity C′ is charged to a potential V, and then discharged n times in succession into a larger reservoir condenser of capacity C, it is easy to show that at the end of the n successive charges the quantity, Q, contained in the large condenser is given by the series

$$Q = C' V (m + m^2 + m^3 \ldots . m^n),$$

where

$$m = \frac{C}{C + C'}.$$

Hence we have

$$Q = C' V \frac{m}{1 - m}(1 - m^n).$$

The capacity C′ of the small aluminium condenser may be considered to be made up of two parts; a part which is changed when liquid oxygen is substituted for gaseous oxygen or air on immersing the condenser, and which thereby becomes increased. If K is the dielectric constant of liquid oxygen, referred to that of gaseous oxygen at — 182deg. C. as unity; and if c is the capacity of this variable part of the condenser when the dielectric is gaseous oxygen, then K c is its capacity when liquid oxygen is substituted for the gaseous oxygen at the same temperature.

In the next place, there is a small part of the whole capacity due to the glass separators. These, as a whole, have a surface very nearly equal to 1 per cent. of the whole surface of the metal plates, and a dielectric constant, as shown below, when cooled to — 182deg. C., of 5·0. Hence it follows that that part of the whole capacity of the condenser which is due to the glass separators, may be represented very nearly by 5c/100.

This part of the capacity remains practically constant whether the condenser is lifted out of the liquid oxygen into the cold gaseous oxygen lying above it, and which is at nearly the same temperature, or put into it, as long as the condenser is very

* Paper read before the Royal Society.

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nearly at the same temperature in the two conditions. Hence when the small condenser is under the surface of liquid oxygen its capacity C′, as a whole, is

$$K c + 0{\cdot}05\, c,$$

and the whole quantity of electricity, Q, given up to the reservoir condenser after n charges of the small one, charged to potential V, have been put into it, is

$$Q = V c (K + 0{\cdot}05) \frac{m}{1-m} (1 - m^n)$$

$$= V c (K + 0{\cdot}05) M,$$

where $m = \frac{C}{C + (K + 0{\cdot}05)c}$ and $M = \frac{m}{1-m}(1 - m^n)$.

Again, when the small condenser is lifted out of the liquid oxygen into the gaseous oxygen lying on the surface, its capacity becomes $c + 0{\cdot}05\, c = 1{\cdot}05\, c$, and the whole quantity Q′ stored up in the reservoir condenser, after n charges at a potential V, is

$$Q' = V c (1{\cdot}05) \frac{m'}{1-m'} (1 - m'^n)$$

$$= V c (1{\cdot}05) M',$$

where $m' = \frac{C}{C + 1{\cdot}05\, c}$ and $M' = \frac{m'}{1-m'}(1 - m'^n)$.

If in each case the reservoir condenser is discharged through a ballistic galvanometer, the "throw" or elongation of which is proportional to the quantity of electricity sent through it, and if θ and θ' are the throws produced by the quantities Q and Q′, we have

$$\frac{\theta}{\theta'} = \frac{Q}{Q'} = \frac{K + 0{\cdot}05}{1{\cdot}05} \frac{M}{M'}.$$

The ratio θ/θ' is given from the observations.

To solve this equation completely and determine K would be difficult, since the quantity M is a somewhat complicated function of K.

We know, however, that the ratio of M/M′ cannot be very far from unity. A rough experiment had shown that K was a number in the neighbourhood of 1·5, and a calculation shows that when 10 discharges of the small condenser are made in each case into the large condenser, and if the large condenser has a capacity of 0·5 microfarad and the small one a capacity of nearly 0·001 microfarad, that the ratio M/M′ = 1,030/1,019 nearly. Hence, M/M′ comes in as a correcting factor of about 1 per cent. in value.

Before relying on the above method, it was necessary to prove that the loss of charge of the small condenser was negligible during the time elapsing between the end of the charge and the end of the discharge of the small condenser. We found on trial that although the small condenser had a capacity of only 0·001031 microfarad, it held its charge when charged with 100 volts, and placed beneath the surface of liquid air in the most extraordinary way. The test for insulation was as follows: The small condenser was charged with 100 volts, and discharged through the galvanometer instantly. The galvanometer throw was 95 scale divisions. The small condenser was then charged and allowed to stand 10 minutes insulated. It was then discharged through the galvanometer, and the throw was 90 scale divisions. In like manner it was charged and insulated for 47 minutes, and the throw was then 80 scale divisions. The above figures show that the charge of the small insulated condenser decreased only by about 15 per cent. in three-quarters of an hour when placed beneath liquid air, and hence the loss of charge in one-tenth of a second was quite inappreciable.* The same remarkable insulation is found when the small condenser is held in the cold gaseous oxygen lying above the liquid oxygen. The low temperature of – 182deg. C. prevents any sensible leakage across the glass distance-pieces, and also increases the specific resistance of the glass itself.

As a further instance of the very high insulating power of liquid air, we may mention that we charged the small condenser when immersed in liquid air with a Wimshurst electrical machine, and, after insulating the condenser and waiting a few moments, closed the terminals of the condenser by a wire. A small spark was seen at the contacts. We thus constructed a little Leyden jar, the dielectric of which was liquid air, and the coatings the aluminium plates. This liquid Leyden jar held its charge perfectly. Having satisfied ourselves in this manner that the condenser when immersed in liquid air would lose no sensible portion of its charge during the fraction (about one-tenth) of a second in which the charge and discharge key was moving between its contacts, we proceeded to experiment in the following manner. The condenser was placed in a very large vacuum vessel, holding about two litres of liquid oxygen, and it was charged as described, and discharged into a very good mica condenser, made by Dr. Muirhead, which had an exceedingly high insulation. The process of charging and discharging 10 times occupied perhaps two seconds. The resultant charge having been measured on the ballistic galvanometer, the condenser was lifted out into the cold gaseous oxygen lying on the surface of the liquid oxygen, and before the condenser had time to alter its form by rising in temperature the same process was repeated with the dielectric changed to gaseous oxygen at - 182deg. C.

The following Table I. shows the observed ballistic throws, all reduced to their equivalents at one common charging pressure of 100 volts:

TABLE I.—Observations to Determine the Dielectric Constant of Liquid Oxygen.

—	Potential to which the condenser was charged in volts.	Ballistic throw in cms., corresponding to 10 charges of the small condenser.	Ballistic throw reduced to correspond to 10 charges of the smallcondenser at 100 volts.
Exp. I.—Condenser at ordinary temperature, 15deg. C.	103·3	7·7	7·45
	103·2	7·75	7·51
	103·2	7·75	7·51
Exp. II.—Condenser in liquid oxygen at – 182deg. C.	103·15	11·3	10 96
	103·1	11·25	10·91
	103·1	11·27	10·93
	103·0	11·27	10·94
Exp. III.—Condenser in cold oxygen gas above the liquid oxygen at – 182deg. C.	101·3	7·65	7·55
	101·2	7 6	7·51
	101·2	7·6	7·51
	101·2	7·58	7·49
	101·2	7·56	7·51
Exp. IV.—Condenser in liquid oxygen.	101·3	10·9	10·77 } bad.
	101·2	10·85	10·72 }
Exp. V. — Condenser in cold oxygen gas above the liquid oxygen.	101·3	7·60	7·50
	101·3	7·60	7·50
	101·3	7·58	7·48
	101·3	7·57	7·47
Exp. VI.—Condenser in liquid oxygen.	101·4	11·1	10·95
	101·3	11·0	10·86
	101·3	10·95	10·81
	101·3	11·0	10·86

Mean ballistic throw in gaseous oxygen = 7·502 = θ'. Mean ballistic throw in liquid oxygen = 10·903 = θ.

It will be seen that the mean galvanometer throw, when the condenser was immersed in liquid oxygen, was 10·903cm., and the mean throw, when raised into the gaseous oxygen, was 7·146cm.

One matter which we felt it important to examine was whether there was any correction needed for the change in the dielectric constant of the glass separators with temperature. Since these glass separators had a total surface of nearly 1 per cent. of the area of the metal plates, the condenser may be regarded as consisting of two condensers joined in parallel, one consisting of a glass dielectric condenser having an effective surface of 1, and the other a condenser having a liquid or gaseous oxygen dielectric having an effective area of 99. In the course of these experiments we have therefore examined the effect of low temperature upon the dielectric constants of glass, paraffined paper, and mica. We find that on cooling these bodies to – 182deg. C. they experienced a marked reduction in dielectric constant. The dielectric constant of a certain specimen of crown glass was reduced by 21·4 per cent. by cooling to the temperature of liquid air or to –185deg. C. The dielectric constant of paraffined paper was reduced by 28·4 per cent. under the same circumstances.* We are engaged in a systematic examination of the influence of very low temperatures on the dielectric constants and specific resistances of the principal dielectric bodies. The crown glass used as separators in the construction of our small condenser had a specific inductive capacity of about 6·0 at ordinary temperature, and this at the low temperature would be reduced to nearly 5·0. Hence in estimating the capacity of the condenser, as constructed, there comes in, as we have seen, a correction from the presence of the glass. We selected glass in the first instance rather than ebonite or sulphur, as we thought it probable we should use the same condenser in determining other dielectric constants, and we wished to construct the separators of a material which was very rigid and not easily acted upon by oils or other liquids.

Taking the formula above given we can deduce from the observed results the required constant, for we have

$$\frac{\theta}{\theta'} = \frac{K + 0{\cdot}05}{1{\cdot}05} \frac{1{,}030}{1{,}019},$$

* These figures do not of course measure the electrical resistance of the liquid oxygen alone. They show, however, that the immersion of the condenser in liquid oxygen enormously decreased, or entirely destroyed any surface leakage over the small glass separators, and, as we have found by an independent examination, increased the resistivity of the glass itself. The specific resistance of liquid oxygen itself is exceedingly high.

* By another method we have found that for the glass of a glass test-tube the dielectric constant was decreased 22·2 per cent. by cooling to the temperature of liquid air. Under the same circumstances, a certain specimen of mica decreased only 3·01 per cent. in dielectric constant.

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and hence substituting for $\frac{\theta}{\theta'}$ the observed ratio $\frac{10{\cdot}903}{7{\cdot}502}$, we find

$$K = 1{\cdot}491$$

as the dielectric constant of liquid oxygen referred to that of the overlying gaseous oxygen at – 182deg. C. as unity. Since the aluminium condenser is at the same temperature when the two measurements are made, no correction is necessary for any change of form of the condenser.

To determine the dielectric constant of liquid oxygen in terms of that of a vacuum taken as unity, we require to know the dielectric constant of the gaseous oxygen lying on the surface of the liquid oxygen referred to the same unit. Boltzmann and Klemencic have both shown that the true dielectric constant of air at a temperature of 0deg. C. and 760mm. is 1·00059. That of oxygen gas at the same temperature and pressure is not very different. If the value of K – 1 for gases varies directly as the pressure, and if temperature, *per se*, make no difference, then the dielectric constant of the gaseous oxygen lying on the surface of the liquid oxygen, and which has a temperature of – 182deg. C. nearly and a density of about three times that of the gas at 15deg. C., is not far from 1·002. Hence the correcting factor to be applied to the above value of the dielectric constant of the liquid is at the most 1·002, and the true dielectric constant of liquid oxygen at – 182deg. C. and under a pressure of 760mm. is not far from 1·493. We intend to examine this correction more closely. As a matter of fact, we were not able to detect any difference between the capacity of the small condenser when held in air at ordinary temperature (15deg. C.) and pressure, and in the cold gaseous oxygen at – 182deg. C. lying on the surface of the liquid oxygen. Until we are able to make a better determination we may take the above number—1·491—therefore as representing in all probability a close approximation to the dielectric constant of liquid oxygen.

The interesting question then arises how far does liquid oxygen obey Maxwell's law, by which the product of the dielectric constant and the magnetic permeability should be equal to the square of the refractive index for waves of infinite wave-length? The materials are at hand for making this comparison, as we have ourselves just determined the magnetic permeability of liquid oxygen, and find it to be 1·00287, and the refractive index of liquid oxygen has been determined by Profs. Liveing and Dewar for several different wave-lengths. Profs. Liveing and Dewar determined the refractive indices (μ) corresponding to certain wave-lengths (λ) for the following wave-lengths:

From lines in the spectrum of	λ		μ
Cadmium	4,416	corresponds to	1·2249
	6,438	,,	1·2211
Thallium	5,350	,,	1·2219
Lithium	6,705	,,	1·2210
Sodium	5,892	,,	1·2114

They state that they consider the best results are given by the first two observations. Taking these wave-lengths, 4,416 and 6,438, and the refractive indices corresponding to them, we have calculated from them by the formula

$$\mu_\infty = \frac{\mu\lambda^2 - \mu_1\lambda_1^2}{\lambda^2 - \lambda_1^2},$$

the refractive index for infinite wave-length (μ_∞) and found it to be as follows:

$$\mu_\infty = 1{\cdot}2181.$$

The square of this number is 1·4837, and this, therefore, is the value of the square of the refractive index for waves of infinite wave-length in liquid oxygen. Taking the product of the dielectric constant, K = 1·491, as above determined, and that of the magnetic permeability, p = 1·00287, as previously obtained by us, we find that this product K p is 1·495, and hence that there is therefore a very fairly close agreement between the number representing the square of the refractive index for waves of infinite wave-length and the above product. The difference amounts to about two-thirds of 1 per cent. Hence liquid oxygen is a substance which very closely obeys Maxwell's law.

We have applied the same apparatus to the determination of the dielectric constant of liquid air obtained in exactly the same manner, and Table II. below gives the results of the observations taken in liquid air. The observed results, when corrected as above described, give for the dielectric constant of liquid air the number 1·495, which is slightly more than that of the liquid oxygen. As, however, by the time the experiment was complete the liquid air had practically become liquid oxygen owing to the nearly complete evaporation of the nitrogen, the coincidence of the two results is only what was to be expected.

The Table II. below gives the observational results in the case of the liquid air—really, however, of liquid oxygen.

With regard to the above-determined dielectric constants for liquid oxygen and liquid air, it may be remarked that these numbers are smaller than those which have been obtained for

TABLE II.—Dielectric Constant of Liquid Air (practically Liquid Oxygen).

In liquid air. Ballistic throw for condenser charged to 100 volts.	In cold gaseous air. Ballistic throw for condenser charged to 100 volts.
9·5	—
9 6	—
9·5	—
—	6·5
—	6·6
—	6 6
9 4	—
9 5	—
9·55	—
—	6·51
—	6·51
9·7	—
9·55	—
Mean = 9 54	Mean = 6 54

Dielectric constant = 1·495.

almost any other solid or liquid substance of which we have been able to find the measured results. It has been already pointed out that large dielectric constant generally accompanies small specific resistance in a dielectric, and *vice versâ*. Hence, as the specific resistance of the liquid oxygen is very large, it being a very fine insulator, it is not surprising to find the dielectric constant very small. As above mentioned, at a very low temperature the dielectric constant of some other solid dielectrics has been found by us to be very much reduced, and hence an interesting field of research is opened out for the examination of the change produced by low temperatures on the dielectric constants of other well-known solid insulators, such as paraffin, ebonite, guttapercha, mica, sulphur, spermaceti, and various frozen liquid insulators, such as the numerous hydrocarbon oils, carbon disulphide, ice, etc. We hope to be in a position shortly to furnish further information on this point, and also, if possible, to say whether the fall in dielectric constant is accompanied by a reduction in the refractive index; that is to say, whether Maxwell's law is obeyed at low temperatures.

We may add that we have already devised a method by which it will be possible to construct a condenser without the above-described distance-pieces, and hence to free the resulting measurement from the small uncertainty—amounting, perhaps, to about 1 per cent.—which may affect the above-given numerical results, and which comes in in consequence of the doubt existing as to the exact area of the separators, and also the exact dielectric constant of the glass at the low temperature.

It is interesting to observe that the numbers which we have found above for the dielectric constant of liquid oxygen and liquid air are not very different in order, though somewhat smaller than the dielectric constant as already determined for some other liquid gases,* such as nitrous oxide and carbon dioxide. In conclusion, we may add that we have been again much indebted to Mr. J. E. Petavel for his kind assistance in making the above-described observations and measurements.

Note added December 15.—In connection with the above investigation it is interesting to note one remarkable difference between the magnetic susceptibility of oxygen in the liquid and in the gaseous state. The mass of 1cc. of gaseous oxygen, taken at 15deg. C. and 760mm., is 0·00134 gramme. The mass of 1c.c. of liquid oxygen, taken at – 182deg. C. and 760mm., as determined by one of us (J. Dewar), is 1·1375 grammes. Hence the ratio of the density of liquid oxygen to that of gaseous oxygen is 849 to 1. The magnetic susceptibility of gaseous oxygen at 15deg. C. and 760mm., as obtained from the figures given by Faraday and E. Becquerel, is $0{\cdot}143 \times 10^{-6}$ per unit of volume, whilst the magnetic susceptibility in the liquid state is, as we have shown,† 228×10^{-6}. Hence the ratio of the magnetic susceptibility of liquid oxygen to that of gaseous oxygen for equal volumes is 1,594 to 1. In other words, the magnetic susceptibility of liquid oxygen is nearly twice as great as that of gaseous oxygen for equal masses. The inference is that magnetic susceptibility is not merely a property of the molecule *per se*, but is a function of the state of aggregation.

Note added December 18.—In addition to the arrangements above described for determining the capacity of the small condenser, we have also employed the well-known method of charging and discharging the small condenser through a galvanometer by means of a contact-maker driven at a speed of 60 contacts per second by an electrically-controlled tuning-fork. By this means a steady deflection of the galvanometer is obtained due to the passage of the rapidly recurring discharges through it. Preliminary observations with this apparatus have confirmed the above given value for the dielectric constant of liquid oxygen, and by a modification of it we hope shortly to make a very careful redetermination of the constant.

* See F. Linde, *Journal de Physique*, vol. 5, September, 1896, p. 413, "On the Dielectric Constant of Liquid Gases."

† See Fleming and Dewar, Roy. Soc. *Proc.*, vol. 60, p. 283, December, 1896.

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METHODS OF CHARGING FOR ELECTRICITY SUPPLY.*

BY R. P. WILSON, MEMBER.

(Concluded from page 342.)

The clock before you is constructed to go for 42 days, is English made throughout, and is guaranteed by the makers not to gain or lose more than one minute a week for 15 years ; it may, therefore, be safely assumed that the clock is not a difficulty, but there is no doubt that, however perfect the clock may be, some of them will stop, and it must be borne in mind that difficulties would arise in the adjustment of accounts if they did. To minimise these difficulties an automatic cut-out is provided, which causes the meter to register the full rate whenever the clock stops, and at the same time throws over the indicator to " sixpence " ; thus the consumer has the opportunity of seeing not only that the clock has stopped, but that he is being charged 6d., so that in all probability he would consider this sufficient inducement to communicate with the undertakers. Another difficulty, which is no more likely to happen than the stopping of the clock, is that a consumer might conceive the idea of trying to obtain an unfair reduction by overstating the time that

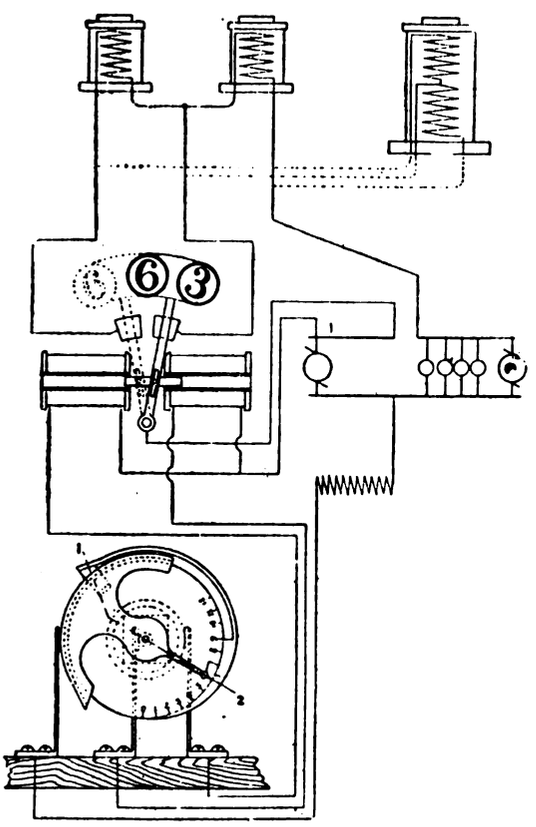

FIG. 4.

the clock had stopped. To obviate any misunderstanding in this way, a set of dials is geared to the switch, showing how many days and hours the clock has gone ; these dials are provided with a clutch, so that they may be set to zero when the meter reading is taken. In Mr. Kapp's original arrangement, the alteration in the registration of the meter was effected by introducing a shunt across the terminals of the meter ; but with very small resistances a shunt does not appear to be satisfactory, as a very small difference in the resistance of the switch contact would interfere with the accuracy of the meter readings during probably 22 out of the 24 hours. It is not quite so simple, but far preferable to alter the ampere-turns by putting the series winding of two meters in series during the 6d. rate, and cutting one out during the 3d. rate, or by arranging the winding on one meter so as to produce the desired result. The diagram shows the connection arranged for a shunt meter, and it will be seen that during the period of light load two compounding coils are provided, so that the starting point of the meter may not be impaired by reducing the current in the armature. In the case of ampere-hour meters (Fig. 4) without any shunt circuit, the indicator, in addition to showing the rate being charged, alters the meter connections and breaks its own exciting circuit at the end of its travel, so that no current is broken on the clock switch.

The other instrument, illustrated in Fig. 5, before you will, however, probably appeal to a larger number of you. It consists of a maximum demand indicator, whose novelty and principal merit lies in its being an integral part of an ordinary meter, so that instead of having two separate instruments to buy and keep in stock you have only one, and of course only one to fix. This instrument serves the purpose also of an indicating meter, and is provided with a pointer, from whose position the rate at which the meter is registering may be ascertained. In addition to saving the loss in E.M.F., inseparable from Wright's indicator, a considerable saving is effected by only having one instrument to calibrate ; there is also only one instrument to get out of order. The principle may, with more or less ease, be applied to any motor meter, and is really a torque indicator applied preferably to the existing retarding mechanism. In the case of the Thomson meter the magnets which provide the brake are suspended, and their motion is opposed by a flat spiral spring. The torque between the disc and the magnets is proportional to the energy passing through the meter, so that the ultimate position of the frame supporting the magnets constitutes a measure of the rate at which the meter is registering. A loose pointer, mounted co-axially with the magnet frame, serves to show the maximum speed the meter has attained, and consequently the maximum demand. The sluggishness of the Wright indicator has been extolled as a virtue, but it is questionable whether it is so altogether. In the combined meter and indicator some care has been taken to avoid sluggishness, except to a very limited extent, although it can be made to work as slowly as may be desired. The net result of the publicity already given to the subject dealt with in this paper, appears to be that the only two systems that have attained any popularity are the maximum demand and the time-switch. Mr. Hordern, in his reply to the recent controversy in *Lightning*, appears to have some fear that the difficulties in solving this question are insuperable ; but the author is sanguine that in the majority of cases it will be solved to the satisfaction of all parties concerned, and that at an early date.

In conclusion, the author trusts that the advertising strain in this paper will not militate against any utility that it may possibly possess ; but he has the satisfaction of knowing that no less a celebrity than Mr. Ferranti expressed an opinion, at an early meeting of this society, to the effect

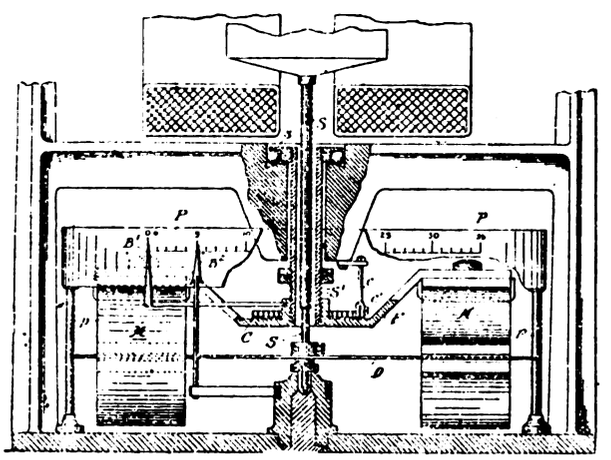

FIG. 5.

that advertisements of this nature were not necessarily objectionable.

* Paper read before the Northern Society of Electrical Engineers, March 8, 1897.

INSTITUTION OF ELECTRICAL ENGINEERS, Mar. 11.

Sir HENRY MANCE (president) in the chair.

We gave the ballot list last week. After formal business,

The **Chairman** said he had the pleasure to announce that the Council had recommended that the honorary membership of the Institution should be conferred on Dr. von Stephan, the Postmaster-General of the German Empire. That was a resolution which required only the formal approval of the meeting, but he would ask Mr. Preece, who knew Dr. von Stephan, to say a few words.

Mr. W. H. Preece remarked that there was little to be said except that in conferring the honorary membership on Dr. von Stephan the Council had beyond all doubt done the right thing. To have Dr. von Stephan as a member would be a great honour to the Institution. Dr. von Stephan was a man who had done much for electricity. He had been the German Postmaster for several years. He would very likely be in England in 1901, and had it not been for an accident causing an injury to his foot, which had resulted in the amputation of a toe, he would have been here now, because next month there was a great gathering at Washington, and, like other Continental celebrities, he would have been passing through on his way there. He (Mr. Preece) would suggest that in forwarding to Dr. von Stephan the intimation of his election an expression of regret at his accident should be included.

The **Chairman**: I am sure Mr. Preece's proposition will commend itself to the meeting.

The following paper was then read.

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ON SOME REPAIRS TO THE SOUTH AMERICAN COMPANY'S CABLE OFF CAPE VERDE IN 1893 AND 1895.

BY H. BENEST, A.M.I.C.E., ASSOCIATE.

In relating the experiences of these two cable repairs, the writer believes that some novel features present themselves—firstly, in the presumable existence of submarine streams, or outlets of springs, or other abnormal conditions, in a certain locality of the North Atlantic Ocean; and, secondly, in the effects of such physical conditions upon telegraph cables. That some such conditions exist appears to be pretty certain by the evidence supplied at the points of rupture.

A brief *résumé* of the establishment of the submarine telegraph between the coasts of Africa and Brazil is here necessary before recounting the work of repairs. The South American cable was made at Silvertown, and laid in 1892 by the India Rubber, Gutta Percha, and Telegraph Works Company, Limited, their s.s. "Silvertown" carrying and laying the whole cable. The terminal points are at Saint Louis, in Senegal, on the West Coast of Africa, and at Pernambuco, on the coast of Brazil. A station is established on the island of Fernando Noronha, some 250 miles from Pernambuco, thus forming two sections. The section between Pernambuco and Noronha has a conductor of 225lb. of copper and a dielectric of 225lb. of indiarubber per nautical mile. A substantial jute bedding surrounds the core, and a sheath of 16 galvanised steel wires of 0·092in. diameter is superposed, the breaking stress of the wire employed being 84 tons to the square inch. Each wire is coated with a tarry compound, and has a tarred cotton tape helically laid around it. The whole cable is served round with a helically laid cotton tape, and then with 20 hemp cords applied with a lay reverse to that of the tape. The finished diameter is slightly over 1in. This type is called light deep-sea, and its weight per knot wet in air is 43½cwt., and in sea-water 23cwt. The specific gravity is 2·107. The heavy deep-sea is sheathed with 12 galvanised iron wires 0·160in. diameter, of breaking stress of 30 tons per square inch; each wire is coated with a tarry compound, the sheathed cable being served with two spiral tapes of reverse lays, with a tarry compound between them and a bituminous one outside. Its weight per knot wet in air is 60cwt., in sea-water 43cwt.; specific gravity, 3·75; finished diameter, 0·975in. The light intermediate type is sheathed with 12 No. 6 gauge 0·192in. diameter galvanised iron wires; each wire is coated as in the deep-sea type, and the external covering consists of two tapes and compound. The finished diameter is 1·14in.; its weight per knot wet in air is 86cwt., in sea-water 62cwt.; specific gravity, 3·65. The heavy intermediate type is sheathed with 12 galvanised iron wires 0·252in. diameter, No. 3 gauge; each wire is coated as in the other types, the sheathed cable being served with two coverings of jute yarn and alternate coats of compound. Its weight per knot wet in air is 155cwt., in sea-water 107cwt.; specific gravity, 3 2; finished diameter, 1·6in. The shore-end type is sheathed first with 12 galvanised iron wires, coated as before, each 0·160 diameter, then served with a covering of tanned jute yarn. The second and outer sheathing consists of 14 wires, galvanised and compounded, 0·300in. diameter, two coverings of jute yarn and compound forming the outer protection. Its weight wet in air per knot is 288cwt., in sea-water 213cwt.; specific gravity, 4·14; finished diameter, 2·01in. This description also applies to the long section between Fernando Noronha and Senegal, except that the dielectric is of guttapercha instead of indiarubber. For telegraphic working, the two sections are joined up at the island, messages being sent direct between St. Louis and Pernambuco. The speed of transmission of messages compares very favourably with other transatlantic lines. In the light deep-sea type of cable, which forms the major portion, pliability and bouyancy are combined. It is easy to coil, runs freely, has no tendency to kink, requires small retarding force in paying out, and in picking it up proves remarkably light to raise. The length of the section between Pernambuco and Fernando Noronha is 357 nautical miles, and the distance over ground along line of cable 316·5 nautical miles. The distance in a direct course is 289 miles, and between the island and Cape San Roque, the nearest point on the Brazilian coast, 193 miles. The greatest depth encountered during the laying was 2,480 fathoms. The island of Noronha lies N.E. and S.W. The extreme length, including outlying rocks and islets at the N.E. extremity, is about seven miles; its greatest breadth is 1½ miles. Cape Placillière, to the S.W., is in latitude 3° 5′ S., longitude 32° 28′ W. This portion is very bold and exceedingly picturesque, consisting of bush-covered cliffs and rocky headlands, alternating with green hollows and sandy coves fringed with palms. The length of the section between Fernando Noronha and St. Louis, Senegal, was originally 1,702·148 nautical miles, the distance over ground along line of cable being 1,548·218 miles. The total slack was originally 9·9 per cent., the greatest average depth being 2,750 fathoms. The coast of Africa in the latitude of Senegal does not lend itself to flowery description; a bare, sandy, hazy coast line, with a heavy surf continually breaking thereon, conveying to the mind an idea of desolate discomfort. Add to this a fierce heat during the day from an unclouded sun, tempered certainly by a cool N.E. wind during the fine season, or winter—from November to April—the other portion of the year being calm and rainy, with frequent tornadoes, and all is said that can be for this uninviting portion of the world. The paying out of the long section was accomplished under most favourable conditions of weather. During eight days the depth passed over was from 2,300 to 2,800 fathoms. In nine days a length of 1,657 knots, including the shore end at Fernando, was laid, this being equal to 184 knots each day of 24 hours, or at the rate of 7·6 knots per hour.

These particulars are here set forth in order to show that the cable was well and truly laid. The agency by which it was broken, three months from the date of its completion in September, 1892, must therefore have been remarkable, especially at such a presumably safe depth as it occurred—between 1,200 and 1,300 fathoms. News was received from St Louis, in Senegal, on December 26, 1892, that the St. Louis-Fernando Noronha section had broken down on that day, rough electrical observations at St. Louis indicating the break at about 130 miles distant by cable from the landing. It appeared that on December 20 both St. Louis and Fernando were receiving messages with some difficulty for the first time since the completion of the line, and that the speed of working had to be reduced by about one-third. On December 24 a very heavy surf was breaking on the beach at St. Louis, the precursor of a violent storm which raged until the morning of the 26th. Some idea of the severity of the gale can be formed from the fact that the seas washed through the roadway in front of the cable house at St. Louis, and flooded a large portion of the native town of Guet n dar. The signals between St. Louis and Fernando had continued to be of the same unsatisfactory character from the 20th, until the closing of the office on the night of the 25th, when the storm was at its height. On the morning of the 26th the cable was found to be broken. The cable steamer "Dacia" was fitted out with all despatch, and left the Thames with cable and all appliances for repairs on January 7, 1893, arriving off St. Louis on January 21, having provisioned at Santa Cruz de Tenerife on the way south. It was found that Monsieur Gantez, a member of the South American Company's staff, had taken a number of tests, localising the break at between 125 and 130 miles of cable distant from St. Louis. Subsequent tests gave a minimum of 118 knots. These tests consisted of direct conductor resistance taken with the bridge coils, using zinc and copper current-reversals. A battery of 20 Leclanché cells was employed. Earth currents were found variable in direction and strength, though not exceeding one-third of a Leclanché cell in E.M.F. All tests were remarkably steady, the greatest divergence placing the break at 24 miles beyond its actual distance—viz., 113 knots of cable—from St. Louis. For the calculation of the conductor resistance per knot, a mean bottom temperature of 44deg. F. was adopted. The true mean bottom temperature was afterwards found to be 44·9deg. F. While the chief electrician, Mr. E. March Webb, was testing from shore, the ship proceeded to carry out a series of profile soundings during three days, when the "Dacia" put into the port of Dakar to take on board Mr. Webb and two representatives of the South American company, and at once resumed sounding work. Some 50 casts with the wire were taken before and during grappling operations up to recovery of first end; a regular and easy descent from shoal to deep water, with soft green and grey mud bottom of varying consistency being found, as details given further on will show. The mean distance along the line of cable from St. Louis was estimated at 100 nautical miles. A mark buoy was placed at 78 miles with a view to grapple the cable at a point to which the line would eventually be diverted in avoiding the dangerous ground. Unfavourable weather interfered with work until January 29. On the 30th, at early dawn, the mark buoy was sighted, flagstaff broken and lamps lost. These were replaced, and in the afternoon, the sea having subsided, the grapnel was lowered in a depth of 850 fathoms. Grappling rope and chain were paid out to a length of 1,200 fathoms, and a drag was made to the south-east, the strain shown on dynamometer being from two to three tons. That evening the cable was hooked, the strain during picking up being from 3 to 4½ tons. At nine o'clock the cable was at the bows, the highest strain being six tons, falling to 4 and 3½ tons, on slack cable coming over the ground. After cutting the cable and speaking St. Louis, the cable was tested and found to be perfect electrically. Tests for conductor resistance and capacity were taken from both ship and shore to determine length of piece in circuit, which was found to be 87·888 N.M. The dielectric resistance at observed temperature was 9,028·7 megohms; conductor resistance, 5·03 ohms per nautical mile; the calculated mean bottom temperature, 46·75deg. F. The mean depth on this length is 565 fathoms, and the mean bottom temperature, from soundings, is 47deg. F.

Picking up the cable towards the break was now proceeded with until the following day. The mean strain while picking up

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was 2·6 tons, falling to 2·1 tons when at rest, the cable coming in in good condition, quite freely, and coiling well. On approaching the end, at a distance of two miles, the strain rose to six tons; and after some manœuvring the cable evidently cleared itself from the bottom, and the end soon afterwards came on board from a depth of 1,220 fathoms. The cable showed evidence of much rubbing, the outer cords being stripped in places, unwound, and rucked up. The tape covering for about 140 fathoms from the end was rubbed bare to the sheathing wires on one side only. About the broken part about ½in. of the conductor was exposed, both copper and gutta being nearly covered by the sheathing wires; the appearance indicated a tension break, with some slight torsion. The sheathing wires were well drawn down at their ends, showing a fair break at full breaking strain; in fact, from its appearance it might have been broken in a testing machine. Additional soundings were taken in a profile line from this position towards the E.S.E., and across the line of cable, as see chart, also details given further on. A marked difference was observed in the character of the bottom on this line of soundings—a very soft green mud, and ooze, in place of the stiff green mud hitherto found. While the sounding was going on, the recently picked up cable, after eliminating the damaged portion near the end, was joined up with the new cable ready for relaying, 23·75 N.M. being thus utilised. On February 2 the last line of soundings was completed. A buoy was prepared for a mark, but could not be placed in position for grappling the Fernando side of the broken cable, because of weather unfavourable for observations to determine the ship's position, through a dense haze which prevailed all day, caused by fine particles of yellow dust blown from the desert land by strong north-easterly winds. Later in the day sights were obtained, and a mark buoy put down in latitude 14° 56′ N. and longitude 18° 3′ W., the depth being 1,200 fathoms. The grapnel was soon afterwards lowered in 1,300 fathoms, 1,650 fathoms of rope and chain being paid out. A drag was made to the S.E., with the strain steady at 3½ tons. Considerable swell was on, and the grapnel rope soon began to suffer by hammering against the bow of the vessel, and by being rolled along the plating by the "send" of the ship. After five hours' grappling, accompanied by severe rolling of the ship, wind and sea had risen to such an extent that operations had to be suspended for a time. On the afternoon of February 3, weather having moderated, fresh lights were placed upon the mark buoy, and the grapnel was again lowered. A drag was again made to the S.E., the strain shown on the dynamometer being four tons. After grappling for five hours at a rate of about one mile overground per hour the strain rose to 5½ tons. The grappling line was now shortened. The strain while shortening in was six tons. No appreciable progress overground was made during half an hour after this, and, the strain still rising, it was believed that cable was hooked. The operation of picking up was now commenced, a five-ton strain being indicated, increasing to six tons, and to seven tons when the cable appeared at the surface. Estimating from the approximate angle between the legs of the cable bight when above sea surface, the strain on the cable was about five tons. The indicated strain fell to six tons when at rest, and afterwards to five tons, as the slack cable was drawn along the ground, thus proving that a sufficient quantity of slack had been laid originally. Four hours were occupied in picking up, and at 3 a.m. the cable was secured by chains and drum ropes and cut at the bight. The Fernando end was taken on board, and electrical tests showed that portion of the cable to be electrically perfect. This Fernando end was now buoyed, and picking up the loose piece towards break was proceeded with, the strain keeping pretty steady at four tons, varying slightly to 3½ tons. On approaching the position of the break a sounding gave 1,160 fathoms, soft mud; the strain soon after this increasing to 5½ tons; and frequent stoppages were now necessary to allow cable to break away from the bottom. The strain suddenly falling to two tons indicated that it had cleared some obstruction on the bottom. The cable now recovered was "screwy," and soon showed evidence of much rubbing, like its counterpart on the St. Louis portion. On the evening of February 4 the end came on board. The break was similar to, and coincident with, the other end; the sheathing wires being close around the core, the conductor scarcely showing. The guttapercha appeared as though it had been nipped by some hard pressure. Nearly 21 miles was recovered on this piece, which, after eliminating the damaged part, was joined up, spliced to the St. Louis portion of picked-up cable, and coiled down ready to relay. The depth at this portion was 1,220 fathoms, soft mud and ooze. The buoy on the end of the St. Louis portion was now "made for," to verify its safety, before raising the Fernando end and joining up cable on board thereto preparatory to paying out and completing repair. Contrary wind and current prevented the ship sighting the buoy that night, and it was at daylight on February 6 before it was seen. Two freshly-trimmed dioptric lights were put on the buoy, and the return to the Fernando end was at once made. Upon reaching this end at the close of the day the weather looked so promising that it was decided to at once pick up the cable and splice on. The strain while picking up was 2·9 tons, and when stopped 2·1 tons. A length equal to 1¼ knots of the cable that had been hanging from the grapnel when raising the bight was taken in, and not a sign of a kink found. At eight o'clock, the splice being finished, the bight of the cable was slipped from forward aft, to bring cable on to the after (paying out) gear. The ship's engines were put slowly ahead at first, on account of cable being high in the tank and there being but slight cohesion between the turns of the coil. The first course was N. 28deg. W. true. The speed was increased to four knots per hour and later on to five knots, at which rate the ship was kept during the night. The distance run upon the first course was 14½ miles. The second course was N. 19deg. E. true; distance run, 12½ miles. The third course was N. 73deg. E. true, and distance run 25 miles; all by log. During the run on this course the ship was stopped in order to coil down in the tank a laid-out splice. When all was clear the ship's engines were put on to 40·44 and 48 revolutions, representing from five to six knots speed per hour; the course being changed to N. 62deg. E. true. The weather being overcast, morning observations could not be taken. Later on the sky cleared and a position was found, but so much haze obscured the horizon that the "fix" was afterwards proved to be incorrect. It placed the ship several miles astern of position by dead reckoning. The ship's engines had meanwhile been increased to 50 revolutions, equal to 6½ knots per hour. Shortly after eight o'clock the buoy on St. Louis end was sighted about two miles slightly on the starboard bow. At 10 o'clock the cable, St. Louis end, was on board, and, tests being satisfactory, the other, Fernando end, was passed from aft, and final splice started; a length equal to 0·25 N.M. on St. Louis end having been hove in to ensure freedom from kinks. In the afternoon of February 7, the splice being finished, the final bight was slipped, and the "Dacia" set on for Dakar, leaving the mark buoys in position until learning result of the final electrical tests from St. Louis. On testing towards Fernando, when the cable was taken on board for splicing on to the tank section, a dielectric resistance per N.M. of 13,756 megohms, at a calculated mean temperature of 34deg., was found; the copper resistance being 4·885 ohms per N.M.; mean depth being taken as 2,142 fathoms, and mean bottom temperature of 35deg. F. The distance by cable from this point to Fernando was 1,567·4 N.M. In speaking to Fernando through this length the ship used 18 Leclanché cells without a condenser in circuit, either on the sending or the receiving side. Signals were extraordinarily good at both ends. After splicing to the tank section on board about 136 N.M., it was found necessary to use a condenser capacity of 100 microfarads. Twelve Leclanché cells were found sufficient for transmitting signals. Forty-seven N.M. of cable was recovered, and 73·6 N.M. used in repair, 39·6 N.M. of which was part of the 47 N.M. recovered. The length of the restored section after repair was increased by 26·5 N.M., the original length being = 1,702·15 N.M. The present = 1,728·67 N.M.; add to this the length of Fernando-Pernambuco section = 357, gives entire length 2,085·67 N.M. A slight alteration in mean depth and bottom temperature occurred in the working out of results—viz.:

	Mean depth.	Mean bottom temperature.
Original section	2,172 fms.	..... 34·9 F.
After repairs.....	2,142 ,,	..... 35·2 F.

Charts showing direction in which the cable was picked up and relaid are appended. It will be observed that the cable was diverted from the original line along other courses for a distance overground = 57 N.M., and 17 miles to the westward of the position where the rupture occurred. The total slack given was = 16·3 N.M. = 28½ per cent. on the length paid out. These repairs being completed the vessel returned to London; but, unfortunately, further experience in this locality was to come.

In March, 1895, a second interruption to the South American cable occurred, when the "Dacia" was engaged on some repairs to the Cadiz-Teneriffe section of the Spanish National Telegraph Company's system off the Straits of Gibraltar, and experiencing very rough weather off Cape Trafalgar in attempting the passage of the Straits to escape from a south-westerly gale of cyclonic violence. To convey an idea of the startling suddenness with which this storm almost overwhelmed the ship, it is worth recording that at 8 a.m. a mark buoy and its moorings had just been picked up. The wind was S.W., afterwards veering to W.S.W. and W., fresh, squally, and cloudy. At 10 a.m. it blew a strong gale, with a heavy sea; at noon, a heavy gale; half an hour after noon, a fierce hurricane, with a tremendous sea: the ship rolled to such an extent that a big cutter in the davits was carried away by the boat filling, and she was smashed to bits against the side. The decks were filled by huge seas, and some cattle were washed overboard. The steam launch started adrift through the ship labouring. Vivid lightning, with terrific peals of thunder, accompanied the storm, which had to be faced, as it would have been impossible to have made the passage of the Straits, or to enter the harbour at Cadiz. Everyone worked with desperate

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energy. Officers and staff toiled for hours getting tarpaulins into the mizen rigging to keep the ship's head to the sea, the after-sails being split and mizen gaff disabled. Broken ribs, hurts, and bruises to the crew and cable hands occurred while endeavouring to secure the heavy steam launch and other gear. During the evening several steamers drew near, and there was a narrow escape from a serious collision, as the steamers were almost unmanageable. Some of them must have collided during that night with fatal results, for several steamers proceeding from the Mediterranean were never heard of from that day. The unfortunate Spanish cruiser "Reina Regente" had taken the Moorish envoys back to Tangier the previous day, and was upon her return to Cadiz—a five hours' run—when she foundered with 423 souls. Some 2,000 people in Selville and Cadiz were put into mourning through that awful disaster. The "Dacia" weatherd the storm with difficulty, and the next morning made her way through the Straits, running before the gale to Gibraltar, where news of the interruption to the South American cable was received. Later on, at Cadiz, on completion of repairs to the Spanish cable, orders, with detailed instructions, were received from London to proceed south and effect repair. The ship left Cadiz on April 10, for a position in latitude 15° 1′ 7″ N. and longitude 18° 4′ 7″ W., about 20 nautical miles to the south-westward of the scene of the former operations, touching *en route* at Santa Cruz de Teneriffe to coal and provision. On April 19 the ship was at the position indicated, a mark buoy being put down and grappling commenced.

In view of this second interruption occurring after an interval only of two years from the first repair, it was decided to make a long detour, and while carrying out this operation to utilise temporarily a cable laid along the African coast between St. Louis and Cape Verde. The first drag was made to the westward in depth of 1,250 to 1,300 fathoms green mud. A heavy intermittent swell, with moderate breeze, and current setting to the northward. Strain indicated on dynamometer varying to as high as six tons. Grappling rope being severely knocked and rolled against the bow. Ship rolling heavily. Conditions not being favourable for securing cable if it were hooked, the grapnel was hove up, and work suspended for the time being. It was observed that the sea was of a dirty-green colour—an unusual appearance in deep water. After dark it became highly phosphorescent, with a strong pungent odour—the more so the nearer to the sea surface; the crew of a ship's boat alongside being severely affected by it. Grappling was resumed on the 20th and continued until the morning of the 21st without result. The climatic conditions at this position (40 miles W.N.W. from Cape Verde), in depth of 1,200 fathoms to 1,300 fathoms, on the evening and during the night of the 20th were worthy of remark. The sun set like a pale distorted moon, sea and sky being of an ashen grey, and the horizon shrouded in mist. A clammy atmosphere, striking chill and raw. A strong odour of phosphorus, suggestive of gases liberated by myriads of decaying organisms. The scene was most weird and uncanny—Dantesque, in fact. Grey, dull, and silent; not a spark of life in sun, sea, or sky. Darkness, necessitating the cheerful brightness of the electric light, was a welcome change. Throughout the night the same conditions prevailed. On the 21st the atmosphere cleared, the sea assumed a brighter tint of green, and the sun shone bright; but this change also brought a strong breeze, rendering grappling out of the question. Some few soundings were taken to discover the nature of bottom to the south-westward. On the 22nd, after a brief lull, the breeze sprang up again, with the usual swell at times, indicative hereabouts of a strong westerly set; the ship being within the influence of the northern equatorial current which sweeps along the north-west coast of Africa, past the Cape Verde Islands, turning to the westward about the latitude of Cape Verde. Part of this current is driven by the north-east trade winds into the Carribean Sea, but most of it sweeps north-westward outside the West Indies towards the North American coast, as explained by Ferrel's law. This meeting or diverging portion of the current is probably accountable for some of the unusual conditions of climate met with. The next drag was successful in hooking the cable, which was at the ship's bows at an early hour on the 23rd; the northern, St. Louis end, being buoyed, and the Fernando end, after testing, being at once spliced up with the section of new cable in tank for paying out towards Cape Verde, off which place it was the intention to break into the coast line of cable from St. Louis to Cape Verde, and join Fernando thereto, thus restoring communication at the earliest possible moment. This operation was of a delicate nature, inasmuch as the cable from Fernando had to be buoyed, the coast cable above referred to grappled up, cut, and the northern (St. Louis) portion of this cable joined on to Fernando end, which had to be raised and the bight lowered after making the splice. The work of paying out cable from the recovered end was successfully performed at a speed of from five to six knots per hour. A dense haze over the land in the early morning disappointed expectations in a looked-for guide—the Cape Verde light. The morning observations were not reliable either, and the cable distance had to be taken for determining the distance run. The Fernando end was buoyed in 200 fathoms when 47·28 N.M. had been payed out, and ship, by dead reckoning, should have been within a mile of the line of the St. Louis-Yof coast cable, to which connection had to be made. However, noon observations—latitude 15deg. N., longitude 17° 30′ 7″ W.—placed the ship two miles to the westward of this line. Grappling for the coast cable was started in the afternoon and continued until the evening of the 24th, when, having made six drags and broken up some grapnels, the cable was hooked, only to lose it while heaving it up. However, soon afterwards it was hooked again, and raised; the bight being cut, the loose south end buoyed, and the St. Louis portion picked up for four miles, when the ship was headed towards buoy on Fernando end, paying out cable. At 8 a.m. the Fernando end was on board. Joint and splice were made, and the bight of the cable lowered to the bottom by a buoy rope, and the end buoyed so as to facilitate the raising of the bight again. By the use of this portion of the coast cable the circuit between Pernambuco and St. Louis was now continuous, and the "Dacia" was set on for Dakar, to make sure of communication being perfectly restored, and to ship stores sent out from home. On the 25th the ship arrived there and received a satisfactory report from St. Louis as to the working of the improvised line of cable between that point and Pernambuco. Not being able to ship stores, on account of Custom House formalities, instructions were sent through the Government land line to St. Louis to look out for signals on the broken part of the cable on the 27th, and the ship immediately left for the grappling ground. Position 15° 1′ N. and 18° 4′ W. was reached by forenoon on 26th, the cable on the loose piece towards the break being then taken up. On testing this length, the distance to the break was found to be 35 knots. Recovery of cable was at once started, and continued until the 27th, when the cable parted near the dynamometer under a strain of 7¾ tons, after all means to break it out of the ground had been tried. About three knots had been picked up under a strain of between four to five tons, and four hours' time was occupied in the recovery of this short length. The ship was now set on for a position in 15° 50′ N. latitude and 17° 11′ W. longitude, to grapple the other portion of the cable from the landing at St. Louis. On the 28th the ship was found, by morning observations, to be eight miles north of position required. A mark buoy was soon placed near the line of cable, and preparations were made for grappling, which, however, was not found practicable, on account of strong east wind and a heavy swell. Early on the 29th the grapnel was lowered, and a drag made to the south and eastward. All day was occupied in grappling, but without result. Wind increasing and sea again becoming too heavy, grappling was out of the question. Several soundings now taken across the supposed line of cable showed that the ship had been grappling to the eastward of, and had not actually crossed, the line of cable; the soundings now obtained not agreeing with the known depths shown on the chart near this locality—viz., soundings now taken being respectively 714, 641, 589, 552, and 492 fathoms. The position of the 641 fathoms sounding, as afterwards determined, was 1¼ miles to the eastward of the actual line of cable, and the sounding of 492 fathoms four miles to the eastward of it. At the position where the mark buoy was placed on the supposed line of cable a depth of 575 fathoms was found, and this proved to be 3¼ miles to the eastward of the actual line, which was equal to the error of chronometer as subsequently determined.

On May 1, there being no signs of the weather moderating, an attempt was made to steam up towards St. Louis, but the ship rolled to such an extent in the high beam sea that the idea was given up, and the ship was kept away for Dakar, where she arrived on the following day. On May 4 a start was again made, after having got fresh rates of corrections for the chronometers, the standard having been 13 seconds in error, or 3¼ miles—due, no doubt, to the violent oscillations caused by heavy rolling of the ship. On arriving at the scene of operations, the weather showed signs of improvement, and grappling was resumed, with good hopes of success. On the 5th the cable was hooked, and up to the bows at daylight. On cutting the bight and testing towards St. Louis, the cable between the ship and that point was found electrically perfect. The St. Louis end was then buoyed, and picking up on the loose piece towards the break proceeded with. The strain being high—from four to five tons—it was necessary to work the gear at low speed. It was May 7 before the broken end was reached; 78·5 N.M. having been recovered. Quite 2½ hours were spent in getting in the last mile. Like the other side of the break, for a distance of three miles it was a tussle to break the cable out from the bed of mud and detritus that evidently covered it and held it fast, the most careful manœuvring being required. Patience was at last rewarded, and by dint of coaxing and handling the ship it gradually broke away—literally foot by foot—until with a jumping strain of from two to five and six tons it finally cleared itself. The end, when it was hove on board, showed evidence of some severe mauling. The sheathing was squeezed flat, and the core protruding in several places.

Extract from Log, May 7, 1895, South American Repairs.—4.25 p.m.—"Fault passed off drum. The fault shows that

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some hard substance had pressed against the bight of cable with a force greater than the breaking strain of cable, forcing the core out on the opposite side of sheathing for about 12in. and breaking it. Probably a large rock borne down on the cable by a mass of mud moving at a right angle, or part of a right angle, to the cable. Cut fault out = three fathoms. 4.31 p.m.—Resumed picking up; cable coming in much strained and entirely stripped of serving. 4.42 p.m.—End of cable came in board bearing evidence of having been caught round a rock and broken by heavy strain. All wires and cores broken off flush. Cut half a fathom of cable."

A sounding taken immediately on the spot disclosed a depth of 1,574 fathoms, green mud, when 1,300 to 1,400 fathoms might have been expected. It may be here remarked that on examining the dried specimen some time afterwards it was found to have changed colour, and upon a preliminary microscopical inspection it showed a broken-up, fragmentary deposit of sand, diatomaciæ, and globigerinæ. Now that the ground was cleared, all cable recovered, and a length amply sufficient spliced up for running out, the next thing to be done was to join and splice up this cable on board to the arm of the main South American cable buoyed off St. Louis, and pay out south to the position of the temporary junction between the cable from Fernando and the St. Louis portion of the St. Louis-Yof Bay coast cable. On Thursday, May 9, a lull in the usually fresh breeze and a diminution of the heavy swell permitted ship to be taken up to the buoy on the cable end, and in due course the cable was got on board. Electrical tests on this portion now disclosed a fault towards St. Louis, but not pronounced enough to localise. It might have been on the beach, or even within the cable-house. To pick up towards St. Louis would have been inconvenient; moreover, it did not promise any tangible result. So, as the weather continued to improve, it was decided to join up this end with cable in tank and pay out south, localising the fault afterwards. To this end it was proposed by the chief electrician, Mr. J. Rymer Jones (after laying cable to position), to get the bight of the other cable up and cut it, using the portion of the St. Louis-Yof coast cable to St. Louis as one side of a loop, with the portion of the St. Louis-Fernando cable just laid (extended) as the other half. Tests would then be carried out on board to localise the fault in the St. Louis end of the South American cable, and Fernando then be joined through to St. Louis as before. The work of splicing, slipping cable from forward aft, and paying out towards position of buoy on the bight south was carried out successfully; but as wind and sea had again increased during the day, it was found impracticable to approach the buoy, so ship was steered close past it about one mile south, and the cable just laid from the St. Louis end buoyed at 7.30 p.m. Early in the morning of Friday, May 10, this buoy was picked up, the cable raised, and two miles of it hove in and coiled down in main tank. Then the ship was steamed towards the buoy on the bight paying out cable. On reaching the buoy it was picked up, the bight of cable raised and taken on board, cut, and testing proceeded with to localise the fault in the St. Louis portion, after five hours' work in getting the cables clear, as they crossed and recrossed at the bows, and a fresh breeze with some sea and swell obtaining the while. Results of the loop test on the St. Louis portion of the main cable located the fault on the beach at St. Louis, about 200 or 300 fathoms from the cable-house. The cable was now joined up through the same circuit as before after an interruption of under four hours, the bight being again lowered to the bottom with a wire buoy rope and buoyed.

The "Dacia" arrived at Dakar that night—11th. On the following morning an electrician, with a jointer and three cable hands, were despatched to St. Louis by rail to cut out fault on beach should it be get-at-able and put in a piece of new cable. Meanwhile, the superintendent at St. Louis was instructed, through the Government telegraph line from Dakar, to make a first cut at 12ft. seaward of cable-hut, and then test; then if fault should be still in the cable, to cut again further seaward at high-water mark, and test again to the sealed end. On checking the results of the first series of tests it was found by Mr. J. Rymer Jones that the fault was much nearer to the cable-hut at St. Louis, so the first cut at 12ft. from the cable-house consequently had eliminated the fault, the total insulation resistance from that point to the sealed end—147 knots of cable—being 24 megohms, as telegraphed to the engineer in charge by the superintendent at St. Louis, Monsieur Tailhand. Instructions were now wired to St. Louis to commence watch upon the St. Louis-Fernando cable to the sealed end at 10 a.m. on Tuesday, May 14. While *en route* for this position the ship was detained for the purpose of making good the Yof (Cape Verde) end of the coast cable, a portion of which was found to be badly worn. This portion was taken out, and, the ground being cleared, ship was then set on for the aforesaid end of the St. Louis-Fernando cable proper. This end being taken up, about a mile of it was hove in, and the ship then headed for the buoy on the bight of the (*pro tem.*) St. Louis-Fernando cable, paying out cable from the bow. The buoy was reached and slipped just before darkness set in; the bight was raised, taken in board, cut, and Fernando called, but, owing to some misconception of orders transmitted through Pernambuco, over an hour elapsed before Fernando answered the call. Tests were then carried out, and, cable being found perfect electrically, the joint was at once started between the two portions of the St. Louis-Fernando cable. The splice was finished about midnight, and the bight slipped at 1 a.m. on May 15, 1895; thus completing a very interesting, if arduous, piece of work. The length of the St. Louis-Fernando Noronha section, on the completion of this, the second, repair, shows a decrease of slightly more than 10¼ miles; the length of the section after the repair of 1893 being ..... 1,728·67 N.M.
After repair of 1895 ..... 1,718·40 ,,

Decrease in length ..... 10·27 ,,

The length of cable recovered during repair of 1895:

On Fernando side of break	33·004	N.M.
,, St. Louis ,, ,, ...	79·209	,,
Total	112·213	,,
Recovered cable relaid	56·37	N.M.
New cable laid	47·27	,,
Total cable relaid in repair	103·64	,,

The electrical and mechanical conditions of the cable as a whole, according to careful and repeated tests in each direction, may be considered unaltered.

A somewhat detailed account of the cable operations has been here given, because it may be that many members present are not, perhaps, familiar with the method of carrying out work of this nature on board a cable steamer.

The author proceeds to theorise as to the cause of the fault as follows: Taking a general survey of the soundings over the entire area covered by the repairs, it is seen that the bottom gradients are easy. At the position of the break in 1893, in 1,220 fathoms, all the soundings around, with one exception, show a gradual descent towards it. From the S.S.W. the grade is about 1 in 21—an approximate angle of slope of 2° 50′. From the south-eastward the grade is about 1 in 7—an approximate angle of slope of 8deg.; this is the sharpest slope met with. From the eastward towards the 1,220-fathom spot the grade is about 1 in 8½—an approximate angle of slope of 7deg. The exception is between the depth of 1,280 fathoms and the position of the break, where the slope is reversed, showing a grade of about 1 in 17—an approximate angle of 3° 30′; but this is only a dip in the huge furrow which may be conceived to exist here. At the position of the break of 1895, in 1,574 fathoms, the gradients of the sea bottom sloping towards it from the S.W. round by S., and S.E. to N., do not in any one case exceed 1 in 26—an approximate angle of slope of 2° 30′. The slope of the nearest profile line is but 1 in 34—an approximate angle of 1° 30′. While picking up the cable towards the break during both repairs of 1893 and 1895, when within two to three miles of the end on either side, the strain indicated on the dynamometer increased from two to five and to six tons. It is therefore only natural to suppose that the cable was embedded upon each side of the furrow. Considering the very slight grades, comparatively speaking, generally obtaining over the ground, it might be presumed that whatever the disturbing influences might be they would be purely local. If this be so, it is remarkable that similar conditions were met with, and that a violent destructive effect should occur at two spots some 17 miles distant with a difference in depth of from 200 to 300 fathoms, and coinciding approximately with the direction of a profile line from the coast. Following the contour lines towards Cape Verde clear evidence is shown of the gully formation, with a depth of over 700 fathoms at the mouth of it. The actual depth from a flying sounding taken while paying out the St. Louis portion of the main cable was 675 fathoms in latitude 15° 11′ N., longitude 17° 27′ W. The depth nearer in to the coast is shown to be 531 fathoms. To the N. by W. of this position is a sounding showing 112 fathoms at a distance of 1¾ miles, and at one mile S.S.E. a depth of 115 fathoms. It may therefore be said that this gully formation extends to within a few miles of the shore, but, judging by the period—over 12 years—during which the coast cable has lain across here in 700 fathoms in perfect safety, the diverted course of the South American cable being now alongside it, it would appear probable that these two cables may be lying upon a ledge above and everhanging a possible submarine river outlet; so that it might be conceived that a vast mass of mud and detritus from this source may flow, however slowly, along a time-worn furrow on the sea bottom. This channel way, or submarine ditch, may be imagined at some remote period to have been grooved out by the constant action of a rush of water from a river outlet. This outlet may have been submarine or at sea-level in connection with the lagoons adjacent, which in turn were connected with a great inland river. The Admiralty charts, and those of the French Depôt Général de la Marine, gave indications in support of such a supposition. A very remarkable phenomenon strongly favouring the theory that a submarine river

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outfall now exists was witnessed during the afternoon of April 23, 1895, while grappling for the coast cable, in position latitude 15° 0′ N., longitude 17° 31′ W., 13 miles from the coast. The ship was gradually surrounded by great quantities of vegetable growth, having the appearance of river weed—a whitish worm-like weed, the roots of which were similar to some that had been met with previously on a soft mud bottom to the south-westward of the Guadalquiver River. There were also birds' feathers, pieces of orange peel, whole and broken gourds, scraps of carpet, pieces of driftwood, small branches, etc.: and the colour of the sea had changed to a dirty brownish green, indicative of the presence of fresh (river) water. On the following morning all this had disappeared, and the sea had regained its usual tint of a pale green. The nearest river outlet is that of the Senegal, 75 miles to the north-east from this position, and it would appear most unlikely that such flotsam as pieces of carpet could have been carried by the coast current, which sets to the S.S.W., to so great a distance. No recurrence of this phenomenon took place during the four weeks that were spent in carrying out cable work in the neighbourhood, nor had such a thing been noticed before so far as records go. If the coast current had brought these masses of weed and refuse of human habitation out of the Senegal River, it would have been a more or less constant and familiar appearance, as would also the colour of the water, but the discolouration of the sea surface, with the accompaniment above described, would appear to be due to a sudden outburst somewhere in the vicinity below sea-level. While upon the subject of submarine gullies and of the probability of their formation by river outlets, whether at or below sea-level, it may be mentioned that many subterranean river outlets are supposed, with good reason, to exist. Off Pescadores Point, on the coast of Peru, and off the Rovuma River, on the East Coast of Africa, similar conditions have been met with in repairs to cables. At the latter place much trouble had been experienced with the cable between Mozambique and Zanzibar, and the conclusion arrived at was that the cause was fresh water making its way to the surface of the bottom, disturbing the level and fracturing the cable. Immense masses of mud are in continual movement off the Congo River, and extend to some hundreds of miles to the westward; but here is a very deep river debouching right into the sea, and scouring out a channel hundreds of fathoms in depth. The West African Telegraph Company's cable between Loanda and the island of Sao Thomé has been broken seven or eight times since its laying in 1886, and some hundreds of miles of cable have been used in repairs. Some valuable remarks upon these and other gully formations may be seen in Mr. E. March Webb's report upon the Congo repairs in 1887, printed and bound in book form, a copy of which will be found in the Institution library.

As regards the probability of volcanic disturbances having been the cause of the rupture to the cable. The Atlantic Ocean North and South, from Iceland to the Cape of Good Hope, is included in the region of the western hemisphere subject to earthquake disturbances; the Azores, the Canary Islands, and the Cape Verde Islands being centres where shocks may be experienced of a severity to cause great damage. It is possible that sea-water filtering through the sea bottom into a moderately heated portion of the earth may cause explosions of a minor kind that would cause local disturbance and an alteration to the features of the surface floor. This might probably cause great upheavals of mud, and displacements of the sea-bed, to the extent of many thousands of tons at a time—more than sufficient to rupture a telegraph cable were it 50 times the strength.

There is not much more that the writer can say, except to draw attention to a few striking facts in connection with these very sudden cases of interruption.

Firstly.—It will have been noticed that very severe weather had obtained prior to and at the time of the first break in 1893.

Secondly.—It will also have been noted that the second interruption occurred during the great storm of March 10, this storm having been experienced in the South, as the weather reports from the Canary Islands at the time testified.

Thirdly.—The remarkable climatic conditions, and the disturbed state of the sea surface in the neighbourhood of the break in 1895, together with the unusual phenomenon observed near to the coast in the vicinity of the gully formation during the repair to and diversion of the cable on that occasion.

Fourthly.—That a length of cable was recovered under heavy strain for a distance of two or three miles upon each side of the break in 1893 and also in 1895, the contour lines clearly indicating hollows between higher levels on the bottom at the positions where the ends came up.

Fifthly.—The distance and direction between the position of break of 1893 and that of the break of 1895 coinciding more or less approximately with the line running towards the mouth of the gully formation to which attention has been directed.

Sixthly.—The remarkable difference in the character of the breaks, the one of 1893 being a clean tension break, the one of 1895 showing evidence of violent action.

And, lastly.—The equally remarkable difference in the character of the sea bottom at the position of the two breaks, as disclosed by the microscope, the locality of the 1893 break showing an abundance of mineral deposit, and that of the 1895 break a scarcity.

No particular cause for these breaks can be insisted upon, because there is no direct evidence in support of any. Nevertheless there are indications of a character that may encourage discussion, and so help to throw more light upon the origin of this, so far, unaccountable destructive agency on the sea bottom.

In concluding, the writer would here wish to record his deep sense of obligation to the India Rubber, Gutta Percha, and Telegraph Works Company for the kind facilities accorded him towards the preparation of this paper and its illustration, also to those members of the Silvertown staff who have so cordially assisted in its production.

Discussion.

Mr. Buchanan said the paper did not give any reason why the cable breakages happened. That was not wonderful if they considered how little they really knew about the bottom of the sea. That was a region which covered three-quarters of the earth's surface, and considering how long it had taken them to know all the land part of the world it might be expected that it would be some few years before they knew much about the ocean bottoms. Practically their information was confined to what could be ascertained in the course of submarine cable work. It was well, however, from the cable point of view to note down and discuss the meaning of all the information that they could pick up, for a submarine cable was an expensive article to have to replace, and was, therefore, worth being looked after. With reference to formations on the sea-bed at the mouths of large rivers, he might take the Congo as an example of what happened sometimes. There the fresh water, more or less mixed with salt, flowed out at the top, but there was an inflow of salt water at a lower level. The general effect would be to prevent a deposit of the fine silt in the immediate course of the stream, but to drop it in two ridges at the sides, so that without any eroding action whatever a furrow came to be formed between the ridges. He did not think they would be justified in assuming the break of the cable to be due to the force of an outbreak of a submarine river.

Admiral Wharton agreed that it was to the work of the cable companies that they had to look if they wanted any trustworthy knowledge of what was going on at the bottom of the sea. If the submarine gully described by Mr. Benest did not extend up to the site of the cable breaks, then these were to him at present entirely incomprehensible. He did not believe that there would be sufficient power behind a submarine outflow to move matter violently along the sea bottom. It was difficult to see where they could get sufficient "head" for that, and he thought some other cause must be sought for.

The discussion was then adjourned to March 25.

LEGAL INTELLIGENCE.

COMMISSION ON THE SALE OF ELECTRIC LAMPS.

In the Lambeth County Court on Friday the case of Collins *v.* Sharpe was tried before his Honour Judge Emden, and was an action by the plaintiff to recover the sum of £2. 9s. 6d., balance of commission due on the sale of electric goods.

Both the parties reside at Walworth-road, and the plaintiff's case was that he was employed to sell goods for the defendant on commission. There was now due the sum claimed, but he was unable to get a penny of it.

The defence was that the orders in respect of which this claim was made had proved to be bad debts, and therefore the plaintiff was not entitled to commission.

After hearing the evidence, his **Honour** gave judgment for the defendant without costs.

DISPUTED LIABILITY FOR ELECTRICAL FITTINGS.

In the Westminster County Court on Tuesday his Honour Judge Lumley Smith, Q.C., had before him the case of Silver *v.* Goodge, in which the plaintiff sought to recover a balance of £4. 10s. in respect of electrical goods supplied to the order of the defendant.

The **Debtor** said he never gave the order for the goods, and was not in a position to pay for them; but his **Honour** said that was nonsense, and made an order for payment in a month, subject to committal in default.

COMPANIES' MEETINGS AND REPORTS.

BIRMINGHAM ELECTRIC SUPPLY COMPANY.

The annual meeting of the Birmingham Electric Supply Company, Limited, was held last week at Birmingham, Mr. H. Buckley presiding.

The report showed that the net profit, including a balance of £770 brought forward, was £9,652. The directors recommended the payment of a dividend of 4½ per cent., and to carry forward £1,042. The directors proposed, in order to meet the further necessary expenditure of the Company, to offer the balance of the

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authorised share capital (£50,000) for subscription by the existing shareholders.

The **Chairman**, in moving the adoption of the report, remarked that the progress of the Company during the last 12 months had been thoroughly satisfactory. It was true that the length of mains laid in 1896 was not equal to the amount laid in 1895, but during the year they had added considerably more to the buildings, plant, and machinery. Everything indicated steady progress from the commencement, but the progress during the last 12 months was exceedingly satisfactory, and in round figures showed an increase of 50 per cent. over the previous year. The increase in the number of lamps was satisfactory, and the month of January last showed an improvement over the month of January, 1896, of 35 per cent., and February, 1897, showed an increase of 55 per cent. over the corresponding month of the previous year. The expenditure on capital account had been heavy, and it had not come to an end, and for that reason the directors recommended the issue of the remaining portion of the registered capital. The unissued portion was £50,000, and the capital paid up £150 000. The report was adopted.

Mr. Rushbrooke (a shareholder) suggested that an interim dividend should be paid, but the **Chairman** pointed out that there would be some difficulty in doing that. The income in the first six months of the year was not similar to that in the last six months, and if the directors declared an interim dividend they could not say whether or not they had earned it.

A motion authorising the issue of the remaining capital was passed, and the retiring directors were re-elected.

BARCELONA TRAMWAYS COMPANY, LIMITED.

The general meeting of this Company was held on Wednesday at Winchester House, E.C., Mr. E. M. Underdown, Q.C., presiding.

In moving the adoption of the report, the **Chairman** observed that they had almost reached the limit of their capabilities in dealing with the traffic, regarding their undertaking as a horse tramway, and application had already been made for the use of electrical traction for that line. During the last two years the directors had been carrying out their ideas for the introduction of electric traction, a matter which required considerable judgment and patience. The project had been approved by the Municipality of Barcelona, and the directors had no doubt that certain formalties with the central Government, which alone remained to be gone through, would soon be brought to a conclusion. It was very necessary for them to be possessed of land for the purpose of carrying out the operations which would be necessary when electric traction had been introduced, and they had acquired several pieces of freehold land in the most valuable part of Barcelona. They had also secured a complete supply of rails for relaying those portions of the line which were unsuitable for electric traction. They had already sanctioned the issue of 50,000 ordinary and 100,000 preference shares, and 30,000 of the latter had already been issued. According to their articles of association one-half of any new issue of shares had to be offered to existing shareholders, and this offer was now open to them at a premium of £2 a share. The other moiety the directors and their friends had agreed to take up at the same premium. The usual resolution for the report and accounts was adopted.

RICHMOND (SURREY) ELECTRIC LIGHT AND POWER COMPANY, LIMITED.

Directors: Frederick W. Reynolds (chairman); Francis E. Savory; the Chevalier Soares. Engineer and manager: A. J. Lawson, M.I.E.E Secretary: H. B. Renwick.

Report to the directors, with abstract of accounts, to be presented to the shareholders at the third ordinary general meeting of the Company, to be held at Moorgate-court, Moorgate-place, London, E.C., on Thursday, March 25, 1897, at 2 p.m.:

The directors beg to present their report and statement of acounts for the year ended December 31, 1896. Within that period a further sum of £1,780 has been expended on capital account, the necessary funds having been obtained by loan from the County of London and Brush Provincial Electric Lighting Company, Limited. The revenue account for 1896 shows a profit of £1,162. 17s. 10d., as against £230. 2s. 1d. in 1895. The balance of this amount, after payment of interest on debentures, mortgages, and temporary loans, has been appropriated as under: writing off balance of preliminary expenses, £138. 17s. 11d.; reduction of suspense account, £210. 17s. 3d.; depreciation, £200; balance carried to balance-sheet, £33. 14s. 9d. The total number of lamps connected on December 31 last was equivalent to 7,125 of 8 c.p., being an increase for the year of 1,639. Since that date further applications for over 1,000 lamps have been received. The number of units sold within the year amounted to 97,044, being an increase of 16,588 over those sold in 1895, while at the same time the working expenses have been materially reduced. The mains were considerably extended during the year, and the Richmond Corporation having consented to nearly the whole of the borough being included in our area of supply (the Richmond order being one of those granted under the Electric Lighting Act of 1882), it is intended to make further extensions at an early date. Arrangements have also been made for doubling the storage battery capacity at the station. Mr. William Charles Braithwaite, having joined the Oxfordshire banking firm of Messrs. Gillett and Co., has resigned his seat at the Board, and the directors have nominated Mr. F. E. Savory in his stead. Mr. Savory now retires by rotation, and, being eligible, offers himself for re-election. Mr. R. H. Marsh, the auditor, also retires, and offers himself for re-election.

Dr. REVENUE ACCOUNT YEAR ENDED DEC. 31, 1896.

	£	s.	d.	£	s.	d.
To Generation of Electricity.						
Coal or other fuel, including dues, carriage, unloading, storing, and all expenses of placing the same on the works	442	13	3			
Oil, waste, water, and engine-room stores	46	4	11			
Proportion of salaries of engineers, superintendents, and officers, as certified by the engineer	69	3	9			
Wages and gratuities at generating stations	320	1	2			
Repairs and maintenance as follows: (1) buildings, £6 4s. 6d.; (2) engines, boilers, £130. 3s. 7d.; other machinery, instruments, and tools, £25. 15s. 2d.; accumulators and accessories, £21. 17s. 2d.	184	0	5			
Special items—cartage of ashes	9	1	6			
				1,071	5	0
To Distribution of Electricity.						
Proportion of salaries of superintendents and officers, as certified by the engineer	69	3	8			
Wages and gratuities to linesmen, fitters, labourers	63	13	8			
Repairs, maintenance, and renewals of mains of all classes, including materials and laying the same	16	12	4			
Repairs, maintenance, and renewals of transformers, meters, switches, fuses, and other apparatus on consumers' premises	7	19	0			
				157	8	8
Royalties, etc., payable for use of patents or patent processes				52	7	2
To Rents, Rates, and Taxes.						
Rents payable	50	0	0			
Rates and taxes	287	9	7			
				337	9	7
To Management Expenses.						
Directors' remuneration	15	15	0			
Salaries, head office	100	0	0			
Stationery and printing	45	3	7			
General establishment charges	81	19	4			
Auditors of Company	16	15	0			
Auditor appointed under the provisions of the order	18	18	0			
				278	10	11
Law expenses				33	0	6
To Special Charges.						
Insurances				80	10	0
Bad debts written off				20	19	0
Balance carried to net revenue account				1,162	17	10
				£3,194	8	8

Cr.	£	s.	d.
Sale of current per meter at 7d. per B.T.U.	2,812	8	6
Rental of meters and other apparatus on consumers' premises	136	1	3
Rents receivable	172	15	0
Discounts	73	3	11
	£3,194	8	8

GENERAL BALANCE-SHEET, DEC. 31, 1896.

Dr. Liabilities.	£	s.	d.
Capital account—amount received	43,080	0	0
Sundry creditors on open accounts	972	17	4
Depreciation fund account	200	0	0
Balance from net revenue account	33	14	9
	£44,286	12	1

Cr. Assets.	£	s.	d.
Capital account—amount expend for works	40,964	14	8
Stores on hand at Dec. 31, 1896—coal, £12. 2s. 3d.; oils, waste, etc., £48. 7s. 5d.; general, £75. 16s. 10d.	136	6	6
Deposit with Richmond Corporation	100	0	0
Sundry debtors for current supplied to Dec. 31, 1896	1,296	5	1
Other debtors	111	6	6
Suspense account, £1,710. 17s. 3d.; less amount written off, £210. 17s. 3d.	1,500	0	0
Cash at bankers and in hand	177	19	4
	£44,286	12	1

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units	105,771
Quantity sold to private consumers by meter	97,044
Quantity used on works	1,891
Total quantity accounted for	98,935
Quantity not accounted for	6,836
Total maximum supply demanded (kilowatts)	135

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WESTMINSTER ELECTRIC SUPPLY CORPORATION, LIMITED.

An extraordinary general meeting of this Company was held at Eccleston place, S.W., on Wednesday, Lord Suffield presiding. The meeting was for the purpose of confirming, as a special resolution, the resolution passed on the 24th ult., empowering the directors to redeem the founders' shares, but

Mr. W. Hayes Fisher explained that it had been suggested that the form in which the Board had proposed to carry out the wish of the shareholders with regard to the redemption might not be unattended with legal difficulties. The points had been submitted to counsel, whose opinion had not yet reached them. It was therefore desirable that the meeting should be adjourned until they were in a position to lay the facts before the shareholders. He therefore moved the adjournment.

Mr. Boulnois, M.P., seconded the resolution, and it was agreed to.

ALTRINCHAM ELECTRIC SUPPLY COMPANY, LIMITED.

The annual meeting of the shareholders was held at Manchester on Wednesday, Mr. F. B. Ross, the chairman of the Company, presiding.

The directors in their report for the year ending December 31 last spoke of most satisfactory progress having been made. Orders had been secured for the equivalent of upwards of 17 500 8-c.p. lamps. The loss on the first year's running had been turned into a small profit on the second year. The Company had obtained another provisional order for the township of Ashton-on-Mersey and a portion of the township of Bucklow Hill, and the steady increase of supply encouraged the belief that the undertaking would shortly become very remunerative.

The **Chairman**, in moving the adoption of the report, said that since the last annual meeting 7,197 yards had been added to what was running in 1896 bringing the total length of the Company's system throughout the old area to 29,521 yards. The length in March, 1896, was 22,324 yards, or equal to 12 miles 1,204 yards, and the additions up to date (7,197 yards) made it equal to 4 miles 157 yards. The total length of the system at present was 16 miles 1,361 yards. That was exclusive of Ashton-on-Mersey. The increase in the number of consumers was very gratifying. There were at the present date 195 actually connected and 19 in active preparation. The continued popularity of the light was indicated by the fact that in the three months ending February, 1897, the increase had been 22 consumers, with an equivalent of 1,042 8-c.p. lamps, while in the corresponding period last year the increase was 17 consumers, with an equivalent of 823 8-c.p. lamps. There was, therefore, an increase on an increase. The recent announcement of a reduction in the cost of current had given much satisfaction to consumers.

The resolution was seconded by **Mr. William O'Hanlon**, and unanimously passed.

The directors and auditors were also reappointed.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Charleroi (Belgium).—Tenders will be wanted on March 30 at the Charleroi station for the construction of a telephone building.

Warrington.—Tenders are required for laying private telephone wire from Mersey-street to Longford Works (length, 1¼ miles). Full particulars may be had on application to Mr. W. S. Haddock, engineer.

Copenhagen.—Tenders are required for the supply of 55,000 oak stakes, about 30 tons of iron wire, 19 000 zincs for batteries, etc., for the Telegraphic Department of the Danish State Railways. Tenders to be in by March 19.

Lubeck.—Tenders are wanted for a telephone installation along the Elbe and Trave Canal. Particulars are obtainable for three marks (3s.) from the Canal Authorities (Kanalbaubureau, Kl. Bauhof 15), at Lübeck, and tenders must be in by March 27.

Scarborough.—The Scarborough Electric Supply Company, Limited, require tenders for the supply of 1,500 tons of coal during year commencing April 1. Particulars as to quality of coal required can be had on application to Mr. John Hall, 24, Westborough, Scarborough. Tenders to be sent in by 24th inst., endorsed "Tender for Coal."

Glasgow.—Tenders are invited for supplying and fixing in the Olympia, New City-road, during the month of April, a 25-h.p gas-engine, together with 20 arc lamps, each of 2,000 c.p., and a quantity of small incandescent lights, together with all the necessary wire cable, switches, etc. Address tenders to E. H. Bostock, care of Lithgow and Son, printers, 76, West Howard-street, Glasgow.

Galatz.—The Secretary of State for Foreign Affairs has received a despatch from H.M. Consul-General at Galatz stating that tenders are invited for the construction and working of a system of electric tramways over a length of about 13 miles of the streets in the town of Braila. The concession is for a maximum period of 35 years. Tenders will be received up to 27th inst. at the office of the Mayor in Braila. Such further particulars as have been received may be seen at the Commercial Department of the Foreign Office any day between 11 a.m. and 6 p.m.

Bristol.—The Electrical Committee of the Council are prepared to receive tenders for the supply, delivery, and erection of condensing plant, steam and exhaust piping, etc. Plans, specification, and form of tender may be obtained at the office of the Secretary on payment of £3. 3s., which will be returned on receipt of a bona fide tender. Any further information required may be obtained from Mr. H. Faraday Proctor, city electrical engineer. Tenders must be delivered not later than noon on April 7, 1897, addressed to Mr. Frank Wm. Prosser, secretary, Electricity Department Temple-back, Bristol, and endorsed "Tender for Condensers."

Wells (Somerset).—The Corporation require tenders for the supply and erection of the plant required for the complete equipment of an electric light station and for the underground conductors, etc. Copies of the specification may be obtained, and plans inspected, at the offices of the Town Clerk, Wells, Somerset; and of the engineer, Dr. John Hopkinson, F.R.S., 5, Victoria-street, Westminster, upon the payment of a cash deposit of £25, which will be returned on receipt of a bona fide tender. Tenders, sealed and marked "Tender for Electric Lighting," must be delivered to the Lighting Committee, Town Clerk's Office, Wells, Somerset, by 27th inst. Mr. Regd. L. Foster, town clerk.

Islington.—The Vestry are prepared to receive tenders for the supply and erection of a combined set, comprising 80-i.h.p. high-speed enclosed engine, 35 to 40 kw. alternator, having very low armature drop and reaction, and 20-kw. continuous-current dynamo, on combination bed-plate. Specification and plan of general arrangement of plant and steam-pipes included in the contract, with terms and conditions of tender and tender forms, may be obtained at the Offices of the Electricity Department, 50, Eden-grove, Holloway, London, N., on payment of a deposit of £1. 1s., which sum will be returned on receipt, and after consideration, of a bona fide tender in accordance with the specification. Tenders must be received at the Works, 50, Eden-grove, Holloway, N., on or before noon on 23rd inst., and must be addressed to the Electrical Engineer, endorsed "Tender for Combined Generating Set."

South Shields.—The Corporation are prepared to receive tenders for the supply of the following plant, and the carrying out of the work connected with the same: Section A—Supply of cast-iron pipes and boxes; Section B—Trenching and laying pipes; Section C—Rubber-covered cables and laying same; Section D—Low tension cables and laying same; Section E—Supply and erection of arc lamps, lamp-posts, switches, and transformers; Section F—Supply of high and low tension switches and transformers for placing underground; Section G—Supply of incandescent fittings for street lamps. Firms tendering are at liberty to tender for any section or sections, but not for part of a section. Copies of the specification, including conditions and form of tender, and also forms of contract, can be obtained from Mr. Joseph A. Jeckell, the borough electrical engineer, South Shields, on payment of £2. 2s., which sum will be returned on receipt of a bona fide tender. Tenders, on the form supplied, sealed and endorsed "Tenders for Electric Lighting," must be delivered at the office of the town clerk, Mr J. Moore Hayton, on or before 23rd inst.

Plymouth.—The Corporation are prepared to receive tenders for the following engineering works in connection with the electricity works of the borough—viz. (Contract No. 1) steam alternators (disc armatures) and dynamos, exciters, motor-generator, rectifiers, etc.; (2) Lancashire boilers with mechanical stokers, steam, exhaust, and other piping, ejector condensers, valves, electric pumps, water-tanks, economiser, etc.; (3) electric accumulators, etc.; (4) overhead travelling crane, jib wall crane, turntable, etc.; (5) switchboard (Ferranti type) and instruments; (6) high and low pressure mains, etc.; (7) stoneware conduits, etc.; (8) alternating-current transformers, sub-station switch-gear, etc.; (9) arc lamps for rectified currents, posts, etc. Contractors, who must in all cases be the actual manufacturers of the apparatus tendered for, are at liberty to tender for any of the contracts, but not for a part of any contract. Copies of the conditions, specifications, and forms of tender, bound up together, may be obtained from Mr. John H. Rider, borough electrical engineer, East-street, Plymouth, on deposit of a £5 Bank of England note for each copy, which will be returned on receipt of a bona fide tender upon the prescribed form and within the stated time. Should a contractor withdraw his tender, the amount of his deposit will be forfeited. In his application the contractor must state which contract or contracts he proposes to tender for, and copies of the drawings relating thereto will be forwarded with the specifications. Drawings must be returned undamaged with the tenders. Sealed tenders, endorsed "Engineering Contract, No. —," must be delivered to Mr. J. H. Ellis, town clerk, Plymouth, by March 26. The acceptance of any tender will be subject to the contractor paying the standard rate of wages obtaining in the district where the work may be carried on.

RESULTS OF TENDERS.

Leeds.—The Tramways Sub-Committee have accepted the tender of Messrs. Fowler and Co. for steam-pipes for the electric power station.

Bolton.—The Town Council have accepted the tender of the Chloride Electric Storage Company for alterations to the accumulators at the electricity works.

Paris.—For the supply of 25 metric tons of 3mm. copper wire to the French Government Telegraphic Authorities the successful tender on March 4 was that of A. Grammont of Pont de Chéruy (Isère), at 40,250f. There were eight other tenders, ranging up to 43,375f.

Reading.—The Town Council have accepted the proposal of the Reading Electric Supply Company to light the municipal build-

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ings at a further reduced price of current of 5d. per unit; and have also accepted the tender for an installation of wiring and fittings for lighting with electricity the town halls and municipal buildings and the new art gallery, etc., of the Brush Electrical Engineering Company, Limited, amounting together to £1,440.

Egremont (Cheshire).—The Wallasey Urban District Council have received the following tenders for the supply and erection of a 200-kw. alternator, with engine combined, and for the requisite switchboard extensions: S. Z. de Ferranti, Limited, Hollinwood, Lancashire (accepted); Johnson and Phillips, Kent; Brush Electrical Engineering Company, Limited, London; J. Fowler and Co., Limited, Leeds; Electric Construction Company, Limited, Wolverhampton; Mather and Platt, Limited, Manchester; Crompton and Co., Limited, Chelmsford.

BUSINESS NOTES.

Wingate.—The ratepayers have adopted the Lighting Act, and have resolved to light the town with electricity, at a cost of about £320.

Dundee.—Lord Morley, as Chairman of Committees of the House of Lords, has given his approval to the electric lighting clauses in the Corporation Bill.

Direct Spanish Telegraph Company.—The Board have decided to recommend a dividend at the rate of 4 per cent. per annum for the half-year ended December 31.

Belfast.—The County Antrim Grand Jury have granted the application of the Belfast Street Tramways Company for powers to extend their system on the Lisburn and Shore roads.

The Brighton Telephone Dispute.—The appeal against the Brighton Stipendiary's decision anent the erection of telephone poles in Ditchling-road is not to be proceeded with by the Town Council.

Birmingham.—Colonel J. Ord Hasted, R.E., has held a Local Government Board enquiry into the application of the City Council for power to borrow £10,143 for the electric installation of the new meat market.

Reading.—The Town Council have accepted tenders for lighting the municipal buildings with electricity. The present lighting costs £480 per annum, and the surveyor estimates that the new system will cost about £450.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended March 14 amounted to £1,280, as compared with £1,095 in the corresponding week of the previous year, being an increase of £185.

Bristol Tramways and Carriage Company, Limited.—The traffic returns for the week ended March 12 were £2,125. 17s. 6d., compared with £1,752. 2s. 3d. for the corresponding period of last year, being an increase of £373. 15s. 3d.

Aberdeen.—The annual visitation of the Corporation gasworks and the electric lighting station took place this week. The members of Council were accompanied over the electric lighting station by Mr. Blackman, the electrical engineer.

Exeter.—At the City Council meeting a communication from the National Telephone Company asking the Council to facilitate the laying of wires underground so as to provide the metallic-current or twin-wire system was referred to the Streets Committee.

Huddersfield.—The minutes of the Electric Lighting Committee read at the Town Council meeting showed that during the month there had been an increase of 17 consumers and of 838 lamps connected, and in the units metered an increase of 13,724, or 48 per cent.

Paisley.—It was intimated at the meeting of the Town Council that the Secretary for Scotland had sanctioned the borrowing of £35,000 for the purpose of capital expenditure on the electric light installation, and advised the laying aside of a sinking fund of £1,000 a year to wipe off the debt.

City and South London Railway.—The returns for the week ended March 14 were £1,031, compared with £949 for the corresponding period of last year, being an increase of £82. The total receipts for the half-year 1897 were £11,806, compared with £10,786 last year, being an increase of £1,020.

Bordeaux.—The Municipality of Bordeaux have appointed a committee to enquire generally into the question of electric traction. A deputation from the company have conferred with the representatives of the city, but at present the authorities are not prepared to definitely deal with the question.

The Lighting of the City of London.—At the meeting of the Commission of Sewers, Mr. Turner called attention to the necessity for some action being taken with a view to effecting a reduction in the cost of the current to private consumers. It was time, he thought, that people in the City should combine to get the charge lowered. No action was taken.

Maidstone.—An interesting presentation took place at the Market Hotel, Maidstone, on Saturday evening, when Mr. Thos. King, who recently started in business as an electrical and mechanical engineer at Maidstone and Brighton, was the recipient of a handsome dressing-case, presented to him by the employés of Messrs. R. Dann, Maidstone, for which firm he has acted as manager for 13 years.

Bolton.—The Gas and Electricity Committee have ordered a main to be laid for the supply of electricity in Bedford-street. A letter was read from Messrs. Dyson and Co., parliamentary agents, enclosing copy of a letter from the Board of Trade as to Clause 16 of the Bolton Improvement Bill, relating to a supply of electricity outside the borough. It was resolved that the clause be retained by the Corporation in the Bill.

National Telephone Company.—The fourth annual staff dinner of the National Telephone Company was held a few evenings ago at the Trocadero Restaurant. Mr. William Gaine (general manager) was in the chair, supported by Mr. J. S. Forbes) president of the Company), Mr. J. C. Lamb, Prof. Hughes, Mr. Quilter, M.P., Sir R. Hunter, Lord Harris, Mr. W. H. Preece, and about 270 members and guests.

Birkenhead.—The Gas, Water, and Electrical Committee of the Corporation have approved a report by the electrical engineer (Mr. Shoolbred) recommending the extension of the electric lighting system to Oxton and Claughton. At present the centre of the town only is provided with electric lighting facilities. Application will be made to the Local Government Board for power to borrow about £20,000 for the purposes of the extension.

Kingstown.—The Board of Commissioners have held a special meeting on the subject of the slow speed at which the electric trams are obliged by the Board of Trade to travel the distance between Northumberland-road and Dalkey. As a result of the meeting it was decided to present a memorial to the Board of Trade demanding that the electric tramway company be allowed to increase the speed of their trams to 12 miles an hour.

Taunton.—The Electric Lighting Committee reported at the Town Council meeting that they had ordered that the necessary steps be taken for obtaining the additional boiler which was included in the loan of £5,000 sanctioned by the Local Government Board in December, 1894. The Council have decided to enter into an agreement with the Electric Lighting Extension Syndicate to introduce their system of free wiring and the supply of electricity by penny-in-the-slot meters.

Leicester.—The Gas and Electric Lighting Committee report that the accounts of the electric lighting undertaking for the half-year ending December 31 last have been submitted to them, from which it appears that the result of the working to the date named, after paying interest on capital and £579. 14s. 8d. on account of sinking fund, is a profit of £457. 14s. 6d. Deducting this amount from £2,060. 18s. 1d. loss to June 30 last, shows a net loss in connection with this department of £1,603. 3s. 7d. The total amount which has been paid on account of sinking fund is £2,500. 10s. 7d.

Brighton.—The accounts of the Corporation electricity works for the past year show a profit on the year's working of £14,680. 19s 5d. With the balance brought from the last account a total of £15,830. 19s. 5d. is attained. Of this £4,519. 18s. 3d. is absorbed by interest charges, and £4,311. 1s. 2d. by sinking funds; £5,000 are carried to the next account, and £2,000 voted to the relief of the district rate. Of the income of the year £22,056. 5s. 7d. came from electricity sales to private consumers, and £5,956. 8s. 8d. from charges for public lighting.

Walsall.—The total number of consumers supplied on February 28 last was 79. The net income for the month was £182. 0s. 3d. The wages paid during the month amount to £40. The value of coal consumed was £23 10s. The chairman of the Electric Lighting Committee has been authorised to accept a tender for putting a large window in the boiler-house in front of the new Babcock boiler to enable the tubes to be withdrawn if necessary. The electrical engineer has succeeded in greatly reducing the smoke from the chimney of the boiler-house, and thus no expense has been incurred, the improvement being due to the careful hand-firing.

Chester.—At the Town Council meeting the Mayor moved that the Electric Lighting Committee be authorised to order additional plant for the generating station at a cost of £8,530, and the resolution was adopted. A further resolution was carried authorising the Council to apply to the Local Government Board for sanction to borrow a further sum of £20,000 to cover the extensions up to now, the additional plant required at the generating station, and future extensions. The gas company having put up the price of gas, the Corporation are now talking of lighting the streets with electricity and doing away with gas altogether.

Tramways Association.—Application has been made to the Board of Trade for a license directing an association about to be formed under the name of the Tramways and Light Railways Association to be registered with limited liability without the addition of the word "Limited" to its name. The objects for which the association is proposed to be established are to promote, encourage, and facilitate the construction, extension, and working of tramways, light railways, and the development of electric and other modes of mechanical traction, and to promote and provide every facility for the discussion and publication of all matters connected with tramways and light railways, and for various other purposes.

London.—The Highways Committee reported at the London County Council meeting that application had been made by the National Telephone Company for permission to place four cable-heads in the Victoria-embankment subway at Blackfriars, two of which would be for connection with certain cables belonging to the Post Office authorities, entering the subway from New Bridge-street, the others remaining for the present unused. The company had submitted a drawing showing the manner in which the cable-heads would be fixed in the subway, and the committee were advised that there was no objection to what was proposed. They accordingly recommended that permission be given. The recommendation was carried.

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Annual Supper.—The employés of the telegraph department, Caledonian Railway Company, held their annual supper last week. The Chairman (Mr. Dunn) drew attention to the enormous development of electrical appliances in connection with modern railway working. He mentioned that the company had now 9,450 electrical instruments on their system and 23,500 miles of wire on their poles compared with 412 electrical instruments and 7,500 miles of wire in 1870. There were 3,500,000 railway messages dealt with last year compared with 360,000 in 1870, and the number of telegrams dealt with on behalf of the public last year amounted to 386,543. The wages bill last year reached £20 000.

Stafford.—Alderman Peach explained at the Town Council meeting, with regard to the electricity department, that in the provisional order for 1890 the Corporation obtained the sanction of the Local Government Board to borrow £20,000 for the purpose of carrying out the electric lighting order, and £15,000 of this amount had been taken up. The committee now agreed with the suggestion of the Finance Committee that the remaining £5,000 be taken up and debited to the electric lighting account. The additional amount over the £15,000 had been spent upon extensions and underground mains to supply the infirmary, the new technical schools, etc. The capital of the electricity department must increase as the business increased.

Appointment Vacant.—A professor of natural science is required for the Thomason Engineering College, Rurki, in the North-West Provinces of India. He should be a practical electrical engineer, and qualified to lecture in and teach electricity, magnetism, heat, sound, light, and the elements of chemistry, geology, and mineralogy. He should understand telegraph engineering. The salary will be Rs.500 a month in the first year, rising by Rs.50 a year to Rs.700. If retained on termination of five years' agreement salary Rs.750 a month rising to Rs.1,000, with benefit of leave and pension rules from date of first appointment. Applications should be addressed to the Secretary, Judicial and Public Department, India Office, London, not later than the end of March.

Leeds.—At a meeting of the Lamp Committee of the Corporation it was decided to recommend the Council to light the streets from the Great Northern Railway Station to the public dispensary by electricity. The lamps to be used will be arc lamps of 1,000 c.p., placed at 40 yards apart. The Tramways Sub-Committee have had under consideration the question of extending the tramways along Armley-road, Whingate-road, and Meanwood-road to the Beckett's Arms. The proposed extension in Armley-road would be 1 mile 167 yards in length; in Whingate-road, 824 yards; and in Meanwood-road, 1 mile 501 yards. It was decided to recommend the Council to allow these extensions to be carried out immediately after the lines to Hunslet, Headingley, and Chapeltown have been relaid.

Hove (Brighton)—At the Urban District Council meeting Mr. Bulmer moved the confirmation of the proceedings of the Town Hall Committee, which contained a return as to the amounts paid for gas and electricity. He said there had been a gradual increase in the cost year by year. If they compared the figures when the hall was lit with gas only in 1863, and the figures now when the building was partly lighted by gas and partly by electricity, they found a difference of £88. 6s. 2d. That seemed a very large increase, but they got a far superior light. They had not yet finished with the electric lighting, for there would have to be six electroliers in the great hall, when there would be 180 lights altogether. No doubt then the difference, instead of being one of £88, would perhaps be £100. The proceedings were adopted.

Bordeaux Tramways.—At the meeting of the Bordeaux Tramways Company, Limited, in the City, Lord Richard Brown, who presided, said with reference to the question of electric traction he thought that the Municipality of Bordeaux were just as enthusiastic as before for the conversion of the company's line into an electric system, and he believed that they were at the present time making enquiries into the subject in various parts of the world. The position of the matter, however, was that they were not any more advanced than they were a year ago, and no scheme had been brought forward up to the present. They did not know exactly the terms on which a concession for the use of electricity would be offered to the company. The directors were anxiously watching the matter, and they had reason to believe that they stood well with the Municipality.

Coventry.—At the City Council meeting Alderman Hill moved the adoption of the Electric Light Committee's accounts for the past year. The consumers on January 1, 1896, were stated to be 31, and the lamps connected equivalent to 1,834 of 8 c.p. On December 31 the consumers had increased to 72, and the lamps connected were equivalent to 5,662 of 8 c p. There has been an actual loss on the year's working of £41, but to this had to be added £895. 13s. 10d. interest on capital, and payment to sinking fund of £769. 19s. 2d., making a total charge on the rates of £1,706. 13s. 8d., which had been provided for in the estimates for the year ending March 31 next. Alderman Hill and Mr. West expressed belief in the ultimate success of this latest undertaking of the Corporation, and they looked to being able to supply electric motor power. The report was adopted.

Llandudno.—At a meeting of the District Council the Clerk read a letter from Mr. Warwick Webb, on behalf of the promoters of the light railway from Colwyn Bay to Llandudno, making an offer to withdraw their present scheme if the Council would come to an arrangement for them to carry out a complete scheme all over Llandudno. The Council decided not to consider Mr. Webb's letter until after the decision of the Light Railway Commissioners had been received. Mr. T. T. Marks moved that it be an instruction to the electrical engineer, Mr. A. H. Preece, to further consider the question of electric tramways as contained in his report of March 3, with a view to the plant and apparatus now being designed for the Council being further developed, so as to provide power for working the tramways proposed to be laid down by the Council. Mr. J. O. Thomas seconded. Mr. Marks's resolution was carried by nine votes to five.

Wolverhampton.—A Local Government Board enquiry was held in Wolverhampton yesterday (Thursday) on an application by the Corporation for £1,555 for the purposes of electric lighting. That sum has been, or is to be, spent in additional machinery. It seems that the light is monthly becoming more popular, and Mr. Lewis, the borough electrical engineer, stated to an interviewer this week that when the books are made up at the end of March he hopes to show a profit on the year's work. Last year there was a small adverse balance of about £200. He also states that a form of reduction in the price of the light will be made, but that cannot be decided upon until the accounts are made up. The number of customers at the end of February was 151, as compared with 111 last year. The total number of private lamps is 9,888, reduced to 8 c.p.—an increase for the year of 22 per cent. There are 51 street lamps, as against 42 last year. For the year so far the increase in units sold over 1895 is 30 per cent.

Derry.—At the meeting of the Corporation, Alderman O'Kane moved, and Councillor Toland seconded, "That steps be taken to improve the lighting of Chamberlain-place, Eden place, and Lecky-road after midnight, on alternate nights, by altering one of the lamps to the opposite circle, at a cost not exceeding £15." The motion was, after a short discussion, agreed to. Councillor Hannigan moved, "That a new arc lamp be erected at head of Wellington-street." Councillor M'Laughlin seconded the motion. Councillor M'Cully suggested that this be put off for some time till the Corporation would have a better system of lighting perfected for general use all over the city. Alderman O'Kane said he heard of no such system being introduced as that referred to by the previous speaker. He was not aware of any intended extension of city lighting except that he had heard it spoken of that house-to-house lighting by electricity was in view.

Tunstall.—At the Urban District Council meeting the Clerk reported that on the 18th ult. the chairman of the Council, the chairman of the Highways Committee, and himself attended the enquiry held by the Light Railway Commissioners at Newcastle as to the granting of the application made by the British Electric Traction Company, Limited, for an order authorising the construction of certain light railways in the Staffordshire Potteries, when the deputation obtained an undertaking from the company to amend their order so as to provide that the construction of the line to Trubshaw Cross should not be optional but compulsory, and that their railways and running powers over the authorised tramways should be subject in the district to the same terms, or terms to the same effect, as those which the Council obtained under the Potteries Extension Tramways Order, 1896. The company further undertook to pay the reasonable costs incurred by the Council.

Edinburgh.—The Cleansing and Lighting Committee recommend that the following extensions of the present public electric lighting of the streets of the city should be made, at the rate of £16 per lamp: for 1897-98—Picardy-place and York-place, from Leith walk to St. Andrew-street, 10 lamps; Abbey-hill and Abbey-mount, connecting Watergate and Regent-road, eight lamps; Grove-street, connecting Fountainbridge and Morrison-street, six lamps; Castle-terrace, seven lamps; Bread-street, three lamps; Market-street, three lamps; Guthrie-street, one lamp; Morningside-road, from Newbattle-terrace to Morningside, 13 lamps; Lothian-street and College-street, four lamps; Grindlay-street and Cambridge-street, six lamps. For 1898-99—Minto street and Newington Station, 16 lamps; Bristo-street, Chapel-street, and West Cross-causeway, eight lamps; Dundee-street, adjoining Dalry-road at Ardmillan-terrace, 13 lamps; Raeburn-place to Comely Bank, 10 lamps; Theatre Royal, Broughton-street, to Canonmills Bridge, 16 lamps. The committee agreed to appoint Councillor Menzies convener during the absence of Councillor Cranston in America.

Guildford.—The town clerk read a letter at the Town Council meeting from the Board of Trade, enclosing certificate of Major Cardew releasing the deposit made by the Guildford Electric Lighting Company, the company having expended a sum equal to the amount deposited by them for works executed in connection with the undertaking. Mr. Bullen did not know whether that had anything to do with the paving, because the way in which that matter was being treated was a disgrace to the town. Mr. Peak asked if the ratepayers were to be put to the great expense of making good the paving after it had been patched about as it had. Instead of the work being properly done, little bits of brick were being put in by a labourer, and the whole thing was in a most unsatisfactory state. The Surveyor said he had seen the contractor on the subject, and he said the stones were broken before he took them up. Mr. Salisbury reminded the Council that they had already passed two resolutions that the surveyor should do the work and charge the company with the costs.

Cardiff.—Alderman Jacobs, at a meeting of the Lighting Committee held on Tuesday under the chairmanship of Alderman P. Carey, said they could secure a tremendous number of customers if they gave inducements to them. Mr. Evans: According to Mr. Applebee (electrical engineer) we are as low as anyone. Alderman Jacobs argued that if they were to make money they must first of all be prepared to lose some. The Chairman explained that there was only one other station (Charing Cross) where the plant was run to such an extent as Cardiff. Alderman Jacobs: We ought to go in for doubling our plant at once. I

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know we could get customers if we supplied the energy cheap. The Clerk read the sanction of the Local Government Board for the Lighting Committee to borrow £2,450 for the purpose of electric lighting works—£850 is for office accommodation at the works, and the rest is for the extension of mains in Cathedral-road. The committee decided to appoint a practical man, to be under the instructions of the electrical engineer, as boiler inspector.

Telegraph Manufacturing Company, Limited.—The above Company, at their Britannia Telegraph Works, Helsby, have been very busy latterly. The works are at present receiving large additions, but this is nothing novel, we are told, for continual extensions have been in progress ever since the works started, or practically so. This is a healthy sign, and one, moreover, which we are glad to report. The work which the Company has on hand at present includes two very large telephone-exchange switchboards for Nottingham and Birmingham respectively. The works demand for light and power has grown beyond the capacity of the electrical plant installed, so that extensions in this direction have also to be faced. It is proposed to erect a small generating station adjacent to the railway line on property owned by the company, and to instal plant sufficient to light the works throughout and to drive the numerous machines in use by means of separate motors. Although the proposed site is some little distance from the works, this inconvenience will, we understand, be more than compensated for by the better facilities which it affords for coaling, and the scheme will allow of the space occupied by the present boiler and electrical plant, etc., being utilised for other purposes.

Yarmouth.—The electric light statement, which was produced at the Town Council meeting, showed a surplus from the working expenses of £135. 5s. 4d. to meet capital and other charges of £150 per month. It was resolved to put up additional condensing plant at the generating station at a cost of £1,200, and apply for a loan for that amount. With a view to improving the lighting of the approaches to Vauxhall Station, so as to have a light at the station entrance all night, the Surveyor said cables could be laid, etc., at a cost of £90, and it would be a public improvement. The Council resolved to carry out the work, subject to the Great Eastern Railway Company undertaking to pay £40 per annum for the two additional lamps provided. On the recommendation of Mr. Preece, it was resolved to reduce the charge for the current motors to 3½d. per unit. Alderman Wiltshire asked why a loan was to be applied for £1 200 for the condensing plant, when, according to the accounts, only £18,495 had been spent out of sanctions for £34,000? The Surveyor replied that between £28,000 and £29 000 had been expended. The loans sanctioned for £34,000 were for specific purposes, in which condensing plant was not included, and the remainder available was for further plant and house-to-house connections.

British Insulated Wire Company.—We recently had occasion to visit the works of this Company at Prescot, and were pleased to find all departments very busy there. One order, which is very much in evidence about the works just at present, is that to supply 60 miles of trunk telegraph cable for the Government. It consists of 76 separate wires, and will form a portion of the proposed new trunk line between London and Birmingham. Only a portion of the cable which will be required to complete this line is, as yet, on order, the value of this portion representing the amount of money voted by the Government for the undertaking for the financial year. A point worthy of notice with regard to the works is the total absence of any shafting and countershafting, the numerous cable stranding and taping machines in use being all electrically driven by means of separate motors. Even the overhead cranes are worked by electric motors, and it is indeed marvellous to see with what ease and facility great reels of cable, weighing, we daresay, from six to eight tons apiece, are dealt with by their means. From what we could gather, this separate motor system gives great satisfaction, the percentage of power lost working out exceeding small when compared with the old-fashioned and clumsy method of running off countershafting. English manufacturers seem to be waking up to the great advantages which electricity affords for running machinery economically, and we shall no doubt witness the rapid adoption of the separate motor system in the near future.

Colwyn Bay.—The surveyor presented the following report at the Urban District Council meeting with reference to electric lighting and the refuse destructor: "As directed by the Council the schemes of electric lighting of the district were sent to Dr. J. Hopkinson, and I beg to submit his report, which I received this morning: 'Westminster-chambers, 5, Victoria-street, S.W., March 1, 1897. I have carefully read all of the 10 schemes submitted for the electric lighting of Colwyn Bay. I am of opinion that the following three are best and of substantially equal merit—Bennett, Fawcus and Clirehugh, and Highfield—and I would prefer to make an award of an equal division of the prizes amongst these three. Any one of them would be capable of carrying out the work in a satisfactory manner. I am, however, by no means sure that it is worth your while complicating your plant by the means of utilising the destructors for generating steam unless you provide batteries on an adequate scale for storing the current generated from this steam during the whole of the 24 hours, and for giving it out as current during the short time during which such current may be used.—J. HOPKINSON." It was agreed that the surveyor be instructed to write to Dr. J. Hopkinson to ask him to make some distinction between the three selected by him, according to merit and price. The surveyor had received a further communication from Dr. Hopkinson stating that in his opinion the scheme of Messrs. Fawcus and Clirehugh was the most adapted to the requirements of Colwyn Bay. The Council resolved to invite that firm, and also Mr. Bennett, to visit Colwyn Bay and explain their respective schemes fully to the Council.

The Liverpool Tramways.—The special committee appointed last Saturday by the City Council to negotiate for the purchase by agreement of the Liverpool Tramways Company have concluded, subject to the approval of Parliament, an agreement for the purchase of the undertaking as from January 1 last. The price paid has not transpired, but is supposed to be on the basis of £12. 15s. per share, or £500,000. The earnings of the company are approximately £35,000, and there is an unexpired lease of 18 years Should the Council determine to introduce electrical or other mechanical traction, which would mean a further outlay of half a million of money, the cost of working would be reduced by 50 per cent. The company, whose assets it is now proposed to acquire was originally founded in 1860 under the designation of the Liverpool Road and Railway Omnibus Company, a designation which was changed in 1878 to the Liverpool United Tramways and Omnibus Company. When George Francis Tram started English street tramcars in Birkenhead, many people were disposed to view them more as curiosities than practical conveniences, and even years later when lines were laid down in Aigburth-road, the metals were considered more perilous than useful, and were removed by order of the Toxteth Park Local Board. The United Tramways and Omnibus Company was incorporated by Act of Parliament in 1879, and five years later the company bought up several rival organisations. The city lines were laid down by the Liverpool Corporation, and the company's lease of them was for 21 years ending in 1905, but a few years ago this lease was extended. Though the company has had some vicissitudes, like most other undertakings, it has had a tolerably long run of prosperity.

The Wiring of Blackwall Tunnel.—The Bridges Committee of the London County Council reported at the last meeting as follows: "We have to report that we have received a letter from Messrs. Laing, Wharton, and Down, calling attention to the fact that when they submitted their tender to the Council on 16th ult., for the wiring required in connection with the electric light for the Blackwall Tunnel, they stated that, as the time was very short to thoroughly go into the matter, they had estimated on the basis of the quantities of wire taken from the plan which they had been furnished with. The firm inform us that, having now gone fully into the quantities, they find that they have under-estimated the quantity required to an extent in value of £250, and they ask that an additional sum of £200 may be added to the contract price, which will raise the figure from £4,700 to £4,900. The engineer has gone carefully into the figures with the contractors' representative, and he reports that the statement which Messrs. Laing, Wharton, and Down have made, that they have under-estimated the quantity, is correct. We feel bound to remind the Council that the time allowed for the preparation of the tenders was very limited, and we, therefore, think that it should accede to the request of the contractors, especially as it is desirable to facilitate the completion of the work, and to remove any feeling of unfairness. In submitting our recommendation to the Council, it is to be clearly understood that the contractors are to take all risks of error in the quantities to be used, and will make no further claim on this head. We have also to point out that the proposed increase will not exceed the engineer's estimate of the cost, which is £5,800. We recommend that Messrs. Laing, Wharton, and Down be allowed an extra sum of £200 upon their contract for the supply of wires for the purposes of the electric light at the Blackwall Tunnel on condition that the contractors do take all risks of error in the quantities to be used and will make no further claim upon the Council under this head." This was agreed to.

Bath.—The Electric Lighting Committee have presented the following report to the Urban Sanitary Authority: "In pursuance of your resolution adopting the report from this committee on October 5 last, a supplemental memorial has been presented to the Local Government Board asking their sanction to borrow a further sum of £13,000 (in addition to the £45,000 previously authorised by the authority) for the extensions and works recommended by Mr. Hammond. The Local Government Board enquiry upon the applications for sanction to borrow for the purpose of the purchase and extension was held before Mr. Inspector Tullock on October 30 last. On December 23 a sanction was received from the Board authorising the borrowing of the sum of £44,578, repayable with interest over a period of 20 years, but the Board intimated that applications for any sums for extensions of mains must be made from time to time as the occasions arose. The committee, with the assistance of Mr. Hammond and the manager, gave instructions for an application to the Board for its sanction to an immediate loan for the extension of low-tension mains within the present area of supply, and such high-tension mains beyond that area as were considered advantageous, and upon the consideration of these extensions a list of streets has been formulated. A plan of the extensions and estimate of the expense has been obtained. These documents have all been submitted to your committee and carefully considered. The total amount required is estimated at £6,880. An application, with the necessary plans and estimates, has been submitted to the Local Government Board for their sanction to borrow this further sum, and is now under their consideration. At the same time an urgent request has been made to the Board to extend the period of repayment to 25 years, and your committee hope for the reasons set forth in the request that the Board will deem it right to grant the request. The tenderers for lamp columns were informed that the height must be reduced from 22ft. to 18ft., and were invited to erect a specimen column in the district for inspection and

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approval. Two firms accepted the invitation, the other firms tendering requiring an amount in excess of what your committee thought it advisable to incur for the sample lamps, consequently sample lamps have been ordered from the two firms—viz., the Electric Construction Company, Limited, and Messrs. Fowler and Co.—who will erect the sample lamps upon the terms offered. After obtaining a certificate from Mr. Hammond that the plant at the works in Dorchester-street was in accordance with the terms of the agreement, instructions were given to your clerk to complete the transfer, and on January 7 last the purchase from the local company was completed by the payment of £24,533 (the contract sum), and the authority became the owners of the undertaking, and have since carried out the public and private electric lighting. Under the Bath Electric Lighting Order, 1896, the Board of Trade is to appoint an inspector, and may do so either at the instance of the authority or of a consumer: your committee have therefore submitted the name of Mr. J. W. Gatehouse as a fit person for appointment by the Board of Trade. The mode of payment for his services has yet to be considered by your committee. The contracts with the Electric Construction Company, Limited, and with Messrs. Callender, Limited, have been settled, sealed, and exchanged; the contract for the supply of the crane is in the course of settlement under the direction of the committee. Mr. Councillor Roadhouse has been appointed auditor of all bills, Mr. Councillor Vincent to act in his absence; and a committee of five—Aldermen Jolly, Sturges, and Taylor, with Councillors Mitchell and Roadhouse—has been appointed, to whom all bills incurred by your committee are to be examined and recommended to your committee for payment if not exceeding £5 or governed by contract. Those over £5 and not governed by contract to be referred to the authority for payment."

Radcliffe.—At a meeting of the Electric Lighting Committee of the District Council the Surveyor presented an interesting report on the use of electricity in Radcliffe. In the course of the report he said: "With an area so fairly compact, and a central station so favourably situated, I think it is now made fairly clear that for nearly all practical requirements of town-lighting, the continuous-current direct-supply system, or low tension with accumulators, will prove simpler and less costly, as well as more advantageous than any other system whether direct or alternating, in which transformers are used; in fact, the use of this class of apparatus except in special cases, such as are exemplified at Windermere and other scattered districts, seems now to be nearly abandoned. The adoption of a higher voltage, however, than what is in use at Nelson or Lancaster will be essential to the success of any extensions beyond the limited area in the centre of the town, and this of course is now made possible under the revised rules of the Board of Trade, and by improvements that have been effected in the manufacture of incandescent lamps. It is generally admitted that in a three-wire distribution system at 110 volts, as at Nelson and Lancaster, it is not economical to extend beyond a radius of three-quarters of a mile from the central station except under special circumstances. The use of a tension of 220 volts, however, permits of the extension of the main supply leads to a triple distance, or say a 2¼-mile radius of the station, and such an augmentation of voltage renders it possible with conductors of a given capacity to feed a double number of lamps at a less percentage of loss and at double distance with the same expenditure of energy. The variations due to the insertion or exclusion of motors or of important groups of lamps, or to errors in working at the central station, will be also reduced to one-half. When it is considered that the cost of the copper conductors constitutes one of the most important items of an installation, the advantage of a higher voltage will readily be understood. As, however, it will be seen that the 1¼-mile radius covers the whole district ever likely to be supplied with electricity, and having due regard to the requirements of consumers, and the present state of incandescent lamp development, it may be desirable for the committee to consider if a lower voltage than 220 should not be adopted, as this latter will involve abandoning the use of 8-c.p. lamps, or of tolerating a greatly inferior efficiency, and this would probably, in a district like Radcliffe, entail the loss of many consumers which it would be desirable—and, indeed, essential—to retain. If, in order to avoid these disadvantages, the standard pressure of distribution was fixed at 150 volts, it would probably far better meet the requirements of this district. On the continuous-current three-wire system this would give 300 volts across the outer conductors, or 150 volts on each side of the middle conductor. The 300 volts is very suitable for feeding motors or for arc lighting, while the economy of 150-voltage lamps very nearly approaches that obtainable in ordinary 100-volt lamps. With regard to the feeder and distribution mains, I think it will be well to keep in view the fact that—at least, in the early development of the undertaking—the Council will probably be the principal consumer, and may, if so disposed, commence operations with a considerable number of lamps in the streets and in public buildings and other undertakings under their own control. It is therefore essential that this public lighting should not be confined within too narrow limits, but be made as far as possible a source of enlarging the revenue of the undertaking, and thus diminishing the probability of any charge having to be made upon the rates in its aid. Beyond this consideration there is also the fact that a better standard of street-lighting than the present is greatly needed. There are in the district at present a total of about 614 street lamps, and of these I have indicated on the larger scale map about 250 that could without any extravagant extension of mains be lighted by electricity. The system of arc lighting would be too expensive to adopt on a large scale. The annual cost of a five-ampere arc lamp, giving about 450 c.p., or similar to one at the technical school, burning 1,800 hours per annum, would be about £15, including current, carbons, and attendance. Arc lamps, however, could reasonably be placed at important centres—say, at the bottom of New-road, on the Market-place, at Sandiford-turning, and at the bottom of Ainsworth-road. With respect to the other lamps, I should say that a 16 c.p. incandescent lamp fixed in each public gas lamp would give the degree of improved public lighting that can be reasonably expected. A 16-c.p. lamp is equal to a gas-burner using 6ft. of gas per hour, whilst the average of the lamps at present in use here is only about 3½ft. per hour. The cost for current per annum for a 16-c.p. lamp burning 1,800 hours would be about 35s., but this might be reduced by having the lamp circuits arranged in suitable groups for switching purposes. The existing standards could be very well used, and also the lanterns; to provide new globes with automatic cut-outs as at Windermere would be very expensive, and any breakages would require an entire replacement, both of lamps and globes. The district shown on the larger scale map could for street-lighting be conveniently divided into eight areas of about 30 lamps each, each area being fed by means of a cable from feeder stations, with switch, placed (1) on the Market-place, (2) at Sandiford-turning, and (3) at the bottom of Ainsworth-road, the lamps to be arranged in simple parallel, and not in series, so that they would not require any automatic switches or stand-by lamps. As the cables for public street-lighting would require very few reconnections making after being once laid, they could be of the concentric armoured type and laid direct in the ground, and about 3in. above them tarred boards 6in. by ¾in. placed so as to give an indication of the presence of the mains to anyone opening the street at a future date. The cost of these public street-lighting cables would be about £140 per mile. The feeder stations mentioned above would also be the points from which the ordinary three-wire distributing mains would radiate. These should be laid under the footways either in cast-iron or stoneware conduits, with drawing-in and service boxes placed at all street junctions and connections. The feeder cables from the central station to the feeder stations should also be laid in similar conduits and provision made in them at least up to the first station at the Market-place for future feeders to be carried down Church-street for Radcliffe Hall Ward. Future extensions of distribution mains in Stand-lane Ward could be supplied by feeders carried direct over the river *vid* the sewer conduit. A feeder station at the bottom of Ainsworth-road would not be absolutely requisite to begin with, but would be desirable for extensions in Black-lane Ward. This latter station might be supplied by feeders *vid* Wilton-street, Radcliffe Bridge Station, Victoria-street, and the proposed canal footbridge. The whole would then form a network, so that should a feeder to any station be damaged current would be supplied from another direction. The distributing mains it would be desirable to have all single-conductor cables, but the feeders could all be concentric cables. With regard to the provision to be made at the central station, I would suggest that the buildings should contain space sufficient for accommodating plant for a total output of about 15,000 8-c.p. lamps—that is, of a size similar to that at Lancaster. The plant to be first installed, however, I would suggest should not have a greater capacity than for an output of 150 kilowatts, which is about 50 per cent. larger than that at Nelson, and about three-quarters of the size of that at Lancaster; it would supply 5,000 8-c.p. lamps at any one time, and probably 7,500 c.p. actually installed. The combined power requisite for this installation would be about 300 i.h.p. The combined power of the engines at Nelson and at Lancaster are respectively 220 i.h.p. and 395 i.h.p. If an output for 4,000 8-c.p. lamps (which would be equal to 6,000 actually installed) is considered sufficient to commence with, the dynamo capacity would be 120 kilowatts and the power 225 i.h.p. The plant in either case to be of course in two or more sets. It will also be desirable to provide a battery of accumulators in two sets of, say, 60 cells each, as at Lancaster for the day load, as, taking into consideration the nature of this district, no scheme can be expected to pay if the machinery has to be kept going continuously."

PROVISIONAL PATENTS, 1897.

MARCH 8.

6017. A new or improved combination and method of working to obtain motive power by the use of carbon dioxides. John Newton, 511, Old Kent-road, London.

6073. System of mounting acoustic trumpets to phonographic apparatus. Henri Jules Lioret, 52, Chancery-lane, London.

6081. Improvements in apparatus for electric lighting. James Hardie McLean, 24, Southampton-buildings, Chancery-lane, London.

6087. An improved electric circuit closing thermometer. Joseph Kent and William Lingley, 53, Chancery-lane, London.

MARCH 9.

6155. Electrical road-traction installations worked by means of both alternating and continuous currents. Max Déri, 28, Southampton-buildings, Chancery-lane, London. (Complete specification.)

6178. An improved device for preventing certain induction effects in electric telephones. Heinrich Messing, 45, Southampton-buildings, Chancery-lane, London.

6188. Improved means applicable for use in the electrolysis of salts. James Hargreaves, 191, Fleet-street, London.

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6181. **Improvements in electric cables and in their manufacture.** Willoughby Statham Smith and William Puddicombe Granville, 24, Southampton-buildings, Chancery-lane, London.

6197. **Improvements in or relating to electric apparatus for governing engines.** John Snow and Alfred George Cooper, 111, Hatton-garden, London.

6212. **Improved means for supplying electric current to electrically-operated time-keeping mechanism.** Alwyn Walter Staveley, Isaac Hardy Parsons, and Thomas John Murday, 4, South-street, Finsbury, London.

MARCH 10.

6243. **Improvements in and relating to the protection and support of underground electric conductors.** Henry Schuster Cowx, 4, St. Ann's-square, Manchester.

6246. **Improvements in electric arc lamps.** Robert Dobson, 14, Sackville-street, Salford.

6251. **A combination watch-stand accumulator or storage battery and electric lantern.** Sidney Frank Walling, 52, West-street, Sheffield.

6262. **An electric brake for road or rail vehicles.** Douglas Neale, 21, Rutland-square, Edinburgh.

6263. **An improved controlling switch for electrically-propelled road or rail vehicles.** Douglas Neale, 21, Rutland-square, Edinburgh.

6276. **Improvements in electric arc lamps.** Rookes Evelyn Bell Crompton and Edmund Arthur Norman Pochin, 55, Chancery-lane, London.

6287. **Improvements in automatic switches by clockwork and actuated by the electric current as applied to the illumination of clock and other dials for advertising purposes, signalling, and the like.** William Henry Stockall, 6, Clerkenwell-road, London.

6303. **Improved electric incandescent lamp.** Richard Bruno Roxby, 18, Featherstone-buildings, High Holborn, London.

6305. **Improvements in multiple-system telephone installations and apparatus therefor.** Siemens Bros. and Co., Limited, 28, Southampton-buildings, Chancery-lane, London. (Siemens and Halske, Germany.)

6306. **Improvements in jacks for telephone exchanges.** Siemens Bros. and Co., Limited, 28, Southampton-buildings, Chancery-lane, London. (Siemens and Halske, Germany.)

6307. **Improvements in pegs and their cords for telephone exchanges.** Siemens Bros. and Co., Limited, 28, Southampton-buildings, Chancery-lane, London. (Siemens and Halske, Germany.)

6308. **Improvements in indicators for telephone exchanges.** Siemens Bros. and Co., Limited, 28, Southampton-buildings, Chancery-lane, London. (Siemens and Halske, Germany.)

6309. **Improvements in calling-off apparatus for telephone exchanges.** Siemens Bros. and Co., Limited, 28, Southampton-buildings, Chancery-lane, London. (Siemens and Halske, Germany.)

6335. **Improvements in electrical arc lamps.** Frederik Wilhelm Andersen, 40, Chancery-lane, London.

MARCH 11.

6351 **Improvements in electric incandescent lampholders.** Herbert Hampton Hall and Thomas Clarke, 57, Barton-arcade, Manchester.

6353. **Electrical switch or contact-maker or contact-breaker.** Francis Fane Teatman and Walter Donovan, 2, The Arcade, Reading.

6398. **Improvements in electricity meters.** George Hookham, 7, New Bartholomew-street, Birmingham.

6428. **Improvements in electrical switches.** Henry Charles Gover, Charles Faraday Proctor, and Alfred Hewson Bate, 28, Southampton-buildings, Chancery-lane, London. (Complete specification.)

6431. **Improvements in electrical apparatus for communication between rooms and other places.** George Shields Eckford, 23, Southampton-buildings, Chancery-lane, London.

MARCH 12.

6433. **Improvements in means for facilitating telephonic conversation.** Alfred Charles Brown and George Richard Neilson, 50, Old Broad-street, London.

6434. **An improved combined brush and holder for dynamo-electric machines.** James Latham, 12, Gladstone-road, Farnworth, R.S.O., near Bolton.

6494. **An electrical destructor or cooker; an apparatus for destroying animal, vegetable, and other refuse (instead of turning it into drains) by means of heat generated by electricity; or may be used for cooking purposes.** James Hibbert, 73, Wilmslow-road, Withington, near Manchester.

6545. **An improved composition for increasing the illuminating power of electric arc lamps.** Paul Mersch, 45, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents, etc., Act, 1883, Section 103, February 19, 1897, being date of application in France.)

6563. **An insulating stud and nut for electrical storage battery plates.** Alfred Martin, 76, Florence-road, New Cross, London.

MARCH 13.

6616. **Improvements in the manufacture of reflectors specially applicable to electric incandescent lamps.** William Evans, 57, Barton-arcade, Manchester.

6666. **Improvements in regulating apparatus for electric arc lamps.** James Brockie, 28, Southampton-buildings, Chancery-lane, London.

6674. **An improved dry primary cell or battery.** William Shaw, 70, Wellington-street, Glasgow.

6687. **Improved means for supplying current to electrically-propelled railway or tramway vehicles.** James Enright, 202, Holland-road, Kensington, London.

6695. **Improvements relating to electric tramways and railways on the sectional conductor system.** Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Riccardo Arno and Aristide Caramagna, Italy.) (Complete specification.)

SPECIFICATIONS PUBLISHED.

1895.

21798. **Telegraph and other signals.** Nicholson.

1896.

3550. **Simultaneous telephony and telegraphy.** Smith and the New Phonophore Telephone Company, Limited.

3968. **Electrical dial indicating and communicating apparatus.** Butcher.

4069. **Electric vaporiser for oil-engines.** Clubbe and Southey.

6148. **Fittings for electric lighting.** Lea.

6692. **Fusible electric cut-outs.** Blackburn and Spence.

7318. **Electric heaters.** Gold.

8062. **Collectors and conductors of electric railways.** Davies.

8338. **Mode of connecting the car with the overhead wire in tramways worked by electricity.** Kenway.

8569. **Apparatus for making electrical contact by passage of a railway train.** Tyer.

27284. **Magnetic separators.** Feeney. (Hamilton.)

1897.

1239. **Means and apparatus for effecting electrical traction on railways and tramways by a contact rail and trolleys at the ground-level.** Demeuse.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	£	9½-9¾
Brush Company, Ordinary	£	⅞-1
—— Non. Cum., 6 per cent. Pref.	£	1½-1¾
—— 4½ per cent. Debenture Stock	100	107-111
—— 4½ per cent. 2nd Debenture Stock	100	96-99
Callender's Cable Company, Debentures	100	104-109
Central London Railway, Ordinary	10	9½-10
——	6	5½-5¾
Charing Cross and Strand	£	10½-11½
Chelsea Electricity Company	£	9½-10
—— 4½ per cent. Debentures	100	113-115
City of London, Ordinary	10	18¼-.9½
—— 6 per cent. Cumulative Pref.	10	16½-17½
—— 5 per cent. Debenture Stock	100	132-136
City and South London Railway, Consolidated Ordinary	100	59 61
—— 4 per cent. Debenture Stock	100	139-141
—— 5 per cent. Pref. Shares	10	15½-16
County of London and Brush Provincial Co., Ordinary	10	10¾-11½
—— 6 per cent. Cum. Pref.	10	14¾-15½
—— 4½ per cent. 2nd Debenture Stock	10	14½-14¾
Crompton and Co., 7 per cent. Cum. Pref. Shares	£	1¾-2¼
—— 5 per cent. Debentures	—	96 98
Edison and Swan United Ordinary	£	1¾-2¼
—— 5 per cent. Debentures	£	3-4
—— 4½ per cent. Debentures	100	105-110
Electric Construction, Limited	£	1½-1¾
—— 7 per cent. Cumulative Pref.	£	2½-3
Elmore's Copper Depositing	1	¾-1⅛
Elmore's Wire Company	£	⅜-½
W. T. Henley's Telegraph Works, Ordinary	10	19½ 20½
—— 7 per cent. Preference	10	18½-19½
—— 4½ per cent. Debentures	100	107-112
House-to-House Company, Ordinary	£	6-6½
—— 7 per cent. Preference	£	8¾-9½ xd
India Rubber and Gutta Percha Works	10	20½-21½ xd
—— 4½ per cent. Debentures	100	106-109
Kensington and Knightsbridge Ordinary	£	11-11½ xd
—— 6 per cent. Pref.	£	8-8½
London Electric Supply	£	1½-1¾
Metropolitan Electric Supply	10	14½-15½
—— 4½ per cent. First Mortgage Debenture Stock	100	120-124
National Telephone, Ordinary	£	6¾-7⅛
—— 6 per cent. Cum. First Pref.	10	16-18
—— 6 per cent. Cum. Second Pref.	10	16-18
—— 5 per cent. Non. Cum. Third Pref.	£	6-6½
—— 3½ per cent. Deb. Stock	100	102-105
Notting Hill Company	10	12-13
Oriental, Limited, £1 shares	1	1½-2
—— £5 Shares	£	8½-9
—— £4½ shares	4½	7⅞-8
Oriental Telephone and Electric Company	1	⅞-1
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	103-105
St. James's and Pall Mall, Ordinary	£	14-15
—— 7 per cent. Pref.	£	9-10
Telegraph Construction and Maintenance	12	89-42
—— 5 per cent. Bonds	100	103-106
Waterloo and City Railway, Ordinary	8	10¾-11½
Westminster Electric Supply, Ordinary	£	12½-13½
Yorkshire House-to-House	£	7-7½

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NOTES.

Institution of Electrical Engineers.—The next students' meeting will be held on Wednesday, March 31, at 7.30 p.m., at the Institution, when a paper will be read on "Electrical Tramway Traction" by Mr. Percy S. Sheardown.

Physical Society.—The meeting to-day (Friday), at the invitation of Prof. S. P. Thompson, takes place at the Finsbury Technical College, Leonard-street, E.C., at 5 p.m. Various exhibitions of experiments, etc., will be shown by Prof. Thompson and others.

Electro-Harmonic Society. — The last Electro-Harmonic smoking concert of the season takes place to-night (Friday) at the St. James's Hall Restaurant, Regent-street, at eight o'clock. The programme has already been given in these columns.

South Kensington.—Judging from a continuance of correspondence in the *Times*, it does not seem as though the decision of the authorities never to do anything more to finish the South Kensington Museum would be acquiesced in. Outside of official circles opinion seems unanimous that the front should be completed in some way or other.

Earth Currents.—According to observations made at Sofia, of all places in the world—by a Mr. P. Bachmetief—earth currents are found to be largely affected by the underground water level and circulation. It does not appear whether this is responsible for the production of part of the current or whether the effect is due to a variation of the conductivity.

The Technical Press in the States.—A notification has been forwarded to us from Chicago stating that *Electrical Engineering* will appear henceforth twice a month instead of monthly. The large number and constant progress of the electrical Press in the United States is a thing which, even allowing for their larger population, is most remarkable.

The Preece Cable.—An article in *L'Electricien* over the signature "E. B." (probably Mr. Boistel) gives a full description of the form of cable (with semi-circular conductors) brought forward by Mr. Preece at the last meeting of the British Association. In about half a dozen lines of comment at the end "E B." foresees difficulties in the way of the construction, storage, and laying of a cable of this kind.

The Marconi Signalling Apparatus.—It is stated that experiments are now being made by the Post Office authorities with Mr. Marconi's apparatus for sending messages without wires by means of rapid electrical vibrations between the Flat Holm, in the Bristol Channel, and the mainland. Nothing at present has been published as to the results obtained, or whether the method can be absolutely depended upon for long-distance work in bad weather.

Journalistic Amenities.—This is the way in which one respectable American electrical paper permits itself to speak of another. There is no need to give the names, but both are issued in the same city. "Of all the servile despicable institutions on this great globe, the newspaper that trembles like an aspen for fear of displeasing and dares not utter an independent idea, is the most cowardly. But what may one expect of the *Oriental Wireman*? Nothing is ever better than its maker." The terse description, "Good print, and bad language" certainly seems to apply in this case.

A Crane Accident.—A curious accident is described in the *Scientific American* which resulted in the power-house at Thirteenth and Mount Vernon streets, Philadelphia, from which the Union Traction Company operated a half-dozen of its lines of trolley cars, being destroyed by fire in the beginning of the month. About six o'clock some of the employés were swinging a big crane around, and the iron chain hanging from the arm struck a generator, smashed it, and blew out every circuit and wrecked all the dynamos which were running. A fire started and gutted the building and destroyed the eight dynamos or rendered them useless. The dynamos were the property of the Westinghouse Electric Company, as the Traction Company said that they were not working properly, and had therefore never accepted them, and the Westinghouse Company were running them at their own expense, pending some decision in the matter.

The Physics of the Arc.—It is now some time since the London Physical Society had that memorable discussion which, beginning with a definite and possibly explicable phenomenon, passed into a general consideration of the physics of the arc. The French Société de Physique have now added their quota to the matter, Mr. Le Chatelier suggesting there that the fixity of the temperature of the positive carbon marks the fusing and not the boiling point (for, as it seems to the writer, quite a wrong reason), which, of course, is probably true enough; but when just about to prove the matter one way or another by examining the arcs formed at reduced pressures his apparatus collapsed. Both from a practical and a scientific point of view experiments on enclosed arcs and at various pressures are much wanted. And before bringing out any explanation it would be well to consider whether it will explain what is supposed to be seen through a stroboscope.

Boiler Explosions.—In view of the strenuous efforts which are being made to carry through legislation which would make the stoker's and engineman's a close trade and take the responsibility of an explosion off the shoulders of the boiler owner in order to place it on the shoulders of a paid inspector, it would be well if someone would make the general public understand, what is, of course, well known to the engineer, that the Board of Trade jumbles up and schedules under the head of "boiler explosions" all sorts of different things. Thus the Board of Trade returns for the year 1895-6 included 79 cases, causing the loss of 25 lives; of these, however, only 24 were actual explosions of steam-boilers, causing the loss of 15 lives, the remaining 55 cases consisting of various accidents, among which may be mentioned 16 due to the bursting of steam-pipes, stop-valve casings, etc.; and 15 to the failure of manhole joints, blowing out of plugs, and so on. The popular idea of a boiler explosion is one in which the shell goes, and not something in which the damage, as well as the fault, is confined to the inside of the boiler-house.

Phylloxera.—Various methods have been tried for making life unpleasant for the phylloxera and saving the vineyards, which else appeared doomed. One promising method extremely unpleasant to others as well as the phylloxera involved the extensive application of carbon disulphide. According to *L'Elettricità*, in Italy, or at any rate in the island of Elba, they have tried electricity. The inventor, who has the un-Italian and Teutonic-looking name of Fuchs, has established at Porto Ferraio a method of killing the phylloxera on the vine by puncturing the stem with a needle, and sending a current down to the roots. The operation has to be repeated about three years in succession, and is said to cost under 50s. per acre. The action of the current is ascribed to the production of ozone, and the vitality of the plant is said to be in no way impaired by the treatment. There are no details as to voltage or current used, and it may also be added that

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L'Electricien some months ago stated that experiments recently made by an engineer of the Siemens and Halske Company to destroy the phylloxera on vines, by means of ozone generated by electricity, had given unfavourable results.

Hæmoglobin.—The function of hæmoglobin as a carrier of oxygen to the tissues is an elementary point of physiology. Mr. W. E. Case, in America, in the course of some lecture experiments to demonstrate this, has come upon the curious fact that it will also act as a carrier of oxygen to carbon in a similar way to that in which the hot caustic is supposed to do in the Jacques cell. The effect is naturally very small. Mr. Case says carbon stick and platinum in a hæmoglobin solution gave ·06 volt, but with platinum and animal charcoal he got ·12 volt. He considers this shows that the hæmoglobin does act as a carrier of oxygen and oxidises the carbon. Bubbling air through does not help the process—that is, the hæmoglobin is so fully oxidised that an excess of air is of no value. Of course, when the hæmoglobin becomes reduced it will absorb more oxygen from the air. With different forms of carbon different voltages are obtained. The hæmoglobin solution would not be of any practical use in any event, as it decays in two or three days. Mr. Case notes the possibility of the results being vitiated by the presence of iron in the carbon. It may be added that the non-technical Press got hold of the matter and at once stated that Mr. Case had constructed a new carbon-consuming battery. Probably the reporter did not know what hæmoglobin was or he would have gone a step further and made it a "Battery from Blood."

Fuses.—When in doubt for a subject, malign fuses; or complain that they are fixed in the wrong place. Also for a change it is possible to extol them in comparison with the only substitute. Thus the New York *Electrical World* says the magnetic circuit-breaker undoubtedly has many valuable properties, and this fact is fully demonstrated by the rapidly extended use with which it is meeting. It does not follow, however, that it more satisfactorily performs in all cases the functions for which it is installed than would a fuse properly designed and acting under the same conditions. "As a fuse is never used for the purpose of protecting a lamp from an excess of voltage there is practically no case in actual practice in which it is desirable to have it melt when subjected to short excessive current fluctuations due to variations in voltage, the extraordinary demands of a motor load or other causes, but, on the other hand, it is highly desirable that it should be able to carry any current which the conductor it is designed to protect will carry without undue heating, and consequent impairment of the insulation. It does not matter, therefore, whether the conductor is connected to lamps or motors, the fuse should bear to it a definite relation." However, a mechanical circuit-breaker constructed so as to have a time factor equivalent to that of the proper fuse could be made to fulfil the same functions as the latter. Really we thought that the point of a circuit-breaker was that it acted at once while other things might also occur while a heavy fuse was melting. If things are arranged properly and motors are properly attended to, the going of a fuse ought to be so rare an occurrence that the point made by our contemporary, that a circuit-breaker can be reset quicker than a fuse replaced, should have very little in it.

The Medical Value of Rontgen Rays.—So far as one can see this is mainly, if not entirely, diagnostic. There are some observers (principally French), however, who, in spite of apparent discouragements, have not lost faith in the ultimate usefulness of the Crookes tube as an instrument in the actual treatment of disease. They recall the fact that in whatever way it may act sunshine has been credited with a germicide property, and they expect a more pronounced result from the ultra-violet and Röntgen rays. "Unfortunately for the support of this theory," says the *Lancet*, "experiments conducted by various observers to show the action of these rays on different germ-cultures have yielded contradictory results, and have not, on the whole, confirmed the expectation that the microbes could be weakened or destroyed in this way." On the other hand, some results of clinical observations are more encouraging. In experiments conducted by Prof. Lortet, of Lyons, last year, on guinea pigs inoculated with tubercle, glandular enlargements, suppuration, and general illness followed in those animals not exposed to the rays, while in the others which were irradiated for an hour daily during 25 days no such effects were observed and the animals even gained flesh. Dr. E. Ausset, after a failure to diminish by means of the rays the activity of tubercle bacilli in a virulent culture, recently employed the same method in the treatment of a long-standing case of pulmonary and abdominal tuberculosis. He failed to save the case, but there appeared to be some improvement. The truth is that the radiations from a Crookes tube are of a mixed character, and no one quite knows at present what proportions of the various radiations he is getting. A special germicidal property is unlikely, but there is no reason why certain of the radiations should not have a beneficial effect as a tissue stimulant. Others of them certainly have anything but a beneficia effect as an irritant of the under skin.

The District Low-Level.—It will be remembered that at the District Railway general meeting the question of constructing an electric express line was argued, not so much on its merits as on the financial position of Mr. Pond. In the Queen's Bench Division last week, Mr. Justice Mathew and a special jury had before them an action—Ellis *v.* Pond—which made public certain matters connected with this. It appeared that the syndicate was formed in 1896 to finance the construction of an electric railway to run under the Metropolitan District Railway from Earl's Court to the Mansion House. It was desired to obtain possession of a quantity of Metropolitan District Company stock, and the defendant instructed the plaintiff in the case to purchase this stock, and provided money as cover. In the end the plaintiff purchased about £200,000 worth, of which £50,000 was taken up. The plaintiff was informed the defendant was an undischarged bankrupt, and wrote to him to forward the sum due on account, and also asked for the names of the members of the syndicate. The money not being sent, the account was closed, and upwards of £8,500 was claimed by the plaintiff to be due. The plaintiff, however, was unable to serve his writ on the syndicate, as he had not obtained the names of members. His case was that the defendant had given the order and was a member of the syndicate. On the other hand, the defendant said the plaintiff, when he undertook the business, was aware that he (defendant) was an undischarged bankrupt, and that he knew the names of the syndicate would not be disclosed. Ultimately the jury found in plaintiff's favour, and judgment was entered for him accordingly. It is unfortunate that the scheme, which looked a promising one, should have been prejudiced by conflicts of this sort between undisclosed and mysterious syndicates and the District Board. Judging by several small matters, the latter have not shown themselves averse to consider novelties. But they have not any money to spare in the ordinary way.

The Carbon Battery.—Messrs. Liebenow and Strasser have given in the *Zeitschrift für Elektrochemie* the results of some investigations into the Jacques cell (carbon and iron

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in fused caustic alkali aerated with a current of air). The behaviour of several metals towards fused caustic alkali was studied. A normal electrode of mercury, covered with calomel, in contact with a solution of potassium chloride, was connected to the fused potash by means of a piece of pipe stem moistened at one end by the potassium chloride solution, and dipping into the fused caustic potash at the other. The difference of potential between this normal electrode and an iron rod immersed in the fused alkali was then measured. For about 40 minutes the potential difference remained almost constant, hydrogen being evolved from the iron, and the fused mass having a greenish colour; suddenly the colour of the melt changed to dark brown, this change being accompanied by a fall of temperature and by a large fall (about one volt) in the potential difference between the iron and the mercury; the dissolution of the iron also ceased. The new potential difference remained practically constant. Similar phenomena were observed with nickel and silver. Only one value was found for the potential difference between carbon and fused alkali. The differences of potential between iron or carbon in fused caustic potash at about 500deg. C. and the normal mercury electrode were: active iron, – 1·5 volts; passive iron, – 0·38 volt; carbon, – 1·32 to 1·12 volts. In accordance with these numbers, a cell consisting of carbon and iron dipping into fused caustic potash had at first a very small negative E.M.F., which rose suddenly when the iron assumed the passive condition to about + 1 volt. The cell developed a very inconstant current, the iron being very rapidly polarised. This might be remedied to some extent by passing a current of air through the fused electrolyte (as Dr. Jacques does). It should be said that the above summary is taken not direct, but from the columns of *Nature*.

New Lamps.—According to the *Moniteur Industrielle*, they have succeeded in France in adapting the incandescent mantle to burn petroleum. Of course, it is necessary to vaporise the petroleum and carry away the vapour in a current of air. The English inventor would be deterred at the very outset by the apparent danger of the thing, but in France inventors do not seem so afraid of explosions, as witness their fondness for acetylene, chlorate instead of nitrate powders, and various other uncertain things. In this particular case, "in conclusion, let us add that all the parts of the lamp must remain mathematically in the state in which the (manufacturing) firm delivers them." Of course, if such a lamp could be built as might be left to the tender mercies of the average housemaid it might affect the lighting question. At present, it does not seem very probable. On the other hand, we have here in England a company which in the interests of safety proposes to deprive the petroleum lamp of its chief merit—that it does not need to be "installed" and that you can carry it where you want it. The gas-pipe is such a terribly stiff affair, and even though we have got a step further with our flexible, the incandescent lamp is always on a string. The Imperial Oil Lighting Company are responsible for the brilliant idea of lamps fed by a supply of paraffin, "regulated by an ingenious contrivance of mercury," which is drawn from a tank through pipes in much the same manner as gas. This, it is claimed, "entirely obviates the possibility of explosion, which so frequently occurs with such disastrous results in the use of the ordinary paraffin lamp, through the proximity of the oil container." "Another great advantage" . . . . But never mind. There is to be a syndicate, and we shall read all about it in the advertisements. If one could imagine it ever getting so far, what funny things the insurance safety rules for house-piping would be in case of installations of the petroleum light.

Tramcar Heating. — Although, speaking generally, the winters in the United States are regarded as more severe than in this country, yet when one remembers that there is California and the South to be considered it will be seen that Transatlantic experience covers the whole ground in the matter of meeting climatic exigencies. The following conclusions of the *Street Railway Journal* on the subject of the electric heating of tramcars will therefore be interesting. During the past winter the experience with electric heaters reported by electric railway companies has been of a varied character. While all unite in their expressions on the convenience of electric heating, the verdict reached by different lines as to the cost of electric heating is not the same, even by lines in the same city. Some companies report that the amount of current consumed by the heaters is trifling, averaging not more than two or three amperes in cold weather, while others state that the amount of power required is almost, if not quite, 50 per cent. of that used to operate the cars. In face of these differing testimonies some other explanation must be had than that of local conditions, different makes of heaters, or leaky cars. "Our own belief, founded on experience, is that the cars upon most roads which report a high consumption of current are overheated. A passenger wears the same wraps inside of a car as he does before he enters it, and does not expect or care for a high temperature. The fault of overheating does not usually lie in the instructions given to the conductors, but with the conductors themselves. Some of them, being obliged to spend considerable time on the rear platform, like a warm car to get into, while others do not take the trouble to change the controlling switch to a lower combination when the car takes in more passengers, or the weather outside gets warmer. It would seem as if the experiment might be worth trying, on roads certainly where the routes are short and where there are a number of register inspectors, to take the control of the electric heaters entirely out of the hands of the conductors and place it in those of the inspectors."

A Telegraphist.—Mr. Brendish, the survivor of the two signallers who sent the historic message from Delhi announcing the outbreak of the Indian mutiny, has just retired from the Indian Telegraph Service, and the *Pioneer*, of Allahabad, takes occasion to tell the story of the message from the records of the department. Mr. Todd was in charge of the Delhi telegraph office, having under him two signallers, Brendish and Pilkington, aged 18. On Sunday, May 10, at 4 p.m., it was found that the line from Meerut was interrupted, and Mr. Todd started to find out the break. At the bridge of boats across the Jumna he was met by the mutineers the following morning and murdered. The lads, who were left alone in the office outside the Kashmir gate, saw the mutineers pass and continued steadily telegraphing to Lahore all the news brought in by peons as to the doings of the mutineers in the city. Brendish went out at noon to see what was going on, but was desired by a wounded British officer to go in and close the doors. There for two hours the two, with the widow and child of Mr. Todd, remained, and at 2 p.m. Brendish went to the Umballa instrument and telegraphed the historic message, which ended with, "and now I am off." The two took Mrs. Todd and the child to the Flagstaff Tower, where the Europeans had congregated, and from there they saw the blowing up of the magazine. That night they fled and made their way to Umballa. Before they left the tower Pilkington went back to the office to send a message for an officer, and this daring mission he accomplished, for the

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message is recorded as having been received. The effect of the warning message to the Punjab was that the regiments tainted with mutiny were disarmed before they knew what had taken place at Meerut and Delhi. Mr. Brendish served through the mutiny, and in 1859 rejoined the telegraph service. On his retirement the Government of India have granted him a special pension equal to his salary, and the Viceroy has expressed his appreciation of and congratulations on the great service he rendered to his country on May 11th 40 years ago.

Terrestrial Magnetism.—Sufficient neither of time nor space was available to deal last week with the paper read at the Royal Geographical Society by Mr. E. A. Reeves, entitled "Some Notes on Terrestrial Magnetism, with Special Reference to the Positions of the Magnetic Poles." The lecturer fell foul of the customary plotting of curves on magnetic charts, and suggested that in some cases these charts were misleading. The observations of the inclination of the magnetic needle are measured for the plane of the horizon of the place where the observer happens to be. (Obviously) What Mr. Reeves desired was a common line to which all observations for inclination should be referred, and he thought it clear that the only natural line to adopt was the geographical axis of the earth. (That is anything but clear. The present plan amounts to selecting the magnetic axis and the centre of gravity, and goes wrong only if the latter is not in or near the former.) If the curves of equal inclination are plotted out in accordance with Mr. Reeves's method, it would be seen that in their general direction they more nearly resembled circles passing round the geographical north pole than did those at present shown on the charts, and in addition were far more symmetrical. But as to this it is obvious that, whether it is inclination or declination that is in question, as the curves are plotted on a Mercator projection, no sort of idea can be got from the chart as to how they would look on a globe. The transference is easy, and in many ways instructive. But with every deference to Mr. Reeves, no amount of dodging will bring the magnetic poles anywhere near the geographical ones. When one comes to think of it, the really remarkable thing about terrestrial magnetism is not that the poles are out of symmetry, but that the declination should have altered at comparatively such a rapid rate without, so far as is known, any corresponding physical change of sufficient magnitude to account for it. And on the top of what we know for certain since the invention of the compass come the topsy-turvy conclusions of Dr. Folgheraiter as to what was the condition of things in early times.

Automatic Signalling.—In the matter of the application of electric methods to railway signalling the Great Eastern has been in evidence of late. They are now tackling the question of fogs, and a new system of fog-signalling by electricity is being tried at the Park Station, Tottenham, on the down line. An electric rail contact is fixed on the metals about 150 yards outside the down distant signal. When the engine of a train reaches this contact a gong, called the "localising" gong, situate about 45 yards in advance of the contact, will be set ringing, whether the signal is at "all right" or "danger." Another gong, called the "danger" gong, situated about 30 yards outside the distant signal, will also be set ringing by means of the same rail contact, provided the distant signal is at "danger." A second rail contact is fixed about 150 yards outside the down home signal, which will, upon the engine of a train reaching it, ring a localising gong about 50 yards in advance of the contact, whether the signal is at "all right" or "danger"; and, if the home signal is at "danger," also ring a "danger" gong, fixed about 40 yards outside that signal. The installation also comprises a ringing key, fitted in the signal box, which is designed for the purpose of sending a signal to warn the driver, in foggy weather, that the home signal has been lowered, after a train has been brought to a stand. The idea of the ringing key is, of course, that an engine-driver's ears may serve him where his eyes are of little use on account of thick weather. The difficulty about the present system of "fogging" is, of course, to decide whether it is really necessary to call out the men, and when that decision is arrived at the process takes time. Consequently one of the principal advantages claimed for the new system is the possibility of immediate application of the signals in case of fog. It has been further suggested that the fixing of treadles of the new automatic apparatus at level crossings might be made to ring a bell on the approach of trains, or to close the gates so as to obviate the possibility of accident. As to making a noise, however, the train can do that with its whistle, while the automatic closing of the gates would probably introduce a much greater danger than it would obviate, since it would be extremely difficult to arrange matters in such a way as to prevent the danger of passengers being trapped and shut on the line by the gates closing while they are in the act of crossing. In Austria, where there are gates operated mechanically from some distance away, there have been some narrow escapes.

Electricity in Agriculture.—An illustrated description is given in *L'Industrie Electrique* of the application of electricity to farming work by Mr. Felix Prat at Enguiland, in the Tarn. The source of power is a waterfall on the estate, and the transmission is, of course, overhead, the wires being in some cases strung upon trees in a very primitive-looking way. Curiously enough, Mr. Prat has not seen that the proper place for the motor is on the plough itself, instead of on the headland pulling by a wasteful wire rope. So, as this, the great advantage of the electric plough, is lost, it would be useless to go into questions of cost of working On the other side of the Atlantic the *Electrical World* devotes a couple of pages to the description of an electric light and power installation at Ellerslie, a model dairy farm of a former vice-president, Mr. Levi P. Morton. There is nothing here beyond the electrical driving of dairy and farmstead machinery and pumps, problems which are essentially of the same character as the driving of factory machinery, which is the subject of a series of articles in our columns. Ellerslie is in the State of New York, and our contemporary says, "The electrical equipment at Ellerslie is thorough and unique, but is only in keeping with the general perfection of detail which makes it in all senses a model farm." In this country the "model farm" is looked at rather askance as a landlord's toy, and for a man who hopes to make rather than to lose money at farming a model only of what is to be avoided in the beautiful but expensive way in which things are done there. Whether it is so in America the writer has no idea—in fact, he believed that the model farm was an English institution which had not yet penetrated there. The *Electrical World* also deals with the subject editorially; but, though there can be no question whatever of the very high position indeed that journal holds as an authority on electrical matters in America, the writer has not the slightest hesitation in refusing to accept its conclusions as to matters of agricultural profits. As a matter of fact, of course, an electric motor is a perfectly ideal method of driving a cream separator. With other farm machines it is merely the general question of motor and conductor *versus* shafting and belt, while, as has been stated more than once, a motor on the plough seems to be the way to

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avoid what has hitherto been the cause of the great waste of energy in steam ploughing. And that is about as far as we have got at present. Nor until farms grow bigger is progress likely to be very fast. Like most other agricultural machinery, it will probably come into general use first in America, and be improved to suit the severer conditions both of cultivation and crop under which we work here.

Animal Electricity.—At the Royal Institution last Tuesday Dr. Waller began by showing the back current obtained from the living body after a continuous current has passed through it, and which he ascribes to polarisation effects in the tissues traversed. The current is received by dipping the fingers into cups containing salt solution. There would obviously be polarisation at the skin surfaces, and the current from this would be superposed on and would mask the back current from the body. The difficulty is got over simply enough by making the contacts with the battery terminal cups with, say, the forefingers and afterwards to the galvanometer terminal cups with the little fingers. In order to check the result the experiment was repeated with the current in the opposite direction, and this brought out the fact that the back current is obtainable for some considerable time. About 20 cells were used to obtain the primary current, and it was received for only a comparatively short time. After enunciating the general principle that in the neighbourhood of the cathode the nerve is excited at making the current, and its excitability is increased by the passage of a current, while in the neighbourhood of the anode the excitation is at break, and the excitability is diminished by the passage of the current, Dr. Waller exhibited the increased or diminished excitability in a rather remarkable manner. Most people know of a point in the elbow where the ulnar nerve comes close to the surface and has a hard bone surface beneath it, and when this spot happens to get hit the effect on the sensory fibres of the nerve is unpleasantly evident. Though not so obvious, the effect of the percussion on the motor fibres is shown by an involuntary twitch of the third and fourth fingers, which may extend to the whole hand. With the hand before the lantern, one contact at the elbow and the other at the back of the neck, the difference in the effect of percussion according to the direction of the current was made obvious on the screen. Dr. Waller remarked mildly that it was not an experiment that he allowed everyone to perform upon him. (One can easily understand that most people would refuse to trust their "funny bone" into anyone's hands.) After these experiments Dr. Waller entered upon another subject, the cause and meaning of which is not so clear. Briefly, it comes to this. If four contacts are made along a nerve, say, A, B, C, and D, and A and B are connected to the terminals of a battery so that a current passes, then, although C and D are outside the primary circuit, if they are connected to the terminals of a galvanometer a weak current is found, which is such that in both circuits the current in the nerve is in the same direction. Moreover, while in the nerve of a warm-blooded animal (kitten) the effect is the same whichever way the current goes, in the case of the cold-blooded animal (frog) the effect is much greater when the direction of the current in the primary is such that the secondary circuit is on the side of the positive terminal (anode) than when the current is reversed. That the effect is not purely physical seems clear from the fact that it is almost entirely abolished after pinching the nerve, and also fails (at least with the frog's nerve) at a very little above 104deg. F. In an amusing parenthesis Dr. Waller related how he had to go to Leipzig to find out what the German physiologists really meant by their own (newly made up) language, and finally discovered that by physical electrotonus they did not mean electrotonus at all, but something which a careless observer who did not remember that the material he was dealing with was all more or less conducting might mistake for electrotonus.

The Institution of Civil Engineers.—A special meeting of the corporate members of this institution has been called for Tuesday next, the 30th inst., to consider some proposed alterations to the by-laws. The general tenor and objects of the proposed alterations are as follows: After very careful deliberation, the council consider that the time has arrived when, in the interests of the profession and of the public, more satisfactory assurance should be afforded of the education and training of candidates for associate membership of the institution. The existing by-laws require the council to consider these matters in connection with candidature; but it is thought that candidates should afford more definite proof of their general and scientific knowledge than under the present system. The majority of those elected give such proof in respect of general education by their degrees and diplomas, or by the fact of their previous admission as students of the institution; and it is deemed that, in the interests of the whole body, a definite standard of attainment, not only in general education, but also in those branches of physical science which form the basis of engineering (apart from any standard of practical engineering) should now be laid down as a qualification for election to associate membership. The council are of opinion that the institution should itself prescribe and hold the necessary examinations, whilst recognising equally those of other bodies which are of a proper standard. Further, that the council should have power to substitute for examination a paper or a thesis, or to dispense with such proof entirely in special cases. Finally, that election or transfer to full membership should continue to rest upon evidence of skill and experience in practical work without examination being required, the limit of age for this class being raised from 25 to 30 years. The council therefore propose that Sections II., III., and IV. of the by-laws should be modified in these respects by the omission of some superfluous words. A second question to which the attention of the council has been directed is the complex process for the removal of any member guilty of grave professional misconduct. A strong feeling is believed to exist that the council should have the power to deal with such cases—as in other important societies, such as the Royal College of Surgeons, the Royal Institute of British Architects, the Institute of Chartered Accountants, and others. The members are therefore asked to approve an alteration of Article 11 of Section III. It is thought that a majority of eleven-twelfths of the council, now proposed, will afford a sufficient guarantee of individual rights. An important matter affecting the financial position of the institution is the amount payable as life-composition in lieu of annual subscription. The council have been advised that the actuarial values of the life-compositions are, having regard to the present value of money, too low—to the manifest disadvantage of annual subscribers. Again, a compounder residing abroad has an anomalous advantage over his fellow in the United Kingdom, which, as an annual subscriber, he does not possess. The council propose that Section V. of the by-laws should be modified so as to place the matter of life-composition upon a more equitable basis. A verbal alteration is further proposed, whereby the class of associate members may be defined and referred to in the by-laws in accordance with the definition given in the report of the council for the session 1878-1879.

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THE MECHANICAL CONSTRUCTION OF ELECTRICAL MACHINERY.

BY F. M. WEYMOUTH.

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THE DYNAMO.

(Continued from page 360.)

Combination Bed-plates (*continued*).—The ventilation of the strong bed-plate shown in Figs. 103 to 105 was a subject not touched upon. In Figs. 106 to 108 herewith, two methods are represented by means of which this object may be attained if desired. The two first are respectively an elevation and a section of an arm of the bed-plate beneath the gunmetal magnet bracket, and show holes cast through both its inner and outer walls. As in this particular design strength has been essentially made a point of, in introducing these holes, it will be noted, care is taken not to weaken the section: and the metal removed to make

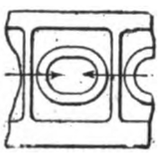

FIG. 106.

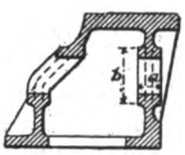

FIG. 107.

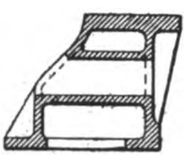

FIG. 108.

the hole is put back again as a fillet or thickening round the edges of the holes. Thus the total of solid section within the dimensions $b \times a$ with the hole is the same as the solid section $b \times$ thickness of the wall without the hole; and, by adding the fillet equally inside and outside, the centre of gravity of these two sections is the same for both. It might seem, perhaps, that under compression (as indicated by the arrows in Fig. 106), and owing to the advantage due to the extra thickness *a*, this dimension might be slightly lessened, the other dimensions remaining unaltered. But tensile strains demand that the new section should fully equal that which it replaces. A disadvantage attending this method is that the fillet on the side toward the magnets will reduce the clearance between these latter and the bed-plate.

Fig. 108 shows an alternative method which involves casting a tube or tubes through from outside to inside the bed-plate. This is better as regards flow of air than that shown in Fig. 107, inasmuch as in the latter the air current will break into eddies inside the channel section, and the two holes will offer more resistance to its flow than the one tube. Thus for efficacy of ventilation the tube would be decidedly the better of the two. On the other hand, both methods are complications; and in the design under question (Figs. 103 to 105) such holes are not shown, as in this case, where the bed-plate does not rise so high as in the cases of the Willans and Belliss bed-plates shown Fig. 92 and 97, the armature is not so shut in and enclosed, and consequently these holes do not become so necessary.

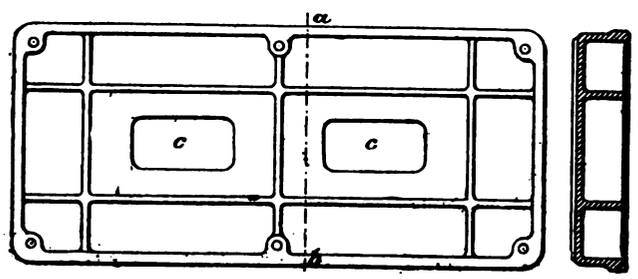

FIG. 109.—Inverted Plan and Section on *a b*.

We may now turn our attention to some further variations in combination bed-plate design, taking them generally in order graduated from strong to weak. As with the bed-plates for belt-driven machines, so with these larger combination bases, many of these in practice appear to be evolved more or less from a plain inverted box, which may or may not be webbed across inside. What may thus be termed the embryo form of this type is illustrated in Fig. 109, with webbing. There are no flanges on the lower edges of the webs, and the whole design is such that the pattern will easily draw out of the mould, and there is no coring except in the bosses. Lightening holes, as shown at *c c*, may be added; and these are in any case perhaps not inadvisable, especially if the metal is thin: for a thin sheet of cast iron, as here, enclosed within a strong outer frame, is apt to crack in the middle when cooling. Thus it is as well, either to put the holes, *c c*, or else to run yet more webs across, so as to reduce the size still further of the individual unsupported parts of the top.

The purely rectangular method of webbing shown in Fig. 109, though to a certain extent generally efficacious, is nevertheless weak in one respect: for it affords but little extra strength to the casting as regards its twisting as a whole. Of course this may not be of much import when the bed-plate is safely bolted down to a level foundation. But, like some previous bed-plates we have discussed, it is not calculated to withstand the strain due to resting on two diagonally opposite corners. This is made clear in the diagrammatic plan of the bottom edges

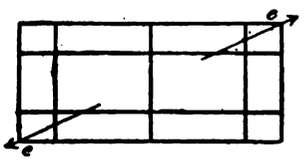

FIG. 110.

of the webs and sides, shown in Fig. 110. If rested on the corners, *e e*, it is quite plain, that with the top in compression, these bottom edges would be put into tension diagonally, as indicated by the arrows; and the result would be obviously that the whole system as here depicted would spring, the two corners, *e e*, each "giving" outwards in the direction of the arrows. Regarded hence from this point of view, we find this particular weakness may be largely overcome by rearranging the webs as shown Fig. 111. The longitudinal webs are made diagonal; and

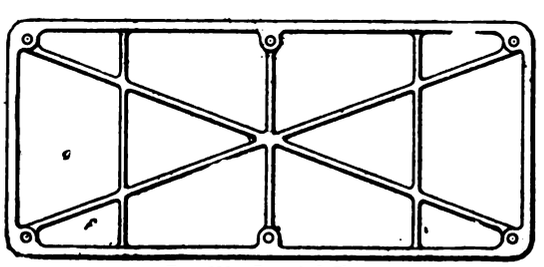

FIG. 111.—Inverted Plan.

the end webs also are brought further in towards the middle. Diagonal strength is thus imparted; and at the same time there are not any such large unsupported portions of the top necessitating, or rendering advisable, lightening holes, as there were in Fig. 109.

Figs. 112 and 113 added herewith merely illustrate alternative methods of running the diagonal into the corner. But the advantage of the method chosen in Fig. 111 is that thereby the pocket, *f*, is made larger, and *g* smaller, than in either of the other two arrangements' without materially altering the effect of the diagonal system. Fig. 114 applies in all these cases of unflanged webbing.

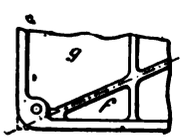

FIG. 112.

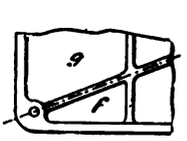

FIG. 113.

FIG. 114.

Being a section through such a web, it shows the "draft" added thereto by the patternmaker to assist its withdrawal from the sand. Thus the root at *a a* will be observed to be thicker than the edge at *b b*; and this extra thickness is usually an added thickness. The dimension *b b* is according to the workshop drawing; but the mean section of the web becomes greater than that intended by the designer. Consequently, together with the effect produced by the knocking of the pattern when in the sand, so as to

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loosen it before lifting, which was a subject alluded to in our opening remarks, the dimension at *a a*, ordered, say, $\frac{1}{2}$in., may, as a fact, in the casting become $\frac{5}{8}$in. or $\frac{11}{16}$in. instead.

It may now be observed that, having regard again momentarily to Fig. 109, if we suppose that to this design a little additional length, and a few more cross webs, be added, and the lightening holes increased, we shall then arrive at a modification shown in Figs. 115 and 116 herewith. This, though from another point of view, may also

FIG. 115.—Elevation with Section on *a b*.

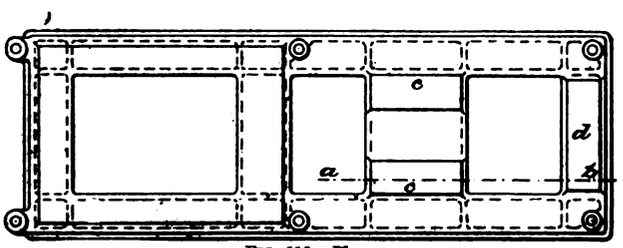

FIG. 116.—Plan.

be said to be a modification merely of the channel frame bed-plate shown Figs. 62 and 71. Judging from the outside appearance of the finished machine, this is an approximation to another design by Messrs. G. E. Belliss and Co. It will be observed that the facings, *c c*, for the magnet shoes come entirely on one of the transverse members, the distance between them being approximately that between the lower horns. The facing *d* is for the dynamo end bearing; and the engine complete with its own base is seated on the other end. We thus find here a simple design. All the facings are on the same level, and so may be planed in one operation. But it is, of course, intended to rest on a properly prepared foundation.

Figs. 117 to 119 show another general type of bed-plate. This is an inverted box with a raised pedestal at one end, as at *d*, to carry the engine. Another pedestal may rise, as shown at *f*, for the dynamo bearing. There are no webs inside; and a lightening hole, as shown dotted at *b b*, is sometimes put in. But the flywheel, shown dotted at *d*, requires a large transverse gap, *e e*.

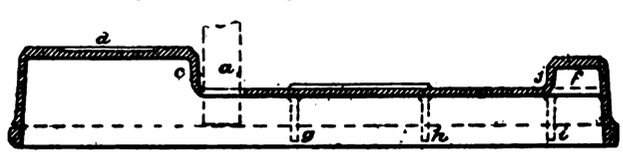

FIG. 117.

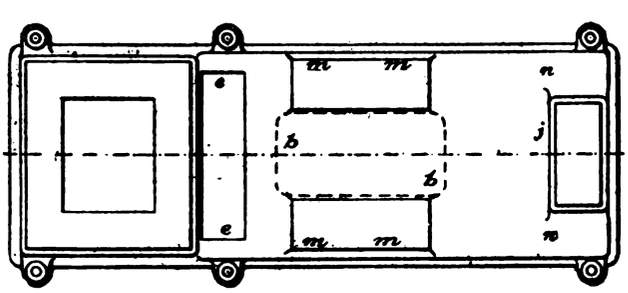

FIG. 118.

With this gap we approach weak designs. Reverting to the pedestal, *d*, we observe that the wall, *c*, is virtually a web running across the bed-plate, but above instead of below. There is thus a sufficiency of stiffness at and about this pedestal. But on the dynamo side of *c* the bed-plate suddenly becomes more or less shallow, and is then further weakened by the gap, *e e*, just at this point. Fig. 119 is a section through the gap, showing also the flywheel. We thus find that as regards even distribution of strength, this type does not compare favourably with others that we have discussed. Yet, of course, this does not apply in cases where the flywheel comes on the other side of the engine away from the dynamo; as then the gap, *e e*, is not required. Without any webs it is evident that this bed-plate could not safely be cast very thin. The side, *j*, for instance, of the bearing pedestal only rests on the top web; and without any stiffening at the points indicated by the letters *n n*, vertical vibration could take place in *j*; and, in fact, the side, *j*, would not be properly supported. This side of the bearing would tend to drop under the weight of the shaft, which would only obtain a rigid support on the extreme end of the bed-plate. A web put across under *j*, as shown dotted at *i*, would seem to be essential. Two webs, as dotted at *g* and *h* beneath the magnets, would also appear very advisable. On the other hand, when the gunmetal supporting brackets, or shoes, and the magnets, are all bolted together, these form together a massive and comparatively rigid structure: and when the shoes are bolted down to the facings, these latter are equally bolted up to the shoes. Thus the bed-plate and shoes and magnets then form one rigid whole; and the weight of the magnets is simply carried on the outer edges of the facings,

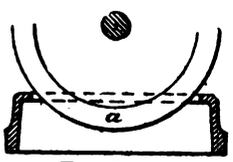

FIG. 119.

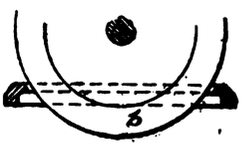

FIG. 120.

as at *m m*, where they approach the bed-plate sides; and the edges of the facings towards *b b*, though unsupported beneath, cannot drop, by reason of the facings being bolted up to the rigid shoes. If we take this bed-plate to be about 7ft. long, and cast about $\frac{3}{4}$in. thick, as here shown in proportion, or say $\frac{7}{8}$in. thick, then it may be doubtless considered that in ordinary running there would not be any

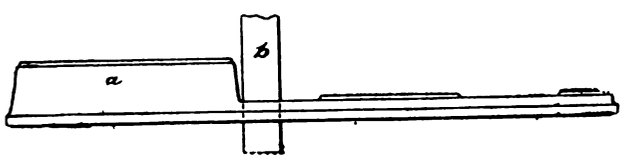

FIG. 121.

vibration or appreciable dropping of the side, *j*, even although the web, *i*, were absent; and this would matter if possible the less with a self-aligning bearing such as is common. Yet, under such circumstances, to omit web *i* would scarcely be good designing. It is a pure case of attaining simplicity by the use of heavy metal.

In Figs. 120 and 121 we have an extremely weak design, where the bed-plate is all but cut in two by the flywheel.

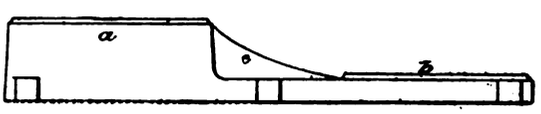

FIG. 122.

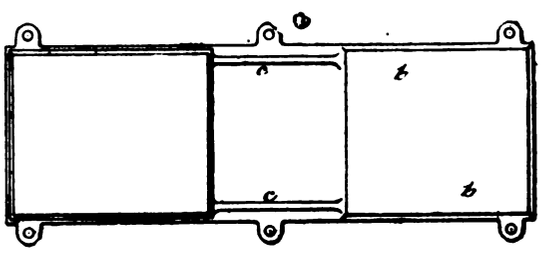

FIG. 123.

The pedestal, *a*, carries the engine. But in such a design as this, of course, the true bearing of all the parts is in every sense entirely dependent on the foundations. It is apparently, however, in vogue.

The last two combination bed-plates we propose to consider have each an especial interest of their own. Thus Figs. 122 and 123 represent in outline a design by Messrs. Robey and Co., Lincoln. The engine, complete with its own base, rides on the pedestal, *a*, with the flywheel at the outer end; while the dynamo, also complete with its own base, is seated on the facing outlined at *b b*. Thus the engine and dynamo are here *both* independent of the larger bed-plate—a peculiarity also observable in a plant by Messrs.

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Clench and Co., Chesterfield. In Figs. 122 and 123 it will be noticed that strengthening ribs, *c c*, are carried down from the pedestal to the shallower part, being rendered possible by the absence of the flywheel from this point.

The bed-plate shown Figs. 124 and 125 exhibits a peculiarity that, instead of the engine being on a raised

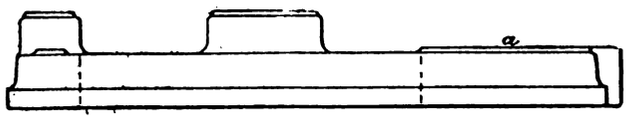

Fig. 124.

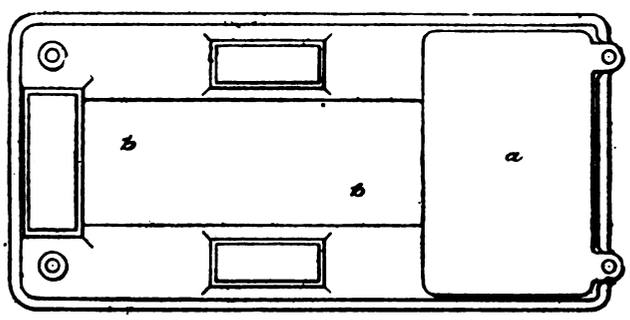

Fig. 125.

pedestal, the reverse is the case, and the magnets and bearings are on pedestals, whereas the engine has a low seating on the facing outlined at *a*. The bed-plate, as a whole, is also constructed on the principle of the inverted channel section frame, as in Fig. 62, with one large well, *b b*, in the middle. This type is approximated apparently in common by two firms—Messrs. Ransomes, Sims, and Jefferies, Limited, Ipswich, and by Messrs. Laurence, Scott, and Co., Norwich.

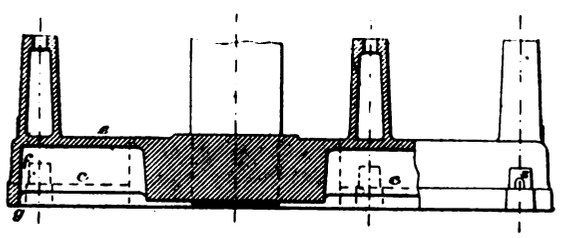

Fig. 126.

In Figs. 24 and 25 on an earlier page we showed a plan and elevation, outside views mostly, of a bed-plate for a belt-driven dynamo, after a design by Messrs. J. P. Hall and Co., Oldham. We have now the pleasure, through the kindness of this firm, whom we have to thank very much for drawings supplied, in presenting herewith further views of this bed-plate. Thus, Fig. 126 is a sectional elevation, Fig. 127 an inverted plan, and Fig. 128 a section on *a b*, with end view of one cover, *m*. It will be remembered

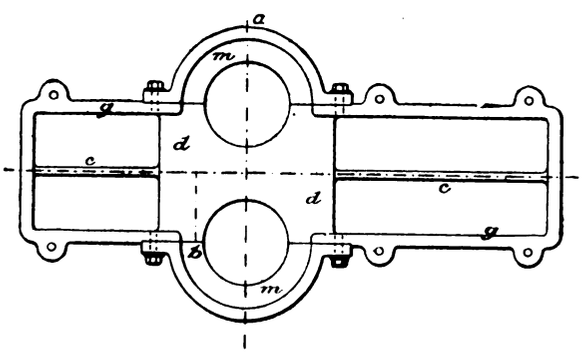

Fig. 127.

that it is these covers, *m m*, which form the special feature of this particular design. For by their use the magnets, here shown circular, can be removed without disturbing the armature. To assist in overcoming the strains and warping incident to the presence of the yoke, *d d*, when the casting is cooling after being poured, longitudinal webs are added, as shown *c c*. The top of the bed-plate is continued through the bases of the pedestals, thereby closing these at their lower ends: the pedestals may thus be used to catch the waste oil from the bearings, as was formerly pointed out. With regard to thickness of metal, if we take this bed-plate as being about 5ft. long, then the top and sides as at *e* and *f*, will be about 1in. thick, though the central webs, *c c*, are only about $\frac{7}{8}$in. thick. This bed-plate thus inclines to be somewhat heavy as compared with others that we have considered. As shown in the illustrations, a bottom facing, *g g*, is carried all round the outer periphery, including the covers, *m m*. The webs, *c c*, are of taper section (as in

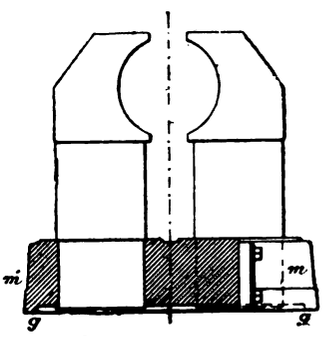

Fig. 128.

Fig. 114), and the sides sloped, so that the pattern may easily leave the sand, though the pedestals will, of course, need to be cored. We thus have here one more example showing how a casting may safely be formed having a mass of metal in its middle. It would appear that Messrs. J. P. Hall and Co. also make dynamos of this type having magnets of rectangular section instead of circular.

(To be continued.)

THE PRINCIPLES OF ALTERNATE-CURRENT WORKING.*

BY ALFRED HAY, B.Sc.(EDIN.), A.I.E.E.

(Concluded from page 299.)

161. The subject of power measurement on ordinary single-phase circuits has been dealt with in Arts. 69-72, and it was there stated that the most generally useful and reliable method was that involving the use of a non-inductive wattmeter. This latter instrument is equally useful in the case of polyphase circuits; there are, however, certain points connected with such circuits which render the measurement of power a somewhat more complicated process than in the case of ordinary single-phase circuits.

162. We shall begin by considering a two-phase (or di-phase) system. If the two circuits of such a system are completely independent of each other the power may be measured separately in each circuit, the connections being made as in Fig. 54. The sum of the two readings gives the total power of the two-phase circuit.

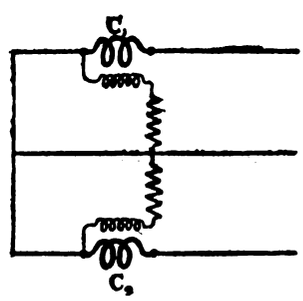

Fig. 113.

If the circuits have one wire in common, as in Fig. 104, the same method may still be used. Two wattmeters are connected as shown in Fig. 113, the current coils, C_1 and C_2, of the wattmeters being placed in the *outside* wires, while their fine-wire coils are connected across the outside

* Based on a series of evening lectures delivered at the University College, Liverpool.

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mains on the one hand, and the central or common main on the other. The sum of the two wattmeter readings gives the total power.

If the load on a two-phase circuit consists partly of motors and partly of lamps, then, as a rule, the distribution of load between the two circuits will be unequal, and we must use two wattmeters (or take two consecutive readings as rapidly as possible with the same wattmeter when placed in each of the two circuits) as explained above. But if the plant be entirely a power plant with two-phase motors, the load is necessarily the same in each circuit. In such a case the system is said to be a *balanced* one. It is obvious that a single wattmeter reading will in that case suffice, the total power being equal to twice the reading of the wattmeter.

163. Passing next to three-phase systems, we shall in the first place take the general case in which the load on each of the three circuits is different.

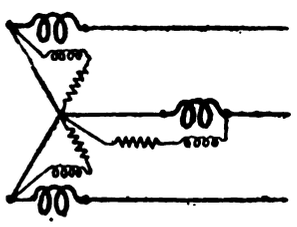

FIG. 114.

Consider a three-phase system with a *star* coupling, as shown in Fig. 108. If the neutral point (Art. 153) is accessible, the simplest plan is to use three wattmeters, connecting the current coils in series with the three circuits, and the fine-wire coils across the neutral point and the three terminals respectively. This arrangement of connections is shown in Fig. 114. The sum of the three wattmeter readings then gives the total power.

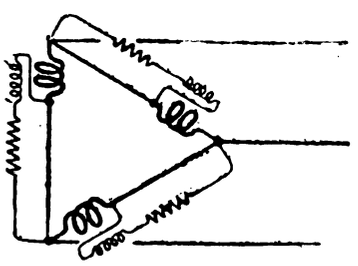

FIG. 115.

If the circuits are arranged in the form of a *mesh* or triangle (Art. 152), as in Fig. 106, and if it be possible to introduce a current coil into each of the three circuits, as shown in Fig. 115, the fine-wire coils being connected between the terminals, then the sum of the three wattmeter readings will as before give the total power.

The conditions required by these methods are seldom if ever met with in practice. The neutral point is not generally accessible, and it is not as a rule possible to connect up the wattmeters as in Fig. 115. Hence some other methods for measuring the power in a three-phase circuit must be devised.

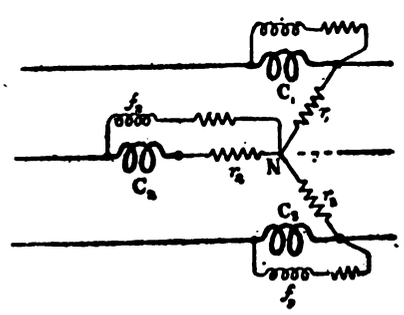

FIG. 116.

164. One of these consists in the creation of an artificial "neutral point" by the use of three equal non-inductive resistances connected as in Fig. 116. The power may then be obtained by taking the sum of the readings of three wattmeters, the current coils of which are in series with the three conductors of the system, while the fine-wire coils, with their non-inductive resistances, are joined across the artificial neutral point and the three mains respectively. The arrangement of connections is clearly shown in Fig. 116, where r_1, r_2, and r_3 denote the three equal non-inductive resistances, N being the artificial neutral point, C_1, C_2, and C_3 the thick-wire coils of the three wattmeters, and f_1, f_2, and f_3 their fine-wire coils. The method is obviously applicable to either a "star" or a "mesh" arrangement of circuits. If the fine-wire circuits of the three wattmeters have the same resistance, the three non-inductive resistances, r_1, r_2, and r_3, may be dispensed with, the neutral point being in this case formed by the junction of the fine-wire circuits themselves.

165. Another method involves the use of two wattmeters only. The arrangement of connections is indicated in

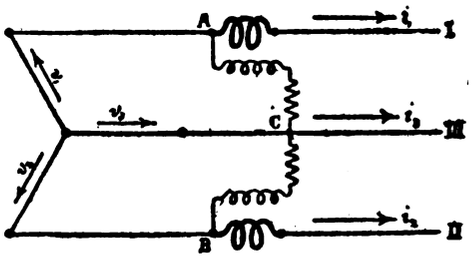

FIG. 117.

Figs. 117 and 118. The thick-wire coils of the two wattmeters are placed in two of the mains, and their fine-wire coils are joined across these two mains respectively and the third main. We proceed to show that whether the arrangement of the circuits be a "star" or a "mesh" combination, the total power may be determined from the readings of the two wattmeters.

Consider first a star grouping, as shown in Fig. 117. Let i_1, i_2, and i_3 denote the instantaneous currents in the three mains, reckoned positive when flowing from left to right; and let v_1, v_2, and v_3 stand for the instantaneous P.D.'s between the neutral point and the three mains respectively, reckoned positive when acting *away from* the neutral point. The instantaneous power is then given by

$$w = v_1 i_1 + v_2 i_2 + v_3 i_3.$$

But we also have

$$i_1 + i_2 + i_3 = 0,$$

whence

$$i_3 = -i_1 - i_2.$$

Substituting this value of i_3 in the expression for the power, we get

$$w = (v_1 - v_3) i_1 + (v_2 - v_3) i_2.$$

Let the two wattmeters shown in Fig. 117 be so connected that when the currents through their main coils have the directions indicated by the arrows, and when the P.D.'s acting on their shunt coils have directions from A and B *towards* C respectively, the corresponding couples on the wattmeters are positive. Under these circumstances it is evident that the wattmeter whose main coil is in I. measures the mean value of the product $(v_1 - v_3) i_1$, and the wattmeter whose main coil is in II. the mean value of $(v_2 - v_3) i_2$. From this it follows that the *algebraical sum* of the readings of the

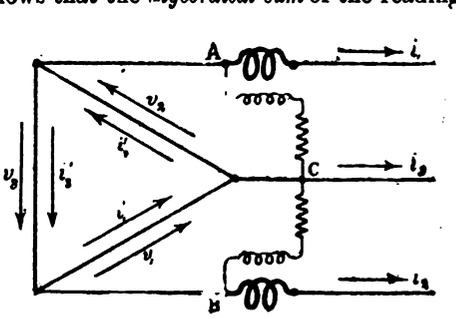

FIG. 118.

two wattmeters gives the mean value of w—*i.e.*, the mean power in the three-phase circuit.

166. Let us next suppose that the three circuits are arranged in a mesh, as in Fig. 118, the wattmeter connec-

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tions remaining unaltered. Let e_1, e_2, and e_3 stand for the instantaneous E.M.F.'s in the three alternator circuits; v_1, v_2, and v_3 for the corresponding P.D.'s between the mains; and i_1', i_2', i_3' for the currents. All these quantities are reckoned positive when acting in a counter-clockwise direction round the mesh, as indicated by the arrows. On account of the symmetry of the three circuits in the polyphase generator, the resistance, r, of each circuit will be the same, and we have

$$e_1 = v_1 + r\,i_1'$$
$$e_2 = v_2 + r\,i_2'$$
$$e_3 = v_3 + r\,i_3',$$

whence $e_1 + e_2 + e_3 = v_1 + v_2 + v_3 + r\,(i_1' + i_2' + i_3')$.

But $e_1 + e_2 + e_3 = 0$,

and $i_1' + i_2' + i_3' = 0$,*

so that $v_1 + v_2 + v_3 = 0$.

The instantaneous power is given by

$$w = v_1 i_1' + v_2 i_2' + v_3 i_3',$$
$$= v_1 i_1' + v_2 i_2' - (v_1 + v_2)\, i_3',$$
$$= v_1 (i_1' - i_3') + v_2 (i_2' - i_3'),$$
$$= - v_1 i_2 + v_2 i_1,$$

from which it will be seen that the algebraical sum of the readings of the two wattmeters gives the total power in the three-phase circuit, provided the connections are made (as before) so that when the currents in the two mains containing the thick-wire coils are from left to right, and the P.D.'s on the fine-wire coils are directed *towards* C, the resultant couples on the two wattmeters are both positive.

167. In the case of a *balanced* three-phase system, a single wattmeter is sufficient for measuring the total power.

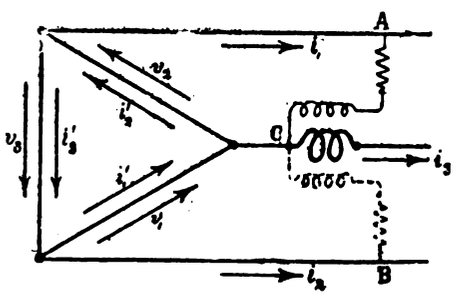

FIG. 119.

The current coil of the wattmeter is placed in one of the mains (Fig. 119), and one end of the fine-wire coil is also connected to the same main. Two readings are taken, with the other end of the fine-wire coil connected to each of the remaining two mains respectively. The sum of the two readings gives the total power. The proof of this result is similar to that used in Art. 166. Assuming a mesh arrangement of the circuits, as in Fig. 119, and using the result already established in Art. 166, we have for the instantaneous power in the three-phase circuit

$$w = - v_1 i_2 + v_2 i_1$$
$$= v_1 i_1 + v_1 i_3 - v_2 i_2 - v_2 i_3.$$

Now, since the circuit is a *balanced* one, it follows from symmetry (Fig. 119) that the mean value of $v_1 i_1$ is the same as that of $v_2 i_2$. The expression for the instantaneous power now becomes

$$w = v_1 i_3 - v_2 i_3,$$

from which it follows that if the thick-wire coil of a wattmeter be introduced at C (Fig. 119), one end of the fine-wire coil being connected to the same point, and two readings be taken, one with the free end of the fine-wire coil connected to A, and the other to B, the sum of the two readings will give the total power in the balanced circuit.

A similar method of proof shows that the measurement is equally applicable to a star grouping.

168. In the above series of articles no attempt has been made to deal with the descriptive and practical aspect of the subject; the aim has been steadily kept in view to explain, in as simple and concise a manner as possible, the leading *principles* which govern the practical applications of alternating currents. For detailed accounts of alternating-current machinery and apparatus the student is referred to the technical journals, and to the excellent text-books already available on the subject. For students whose mathematical knowledge is somewhat limited, it is hoped that the above series of articles will form a useful introduction to a more advanced study of this somewhat difficult subject, and that by their perusal they will be enabled to follow more intelligently the numerous contributions relating to alternate-current working which are so prominent a feature in current technical literature.

* Since there is no local current round the mesh.

ELECTRICITY AND PHOTOGRAPHY.

The atmosphere of any great city is at times prejudicial to the production of good photographs. Unless very special precautions are taken to mitigate the effects of fog or haze, the question of defective light is by no means the most important trouble. The electric arc, or a number of over-incandesced glow lamps, can be used as a source of light

FIG. 1.—A Corner of Mr. Lafayette's Reception-Room, showing Design of Ceiling-Lighting.

with satisfactory results. The presence of fog in anything like the proportion found in London on a November day will, however, prevent any high-class work being done by artificial light. Mr. J. Lafayette, the noted Dublin photographer, has just opened a studio in New Bond-street, in which it will be possible to take photographs at any time irrespective of the state of the atmosphere. As electricity plays so great a part in the equipment, we have been allowed to inspect every department and to collect details of the apparatus used. The house at 179, Bond-street has been entirely remodelled for the purposes to the designs of Mr. Edward W. Wimperis. The old attic was removed and a studio built of iron and glass substituted at a higher level. This raised the pitch of next lower floor, containing the series of dressing-rooms and laboratories. The first floor consists chiefly of a large reception room, one corner of which is shown in Fig. 1. The upper part of the street frontage is new, and is executed in Portland stone from cornice to

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window head; glazed buff terra-cotta from the Burmantofts Company, of Leeds, forms the main ground inside the heavy stone coping. It is relieved by the modelled Royal coat-of-arms, which is in a rich glazed red inside a green wreath. The windows of studio front are lead-glazed casements of iron construction. The rising sun is executed in golden glass mosaics by Messrs. Powell and Sons, of Whitefriars Works, E.C.

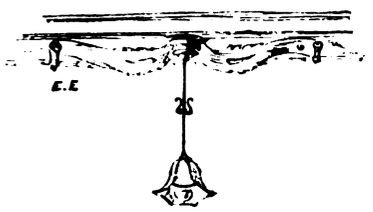

FIG. 2.—Type of Electrolier used in the Entrance.

The electric lighting of the premises was carried out by Messrs. Strode and Co., of Osnaburgh-street, the fittings being made to the designs of the architect. Those in the reception-room are placed as shown in the sketch. The fittings are made to fix close to the ceiling, and the ceiling is divided into square panels by the ornamental mouldings carrying the wires. In this way the lamps are distributed all over the area to be lighted, and a good diffused light is obtained. Also the position of the lamps is such that they never disturb the line of vision when the many works of art in the room are being

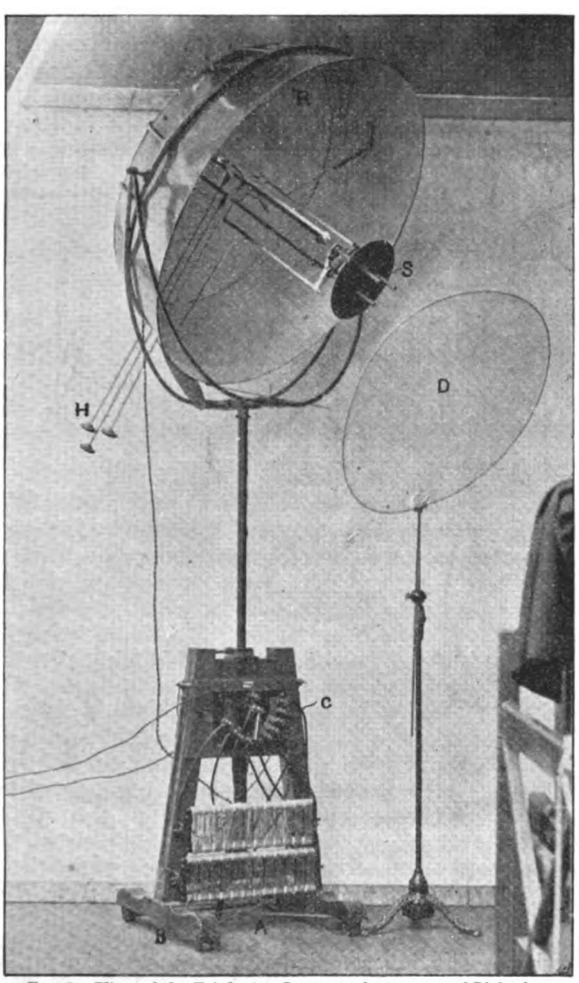

FIG. 3.—View of the Triple Arc Lamp used as source of Light for Photographic Purposes.

inspected. The reflectors of the fittings are of polished copper silvered on the inside. The entrance is lighted by the neat electroliers shown in Fig. 2. At the top of the stairs a most handsome bronze figure is arranged in a recess, and lamps worked in with the design of the surroundings light the landing. About 80 16-c.p. lamps have been fixed altogether, and Messrs. Strode also provided the separate leads and connections for the triple arc lamp in the studio. The circuits are well divided, and the work, although carried out in the much-maligned wood casing, is of first-rate quality.

The triple arc lamp, used as the source of light when photographs have to be taken, is the outcome of Mr. Lafayette's many years' experience in this direction. The photograph of this apparatus reproduced in Fig. 3 is nearly self-explanatory. Instead of using one large arc, three smaller ones are employed, each taking about 20 amperes. These are struck and regulated by the hand-gear, marked H in the illustration. Each arc is regulated entirely independently of the others, and a dark glass is conveniently placed by the handles so that the lengths of arcs can be seen. The screen, S, prevents any direct rays from the arcs reaching the sitter. The large reflector, R, is of parabolic form, and is carefully constructed. It has a matt-white surface, tending to give a diffused light, but this is also assured by the diffuser, D. The arcs and the reflector can be rotated round both a vertical and a horizontal axis. The whole apparatus can be moved about the floor on four wheels, B B, the angle of which relative to the stand can be set by a linkwork, A. This provides a much neater arrangement than the ordinary castors. The regulating resistances are shown on the stand of the lamp, which is connected direct to the 100-volt supply. The triple arc was manufactured to Mr. Lafayette's designs by Messrs. Yeates and Son, of Dublin, and gives, we are told, so near an approach to the light obtained by a north aspect that the difference cannot be detected from the resultant photographs.

We now come to the fog-dispelling apparatus, which was supplied by the Sturtevant Engineering Company, of 75, Queen Victoria-street. The apparatus was arranged to Mr. Lafayette's designs, and is similar to a plant erected for his Manchester studio. The principal requirement was to entirely eliminate fog from the studio, as it was found by practical experience that fog seriously interfered with photographing by electric light. In addition to this the apparatus had to provide a constant supply of fresh air in the studio and also to maintain the temperature at 60deg. F. as a minimum in the very coldest winter weather. In order to fulfil these requirements, a specially-constructed filter is used, through which all fresh air admitted into the building has to pass to free it from all mechanical impurities. After passing through the filter the air is

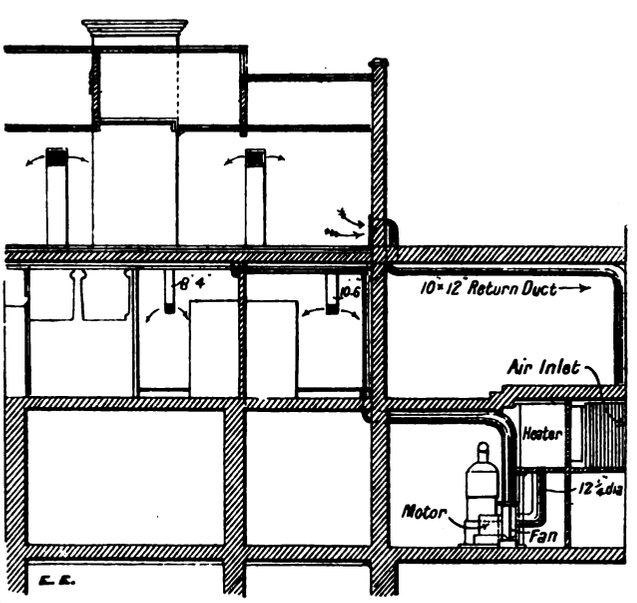

FIG. 4.—Sectional Elevation of 179, Bond-street, showing the Heating and Fog-Dispelling Apparatus.

drawn through a Sturtevant heater, which is automatically supplied with steam from a low-pressure boiler. The condensed water from the heater is automatically returned to the boiler. The heater is enclosed in a sheet-steel casing, thereby doing away with all risk of fire; the purified and warmed air is then drawn from the heater by an electrically-driven fan, and is conveyed through sheet-iron ducts to the studio and the dressing-rooms, where it is delivered at a summer temperature. The

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arrangement of the air-ducts can be seen in Fig. 4, which is a section of practically half the building. It will be seen from this view that the warm air is delivered at a good height, so that strong upward currents of warm air are not set up.

Under ordinary conditions fresh air is drawn into filters, which consist of cotton wool supported on galvanised iron netting. When the fog is dense, however, the air is drawn from the studio instead, by means of the return duct shown, a small proportion of fresh air only being admitted. The whole of the glass front of the studio is made air-tight, and the pressure inside is, if anything, slightly above that of the outside air.

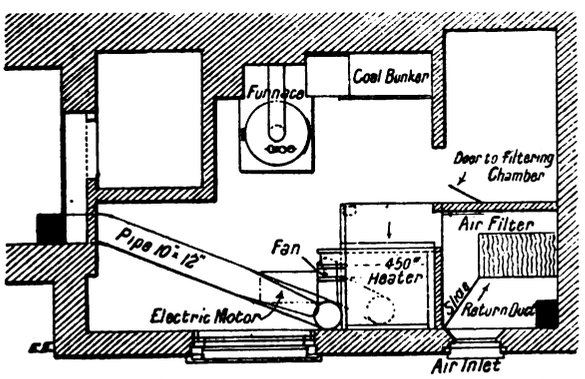


FIG. 5.—Plan of the Heating and Fog-Dispelling Plant, showing the Electrical Driving Fan.

In this way the tendency is for the purified air to pass out, and not for the foggy atmosphere to leak in. The arrangement of the heating and air-circulating plant is shown in plan in Fig. 5. The centrifugal fan is capable of delivering 90,000 cubic feet of air per hour, and hence can change the air in the buildings six times in the hour if required. About half this quantity is found to be usually sufficient. The fan is driven by a 1-h.p. electric motor by Laurence, Scott, and Co. (Fig. 6). The motor is shunt

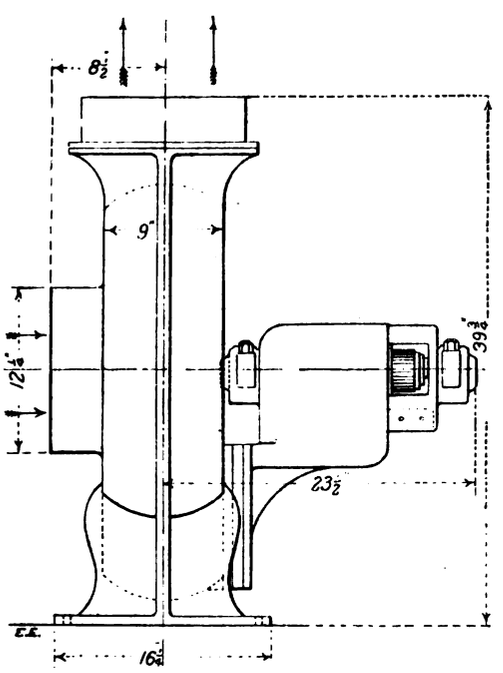


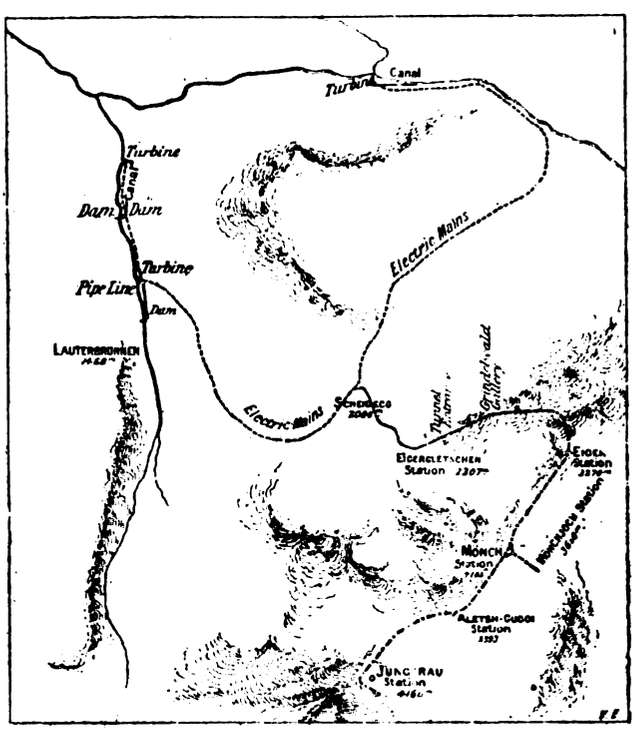
FIG. 6.—Elevation of Laurence-Scott Motor Driving a No. 5 Monogram Fan.

wound, and exerts its full power at a speed of 935 revolutions per minute. We were shown by Messrs. Sturtevant and Co. the method by which they calculate the necessary quantity of heat required in any given building, and were struck by the thoroughness of the treatment. Thus for every room the material and area of the walls is ascertained, the window area, the volume of air in the room, the floor and ceiling area, etc., and from these data the calories lost per hour with a given difference of temperature is calculated. Hence the volume of heated air required per hour can be ascertained. In the present case the large area of glass in the studio, coupled with the comparatively good conducting power of glass for heat rays, called for a large quantity of heated air per hour. In the hot weather the process can, of course, be reversed, and by placing ice in the chamber behind the filter cold air can be supplied to the various rooms.

All concerned in the equipment of this new home of photography are to be congratulated on the results of their endeavours to conquer the atmospheric defects of London, and we are glad to note that electricity has been a most valuable tool in their hands.

THE PROPOSED JUNGFRAU RAILWAY.

Mr. Guyer-Zeller, the chairman of the Jungfrau Railway Syndicate, has sent us a portfolio containing interesting maps and particulars of the proposed line to the mountain top. The station Scheidegg of the Wengernalp Railway, 6,760ft. above sea-level, will be the starting point of the new line. From here the Jungfrau Railway will run on the western slope of the Fallbodenhubel, making straight for the foot of the Eiger glacier. Thence it will turn due east, and later on due south, in a tunnel winding round the solid mass of the Eiger as far as the Eiger station, 10,160ft., which is to be laid open by galleries similar to those along the Axenstrasse. The tunnel will then continue in a straight line towards the Mönch and the Jungfraujoch, which it will reach at 344ft. below the surface, and will finally curve round the uppermost block of the mountain, reaching its terminus on a plateau, well known to the guides, at 13,430ft. above sea-level. This platform lies about 213ft. below the snow-covered summit of the mountain, and measures 80ft. by 100ft. It is free from snow during the summer months. From this level a lift, 213ft. high, will take the enterprising tourist to the highest summit of the Jungfrau, 13,660ft. This elevator will consist of two concentric iron cylinders, placed telescope-fashion one within



Plan of the Jungfrau Mountain Railway.

the other. The inner cylinder will contain the lift, and between the inner and outer cylinders a corkscrew staircase will be fitted, forming a footway from the terminus of the line to the summit.

Half-way between the stations of Scheidegg and Eiger, as well as between Eiger and Jungfrau, there are to be turn-outs to enable trains to pass each other.

The station Scheidegg of the Wengernalp Railway being the starting point of the contemplated line, the same class of permanent way has naturally been chosen for the new line. The gauge is 2ft. 7½in., the minimum curve of a radius of 196ft., the maximum gradient 25 per cent. The tunnels are to be of 130 square feet in cross-section.

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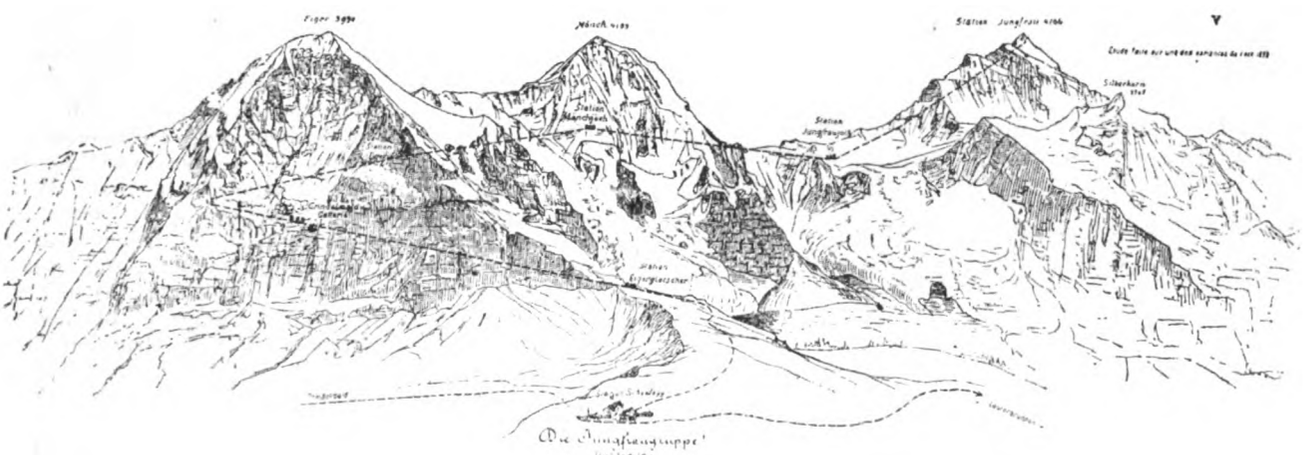
Wherever possible, headings or ventilating shafts are to be driven, leading from the tunnel to the surface of the mountain. They will also serve the purpose of facilitating the removal of the spoil. The railway is to be built and opened at first as far as the Eiger station only, which it is expected can be done in two years. Later on the upper portion, Eiger-Jungfrau, of the line, will be taken in hand, requiring about another two years to complete the undertaking.

The conditions for supplanting steam by electricity on the Jungfrau Railway are extremely favourable; there are distinct advantages to be gained as regards the supply of motive power both during construction and when working. In consideration of the present status of electrical science, one system—viz., that of a overhead conductor with continuous currents—stands before all others. With regard to the trustworthiness of electric traction, its regularity, and the safety necessary for traffic, we may take it for granted that these main considerations have already been fulfilled, and can be guaranteed by careful workmanship. The overhead conductor is also sufficiently perfect to be certain in its working and free from danger. At the same time the altitude of the Jungfrau Railway, and consequently the smaller security against the effects of lightning, call for a most carefully-designed electrical plant. In other respects electric traction has the following undoubted advantages as compared to steam locomotive power—viz., (1) a better relation between paying and dead weight; (2) noiseless and smokeless running; (3) the rack gearing works more safely, as the motive power is imparted to the wheels of the vehicles by a rotary motion; (4) attendance on the rolling-stock and maintenance of the same are decreased; (5) a saving in traffic expenses.

The concessionnaire for the Jungfrau Railway has the water power of the Black and White Lütschine at Burglauenen and Lauterbrunnen at his disposal. At least 3,000 h.p. can be taken off the Black Lütschine within a distance of 2,460ft., and from the White Lütschine 1,500 h.p. in a distance of 2,300ft. The works in Lauterbrunnen will be first carried out. To avoid as far as possible any interruptions in the working arrangements, it is intended that as soon as the turbines at Burglauenen are erected, the electric conductors for the line Burglauenen-Scheidegg are to be put up. If we accept as the greatest strain on the power plant a period when three trains will be going up and simultaneously three trains coming down, each with its full complement of passengers (about 400 in all), then the maximum supply required from the power station will amount to about 1,400 h.p. We arrive at this figure as follows:

(1) Power given off by secondary conductors along the line to the rolling-stock	h.p.	667
(2) Lighting the tunnels	h.p.	50
(3) Lighting six carriages	h.p.	8
(4) Lighting the stations and lift	h.p.	200
(5) Warming six carriages: if the external temperature be – 3deg. C., the required temperature of the car + 17deg. C., and the speed of the train 8 km. per hour, then each carriage will require about 20 effective horse-power, or, altogether	h.p.	120
Total power to be given off by secondary conductors	h.p.	1,045
(6) We take the working loss in the secondary conductors as 10 per cent., in the transformers as 6 per cent., and in the primary conductors as 10 per cent.; the power station must therefore be designed so as to give off	h.p.	1,325
(7) Power to be supplied gratuitously to the parish of Lauterbrunnen	h.p.	50
Total	h.p.	1,375

The syndicate, as has been mentioned previously in our columns, has awarded some 40 money prizes for the best plans sent in for details of the line and generating plant, etc. The company for carrying out the work is to be floated in a few weeks, and we believe that support is to be asked for from this country.



Prospective View of the Proposed Works for the Jungfrau Railway.

SHEFFIELD.

REPORT ON TRAMWAY TRACTION.

(Continued from page 366.)

DRESDEN.—Population, 334,000.

The thanks of the deputation are due to G. Strachey, Esq., H.M. Minister in Dresden; the directors and engineers of the two tramway companies; and Herr Palmie, H.M. Consul, for the information received in Dresden, and especially to the latter gentleman for the great amount of trouble he took in facilitating the inspection of the routes and depôts, and in collecting all the facts and details ready at hand, thus effecting a saving of very much time. The streets are a fair width, but some of the older ones are narrow. The gradients are generally flat—the steepest is 1 in 19, and the sharpest curve has a radius of about 60ft. The tramlines are cheaply built, and for a length of about one mile macadam is used without paving, This, however, is stated to be very unsatisfactory. Generally, the paving is of granite, extending across the track, and for 6in. on each side. The roadways in the centre of the city are also paved with granite, and there is a small length of asphalte. The rails weigh about 84lb. or more to the yard, and the section is that known as the Phœnix. There are two tramway companies in Dresden. The capital of the Dresdner Strassenbahn, formerly the English company, is £430,000 in shares and £100,000 in debentures; and of the Deutsche Strassenbahn, or Germany company, £250,000 in shares and £150,000 in debentures. The English company have 26¾ miles of tramways (6¾ miles single), and the German company about 15½ miles. The lines are constructed on the broad gauge. The systems of traction are: (1) horse; (2) electric overhead; (3) electric conduit (about ¼ mile; (4) electric accumulators.

Gas traction, said to have been invented here, has also been tried, and the following particulars are furnished respecting it. These cars have been in use 21 months, and although they have faults, like any other new invention, it is said there is all ground for believing that the system may be perfected. The working of the invention has been undertaken by an English company—the Gas Traction Company

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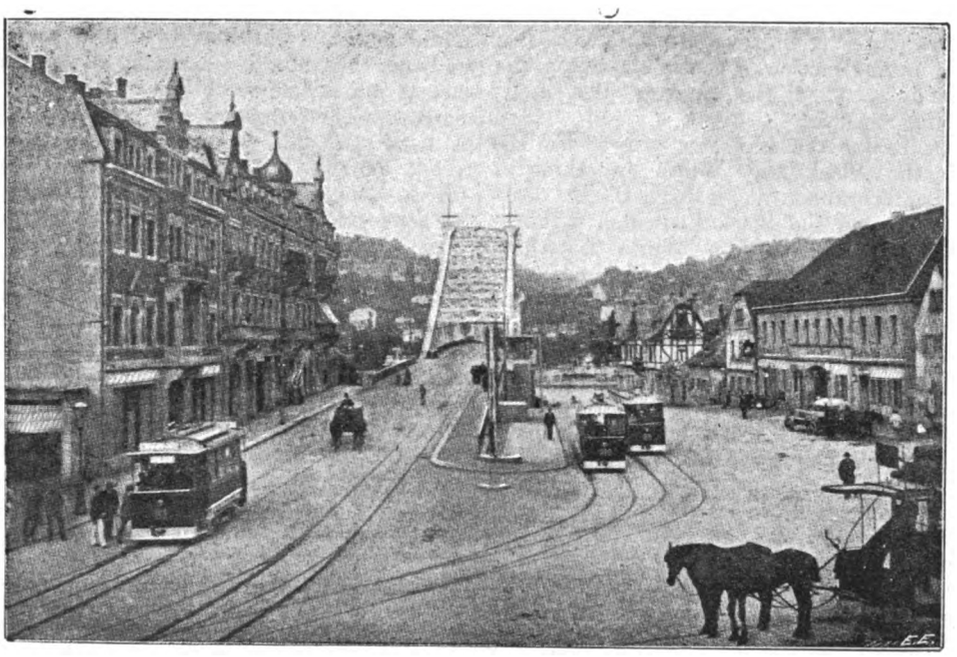
of Germany, Limited, now at London. The German patents have been acquired by a German company at Dessau, and are utilised by them. The gas traction cars were used in Dresden provisionally only, as the city gave

Dresden Tramways—View showing Overhead Construction (Siemens and Halske) in one of the Principal Streets, with Curve.

the concession exclusively for the electric system, and therefore the German company had to give up the gas traction system at the day on which the patents were bought by the Dessau company. One company is experimenting with the conduit system and the other with accumulators, but only because they are required to do so by the Municipality, which is putting pressure upon the companies to find a substitute for the overhead wires, etc., in some parts of the city. Overhead, however, would be much preferred by the companies on the ground of economy. As the accumulator experiments have only been in progress four months, and the conduit is not yet working, no very definite results can be given. It is, however, stated that although the first cost is small, the wear and tear of accumulators is great, and 30 per cent. more electricity is consumed than on the overhead system. The accumulators are placed under the seats, and the deputation while riding in one of these cars noticed that there was a strong unpleasant smell from the acids, although the cells were mounted in rubber. The cells have to be recharged after running about 2½ miles, or otherwise, in from 1½ to 2 hours. The charging is done from the top while the cars are running, no stoppage being necessary for the purpose, and takes half an hour. If accumulators, which will necessitate the carrying of an extra weight of two tons per car, are finally adopted in Dresden in those parts where the overhead system is objected to, they will have to be carried for four-fifths of the distance simply as dead-weight. The cost of the accumulators is £250 for each car, in addition to the cost of the car, and one-third of this sum is allowed per annum for depreciation, as the accumulators may only last three years. The concession is for 30 years. The Municipality owns the power stations, posts, wires, etc., and supplies the electric power. The companies supply the rails and cars, and pay for keeping the track in order, the Municipality doing the work at their expense. The companies are bound to take their electricity from the power station belonging to the Municipality, and pay about 1½d. per unit as a minimum for the first three years, but they hope to obtain a further reduction from the Municipality. The companies pay 20 per cent. of their profits for the concession. They also pay 15 per cent. per annum for depreciation of electrical apparatus. There is a concession to the company using horses which cannot be altered. Horse traction may be abandoned in five or six years, but further devolopments in electricity are being awaited. The first of the overhead electric tramways was opened in 1893. The lines have been constructed, as to this electrical work, by the Union Company, of Berlin; Messrs. Siemens and Halske; and a Dresden firm (the Electricitäts Werke, O. L. Kummer and Co.). In some cases rosettes are used instead of poles. A hissing noise was observable at the point of contact between the trolley and the overhead wire.



Dresden—View of Overhead Electric Tramways (Siemens and Halske) at Crossing of Elbe Bridge.

The installation is of the usual type, fully described in the Hamburg report. Three photographs are given herewith, two illustrating the general aspect of the principal streets, the other showing one of Messrs.

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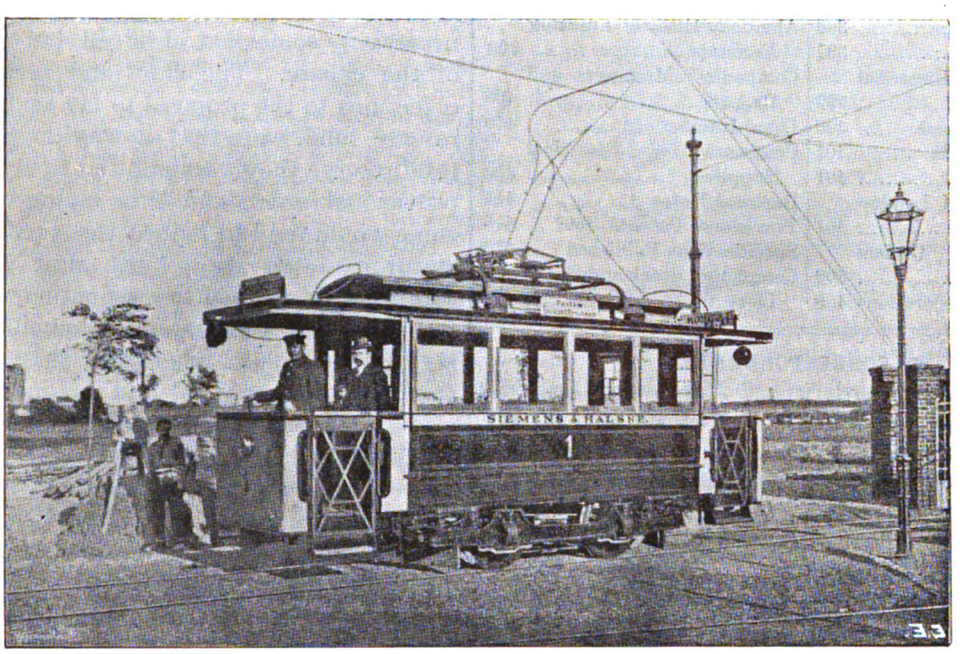
Siemens and Halske's cars with bow trolley. A short length of conduit is constructed, but is not yet at work. This system is said not to be practicable for the routes crossing bridges, because the arches of the bridges are too near the surface to allow for the depth of conduit. The cost of the conduit was stated at from £4 to £4. 10s. per yard run, as against £1. 3s. to £1. 12s. for overhead, or about 14s. where rosettes are used. This only includes the conduits or poles, wires, etc., and not the cost for laying down the paving or rails. The receipts per mile run of the (late) English company are stated at 10·8d. per car mile, and the expenditure at about 6d., while the German company state the cost per car mile as follows :

Electricity	1·45d.
Drivers' and conductors' wages	2·41d.
Total.....	3·86d.

The power station, which belongs to the Municipality, supplies power for both companies, but not for electric lighting. There are no accumulators at the power stations. The horse-power is 2,000, and the voltage 500 or 550. The current is direct. The cars are of the usual small pattern, and the cost was said to be £500 to £800 per car.

Generally, 22 people are carried inside and 20 outside, 45 places being the greatest number on any one car. There are five different kinds of cars. There is one motor to each, and the horse-power varies from 16 h.p. for small cars to 30 h.p. for the larger ones. Small windows are provided at each end of the car, through which the conductor can collect the fares of the passengers riding on the platform in front without opening the door. The cars weigh from 5½ to 8½ tons empty, and travel about 93 miles per day. There are 146 motorcars and 30 trailers. The bow form of trolley seems to be preferred in Dresden. The fares vary from 1d. for 1¾ miles to about 3d. for 4¼ miles. The interchangeable ticket system is used. Stopping places are provided, and the cars do not stop between. It is said that accidents have not been numerous, and what there have been were due to carelessness. The cars are, of course, provided with brakes, and bells are fitted in connection with them, which can be used to warn the public of the approach of the cars. These are rung by moving the brake handle. Electric brakes are to be provided eventually. There have been no interruptions of traffic through the breakdown of machinery. The speed of the overhead electric trams is about seven to eight miles per hour in the busier parts, and in the suburbs about 20 miles per hour. The deputation travelled on a car at this speed for about two miles, but as the roadway was not well laid the car pitched considerably. The service on some lines is stated at 16 cars per hour on an average. Both drivers and conductors are paid 3s. to 3s. 6d. per day, and work 11 hours. In addition they receive premiums up to as much as 10s. per month for good conduct and attention to duties. Uniform is provided, and the men pay 5 per cent. of their wages for its maintenance. Though the engineer for Messrs. Siemens and Halske said he liked the conduit system, the overhead system generally seems to be strongly preferred, both by the company and the Municipality, on account of its cheapness, and the ease with which repairs, etc., can be effected. It does not seem probable that the conduit system will ever be adopted largely in Dresden, but as the authorities object to the overhead apparatus in some parts of the city, the companies are trying to arrive at some practical method of accumulator traction, this being regarded as the lesser evil. The director of one of the companies informed the deputation that he was strongly opposed to the conduit system and did not think it could be satisfactorily worked in Dresden. The price paid by the companies for electricity is considered a high one, the Municipality requiring a profit of 20 per cent.; still, electric traction is said to be cheaper than horses.



Dresden Tramways—View of Siemens and Halske Car for Overhead Electric Tramways, with "Bow" Trolley.

INSTITUTION OF ELECTRICAL ENGINEERS, Mar. 25

At last night's meeting of the Institution the following candidates were balloted for :

Foreign Member.—B. L Vogels-Dolhain, The Hague.

Associates.—Charles Frederick Clapham, 139, East India-road, E.; Charles Philip C. Cummins, Spy Hill, Queenstown; John George Griffin, 37, Camden-road, London, N.W.; John Louis Hermessen, Kleist-Strasse, 29, Berlin; Albert Higgins, 48, Osnaburgh-street, Regent's Park; Bertram Hopkinson, Holmwood, Wimbledon Common, S.W.; Thomas Henry Lloyd, the Anglo-American Telegraph Company, Brest, France; John Francis McMahon, Power House, St. George, Bristol; Hans Jacob Pheodor Norballe, Penywern House, Earl's Court, S.W.; Frank C. Porte, Dawson-street, Dublin; George Ward, Malaya Morskaya 21, St. Petersburg, Russia; Henry Edward Allan Wiggett, 33, Stirling-road, Edgbaston, Birmingham.

Students.—Arthur B. H. Cope, Broxton, Chester; George William Harris, 45, Cathles-road, Balham Hill, S.W.; Charles Jones Lockyer, 64, Josephine-avenue, Brixton Hill, S.W.; Wilfrid John Murphy, Penywern House, Earl's Court, S.W.; Mark Packer, Hampton House, Luton-road, Chatham; John Price Trotman, 31, Balchier-road, East Dulwich.

Lightning.—According to Mr. Turquan, writing in *L'Eclairage Electrique*, statistics for France show that for one person killed by lightning there are three or four only injured. June, July, August, and September are the dangerous months. Most of the cases occur in fields and roads, and one out of four are killed while taking shelter under a tree.

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TO CORRESPONDENTS.

All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notice of Meetings, Issue of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

All communications intended for the Editor should be addressed C. H. W. BIGGS, *139-140, Salisbury Court, Fleet Street, London, E.C Anonymous communications will not be noticed.*

TO ADVERTISERS.

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BOUND VOLUMES.

Vol. XVIII. of new series of "THE ELECTRICAL ENGINEER" can be had bound in blue cloth, gilt lettered, price 8s. 6d. Subscribers can have their own copies bound for 2s. 6d., or covers for binding can be obtained, price 2s.

EMBARRAS DE RICHESSE.

So few of the departments under the control of a town council are profit-earning that we seldom hear of trouble arising owing to the excess of income over expenditure. Consequently we rejoice to hear that at Edinburgh on Wednesday last the success of the electric lighting venture of the Corporation was the cause of a long and fiery debate. The discussion arose from the fact that after the end of only the second year of working the committee proposed to put aside about £4,000 to a reserve account. The department had met all outgoing expenses, and also cleared off an amount owing to the city treasurer for the interest and repayment of loan for the first year of working. Hence the £4,000 was free, and several of the councillors wished to have a word as to how it should be appropriated. The account of the discussion found in our column of notes is necessarily somewhat abridged, but gives the trend of the debate. The chief and perhaps only valid objections to the proposal to lay aside the sum for a reserve fund, were that it was 25 per cent. of the total reserve they were allowed to accumulate by the provisional order, and that laying by of such large sums would tend to reduce the surpluses below the statutory 5 per cent. limit, after which the consumers were entitled to a reduction. There seemed to be an idea amongst the councillors opposed to laying by the sum mentioned that the money was to be used as a renewal and repairs account. That was explained to be a totally erroneous idea. Mr. Mackenzie, the chairman of the Electric Light Committee, made an excellent speech justifying the course it proposed of wisely making provision for the future before either reducing the price per unit or relieving the rates by the surplus earned. It was also pointed out by another speaker that the ratepayers had taken the risk in starting the undertaking, and that the consumers of the light should rather be debited with the provision of the reserve fund to guard against a call on the rates at any future time when the revenue may not exceed the outgoing charges. The voting showed that the Council fully appreciated the financial policy of the committee. This troublesome question of surplus wealth being disposed of, the Council proceeded to consider the necessary extension. It was decided by a large majority to make provision for lighting ten additional streets by electricity during the present year. The streets were selected either because they were badly lighted or because they lay in congested districts where good illumination was essential. We consider that Prof. Kennedy is to be congratulated on this rapid extension, which is well warranted by the success of the undertaking. It must be remembered that the charge per unit in Edinburgh is only fivepence. The rapid growth of the income of municipal electricity works in large towns such as Edinburgh and Manchester shows clearly that in a few years the subject of how to deal with large surpluses will frequently arise. It shows conclusively that the policy of the corporations who have kept the electric lighting in their own hands is in every way to be commended. The consumers in such towns will benefit by the

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reduction of the cost of their light to an extent not possible under any profit-dividing company. One has only to look forward some twenty or thirty years, to the time when the original loans will be repaid, to realise what a most valuable asset will then be held by the corporations in question. In the meanwhile, we are pleased to note the instance of a council in trouble as to the disposal of profit from electric lighting rather than accounting for annual losses, as predicted by our gaseous contemporaries.

FORTHCOMING EVENTS.

The following are some of the announcements for the forthcoming week:

TO-DAY (FRIDAY).—Civil Engineers' students' meeting ("The Resignalling of the Liverpool-street Terminus of the Great Eastern Railway," by Mr. W. J. Griffiths), 8 p.m.—Electro-Harmonic Concert.—Royal Institution (Sir William Turner on "Early Man in Scotland"), 9 p.m.

TO-MORROW (SATURDAY).—Royal Institution (Lord Rayleigh on "Electricity and Electrical Vibrations," Lecture IV.), 3 p.m.

MONDAY, MARCH 29.—Metropolitan Electric Supply Company's meeting, Portman Rooms, Baker-street, W., at 12 noon.—Society of Arts, John-street, Adelphi, at 4 30 p.m. (Cantor Lecture on "Alloys," by Prof. W. Chandler Roberts-Austen. Lecture III.—"Steel and Cast Iron Considered as Carbon—Iron Alloys").

TUESDAY, MARCH 30.—Institution of Civil Engineers, special meeting to consider alterations of the by-laws at 4 30 p.m.; ordinary meeting at 8 p.m. ("Electric Lifts and Cranes," by Mr. Ravenshaw).—Direct Spanish Telegraph Company's meeting, Winchester House.—Royal Institution, 3 p m. (Dr. Waller on "Animal Electricity").—Society of Arts ("Lead Work," by Mr. Lethaby), at 8 p.m.—Crystal Palace, lecture, 8 p.m.

WEDNESDAY, MARCH 31.—Institution of Electrical Engineers' students' meeting, 7.30 p.m. (paper on "Electrical Tramway Traction," by Mr. Percy Sheardown).—Anniversary Meeting of the Chemical Society, 3 p.m.; dinner at the Criterion, 7 p.m.—Society of Arts, 8 p.m. ("Cycling," by Mr. G. Lacy Hillier).—Also at Sheffield, meeting of the Sheffield Electric Light Company, Cutlers' Hall, 12 noon.—And at Liverpool, Liverpool Engineering Society.

THURSDAY, APRIL 1.—Royal Institution, 3 p.m. (Prof. Boyd Dawkins on the "Frontier of History in Britain").—Chemical Society, Burlington House (Dr. Norman Collie).—Institution of Civil Engineers' students' visit to the Bankside Generating Station.—Society of Arts, Indian Section, at 4.30 p.m. ("A Visit to Russian Central Asia," by Mr. M. F. O'Dwyer, I.C.S.)

FRIDAY, APRIL 2.—Institution of Junior Engineers, at 8 p.m., at the Westminster Palace Hotel, Victoria-street ("Cycle Construction," by Mr. A. W. Marshall).—Royal Institution (Mr. C. T. Heycock on "Alloys and the Theory of Solution"), 9 p.m.—Also at Paris, meeting of the Ingenieurs Civils de France.

SATURDAY, APRIL 3.—Royal Institution, 3 p.m. (Lord Rayleigh on "Electricity").—Chesterfield and Midland Engineers' meeting at Tamworth.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

NEW AMERICAN PATENT LAW.

SIR,—The Americans have at last become alive to some very serious abuses incident to their boasted examination system. Among these are the following: (1) patents have frequently been many years (in one or two instances lately, 16 years) in passing through the office, from the date of original application to the date of actual grant; (2) it has often happened that an invention has been published for many years in the country without being patented, and then, when some enterprising firm has taken it up and made it valuable, the original inventor has taken out a patent for it, and made the said firm pay heavy royalties for its use; (3) as an American patent is only granted for the duration of the earliest expiring prior foreign patent, if there be one, Americans very frequently lose their foreign rights through being forestalled abroad, while they are slowly working their American patents up to allowance, they not daring to apply for foreign patents in the meantime for fear of injuring their home rights.

To meet these and other defects, Congress has just passed a new Patent Act, to come into force on January 1 next. Its principal points are as follows:

The patenting abroad by other parties, or the publishing of the invention in any country more than two years prior to the application for an American patent, is fatal to the latter. So is the public use or sale of the invention in America more than two years prior to the application for a patent there, unless it be proved that such use was abandoned by the applicant or his representatives.

The application on an invention patented abroad must be filed within seven months of the earliest foreign application; the patent will then be granted for 17 years. If the application be not filed within that time the patent (if granted) will be void.

A patent application refused by an examiner must be amended or the refusal appealed against within a year of such refusal, otherwise the refusal will become final (hitherto the law gave two years, which the Patent Office of late arbitrarily shortened in practice to six months)

Similarly an application filed in an incomplete state must be completed within a year or will be held to be abandoned.

The Statute of Limitations (six years) shall apply to infringements of patents. These acts, except this last previous clause, shall not be operative on any patent applied for before January 1, 1898.

As this new enactment is of vital importance to English patentees, it is desirable to give it as wide a publicity as possible.—Yours, etc., WM. P. THOMPSON AND CO.

Liverpool, March 23, 1897.

CITY AND GUILDS OF LONDON INSTITUTE.

SOLUTIONS TO THE NUMERICAL EXAMPLES IN ELECTRIC LIGHTING AND POWER TRANSMISSION SET 1896.

PRELIMINARY STAGE.

1. How many volts are needed to send a current of 20 amperes through a conductor having 10 ohms resistance? What difference would it make in your answer if the circuit included a motor having a back E.M.F. of 450 volts?

Solution.—By Ohm's law, $E = C \times R$

$= 20 \times 10 = 200$ volts.

(2) When a back E.M.F. is present, as when the circuit includes a motor, the current flowing is given by the equation

$$C = \frac{E - e}{R},$$

in which E is the pressure of supply and e the back E.M.F.

$$\therefore 20 = \frac{E - 450}{10},$$

and $$E - 450 = 20 \times 10 = 200;$$

$$\therefore E = 450 + 200 = 650 \text{ volts.}$$

2. How many (electric) horse-power are needed to drive a dynamo supplying 120 16-candle lamps if the lamps take half an ampere each and are supplied at 120 volts?

Solution.—

Power required for one lamp $= C \times E = \frac{1}{2} \times 120$ watts

$= 60$ watts.

$\therefore$ „ 120 lamps $= 120 \times 60 = 7{,}200$ watts;

but 746 watts = 1 h.p.

$$\therefore \text{h.p. required} = \frac{7{,}200}{746} = 9{\cdot}65.$$

3. You are given 16 cells, each having an internal resistance of one ohm. How would you connect them up so as to get as large a current as possible through a wire of four ohms resistance? If each cell had an E.M.F. of one volt, what current would you get through the wire?

Solution.—For the current to be a maximum, the cells must be arranged so that the internal resistance of the whole battery is as nearly as possible equal to the external resistance.

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Let p = the number of rows of cells connected in series;
then $\frac{16}{p}$ = the number of cells connected in series,

and total internal resistance $= \frac{16}{p} r \div p = \frac{16r}{p^2}$,

where r = internal resistance of each cell;

$$\therefore \frac{16}{p^2} \times 1 = 4;$$

and $$4p^2 = 16;$$

from which $$p = 2.$$

Therefore the maximum current results when the cells are connected in two rows of eight in series.

The resulting current with this arrangement

$$= C = \frac{\frac{16}{p} \times e}{R + \frac{16r}{p^2}} \left\{ \begin{array}{l} e = \text{E.M.F. of each cell} \\ R = \text{external resistance} \end{array} \right.$$

$$= \frac{8 \times 1}{4+4} = \text{one ampere.}$$

ORDINARY GRADE.

4. Define one watt, one kilowatt, and 1 h.p.; also, if 1ft. = 30·48 centimetres, and 1lb. = 453·6 grammes, calculate the number of ergs equal to one foot-pound at a place where the acceleration of gravity is 981 centimetres per second. Lastly, calculate the number of ergs per second equal to 1 h.p.

Solution.—One watt is the practical unit of power, and is the rate of doing work when a pressure of one volt sends a current of one ampere through one ohm resistance.

One kilowatt is the power expended at the rate of 1,000 watts.

One horse-power is the engineer's unit of power, and is the power expended when 33,000 foot-pounds of work are done per minute.

The erg and foot-pound are units of work—the former in the C.G.S. absolute system, and the latter in the English gravitation system. They are related to one another as follows:

One erg of work is done when a force of one dyne is overcome through one centimetre, and one foot-pound of work is done when a force of 1lb. weight is overcome through 1ft. To change from the gravitation unit of force, the pound weight, to the absolute unit of force, the poundal, we have to multiply the gravitation unit by "g," the acceleration of gravity.

And since 1lb. = 453·6 grammes,
and the force of 1lb. weight = the force of 453·6 grammes weight,
but the force of one gramme weight is a gravitation unit and = g dynes,

$$\therefore \text{force of 1lb. weight} = g \times 453{\cdot}6 \text{ dynes};$$
$$= 981 \times 453{\cdot}6 \text{ dynes}.$$

$$\therefore \text{one foot-pound} = 981 \times 453{\cdot}6 \text{ dynes} \times 1\text{ft.};$$
$$= 981 \times 453{\cdot}6 \times 30{\cdot}48 \text{ dyne-centimetres};$$
$$= 13{,}563{,}039{\cdot}168 \text{ ergs}.$$

Also since 1 h.p. = 550ft. per second,

$$\therefore 1 \text{ h.p.} = 550 \times 13{,}563{,}039{\cdot}186 \text{ ergs};$$
$$= 7{,}459{,}671{,}542{\cdot}4 \text{ ergs};$$
$$= 746 \times 10^7 \text{ ergs (approximately)}.$$

5. Calculate the number of (alternating) volts needed to drive an alternating current of 10 (virtual) amperes through a choking coil, having a coefficient of self-induction of $\frac{1}{100}$ henry, the frequency being taken at 80 periods per second.

Solution.—The alternating E.M.F. required $= 2\pi n$ L C virtual volts,

where n = the frequency = 80;
L = the coefficient of self-induction = $\frac{1}{100}$;
C = the current;

$$\therefore E = 2\pi + 80 \times \tfrac{1}{100} \times 10 = 16\pi$$
$$= 16 \times 3{\cdot}1416 = 50{\cdot}2656 \text{ virtual volts}.$$

6. A transformer with a well-closed magnetic circuit is taking 10 amperes at 2,050 volts. Its primary coil consists of 860 turns of wire, having a total resistance of five ohms. Its secondary consists of 43 turns, with a resistance of $\frac{1}{80}$ of an ohm. Assuming that magnetic leakage, eddy currents, and hysteresis are negligibly small, calculate the pressure of the secondary terminals when 200 amperes are being supplied to the lamp.

Solution.—

Let V_1 = the terminal E.M.F. of supply to the primary;
V_2 = the terminal E.M.F. of secondary;
E_1 = the E.M.F. of the primary transformer;
E_2 = the resulting E.M.F. given to secondary;
r_1 and r_2 = the primary and secondary resistances respectively; and
C_1 and C_2 = the primary and secondary currents respectively;

Then $\left.\begin{array}{l} V_1 = E_1 + r_1 C_1 \\ V_2 = E_2 - r_2 C_2 \end{array}\right\}$ and $\frac{E_1}{E_2} = \frac{860}{43} = 20$
= ratio of transformation.

Substituting the values given,

$$2{,}050 = E_1 + 5 \times 10 \quad \therefore E_1 = 2{,}050 - 50 = 2{,}000;$$
$$V_2 = E_2 - \tfrac{1}{80} \times 200 \quad \therefore E_2 = V_2 + 2{\cdot}5;$$

and $$\frac{2{,}000}{V_2 + 2{\cdot}5} = 20 \quad \therefore 100 = V_2 + 2{\cdot}5;$$

and $$V_2 = 97{\cdot}5 \text{ volts}.$$

7. What must be the value of the (alternating) magnetic flux in an iron core if, with a frequency of 100 periods per second, it is to generate 40 volts (alternating) in a coil of 100 turns surrounding it? What cross-section of iron would be suitable to carry this alternating flux or total field?

Solution.—The relationship between the E.M.F. generated and the magnetic flux, the number of turns, and the frequency is given by the equation:

$$E = 4{\cdot}45 \, S \, . \, N \, . f \times 10^{-8} \text{ volts},$$

in which E = pressure generated in volts;
S = number of turns;
N = magnetic flux in C.G.S. lines;
f = the frequency;

$$\therefore N = \frac{10^8 E}{4{\cdot}45 \times S \times f};$$
$$= \frac{10^8 \times 40}{4{\cdot}45 \times 100 \times 100} = \frac{4 \times 10^5}{4{\cdot}45};$$
$$= 89{,}887{\cdot}6 \text{ C.G.S. lines}.$$

Assuming that the induction is 7,000 C.G.S. per square centimetre, the area of cross-section

$$= \frac{89{,}887{\cdot}6}{7{,}000} = 12{\cdot}8 \text{ square centimetres}.$$

ELECTRICITY FROM CARBON WITHOUT HEAT.*

BY WILLARD E. CASE.

The subject has such possibilities, all within reasonable bounds, that I hardly know where to commence or finish. At present we have only crossed the boundary line of that field which I am sure will be productive of tremendous results. Thermo-electricity has attracted attention for a great many years past, and now and then we have heard of new inventions which led us to think that we were about to solve the problem. As far back as 1801, Ritter noticed that a current was set up when the junctions of dissimilar metals were heated. And following down to a later date, we find that some thermo-electric batteries were constructed which really produced electrical energy at small cost, and which have been to some extent found practicable. A thermo-cell was described by the speaker before the Royal Society in 1886. It consists of plates of tin and platinum, forming the electrodes, immersed in a solution of chromic chloride. When the cell is heated, the electrolyte becomes active; chlorine, leaving the chromic chloride, temporarily combines with the tin and forms proto-chloride of tin. This chemical action generates electricity, and soon the tin is all converted into chloride and the current ceases. When the

*Lecture delivered before the New York Electrical Society, February 24.

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cell is cooled this temporary combination of the chlorine and tin is broken up and the chlorine returns to chromium proto-chloride. The tin being set free falls as a metallic precipitate to the bottom of the cell in the form of crystals ready to renew the operation. If this cell works between 80deg. and 180deg. F., or 538deg. or 638deg. absolute, the E.M.F. at the higher temperature is about ·26 volt, but the possible efficiency is less than 16 per cent., owing to the operation of the second law of thermo-dynamics, which provides that in the conversion of heat into work the efficiency equals the higher temperature minus the lower temperature divided by the higher temperature reckoned from an absolute zero, the latter being minus 273deg. C. So that this cell is a heat engine—a reversible voltaic cell which passes through a complete cycle. It must be heated to operate, and cooled to regenerate itself. In this connection it may interest you to see in operation a more practical thermo-cell which converts heat into electrical energy. This battery (the Cox thermo generator) is said to consume 2½ cubic feet of gas per hour and to generate 12½ watts.

In order to make the subject clear to those who are not familiar with it, let me say that all electricity (except that produced by water power or galvanic batteries) is obtained from carbon. That is to say, our electric power of to-day is generated by the combustion of coal under the steam-boiler or by means of the gas-engine, and through the intermediary of engines and dynamo this energy is converted into electricity. Now, we all know that this conversion of the potential energy of coal into heat and then into work is a most wasteful process, owing to the intervention of the second law of thermo-dynamics above referred to, and how to overcome this law and to avoid this waste is the subject under discussion to-night. Practically, we only convert a small percentage of the potential energy of the coal into work, a large portion being wasted. It is not so much the inefficiency of the boilers, or the steam-engine, or dynamo, which converts this energy into electricity, as it is the method adopted. When we burn coal under the boiler, we transform the energy of that coal into heat energy, and the moment we do this, we come in conflict, or rather become governed by, the second law of thermo-dynamics. It is an inexorable law of nature that under the conditions in which we live, a great waste must accompany the transformation of heat into any other form of energy. To illustrate, in hot-air and gas engines, a cold water jacket is usually employed, and to raising its temperature is diverted the larger share of the heat. In the thermopile, the junctures must be cooled by a circulation of air or water, and in Edison's pyro-magnetic generator the iron tubes must be cooled by application of cold air.

In accordance with the second law of thermo-dynamics, the heat not lost but which we can utilise in a given case equals the difference between the high and low temperatures used divided by the low temperature. Now, to express this more simply, there is heat, or an expansive force in everything, down to an absolute zero; but under ordinary conditions we cannot economically use this heat in any machine below the average normal temperature in which we live. So when once we set up molecular motion, called heat, we only use it above the normal temperature up to that point to which we are limited by the destruction of matter. Or, as we might say, to that point at which we burn out our boilers or melt our containing vessels. And this range is but a small fraction of the total range of the heat we have produced. Lodge has shown us that the energy in a pint of boiling water, if it could be all utilised, amounts to more than half a million foot-pounds, and even if the water were quite cold, and on the point of freezing, it would still contain energy of 350,000 foot-pounds of work, or one-sixth of a horse-power hour in every pint. Now, coal or zinc could be burned to heat this water to a boiling point, in which case only a part of the energy between that point and freezing could be utilised, which is a small portion of the total range between the boiling point and absolute zero. But either material can be oxidised in a galvanic battery without heat and waste, and electricity produced. If we burn the coal, as Lodge has suggested, the highest temperature commonly available is that of the furnace; hence the heat should be supplied to the working substance in the cylinder at a furnace temperature. This condition is roughly satisfied in internal-combustion engines, though they have many defects at present. This furnace temperature is about 2,000deg. above absolute zero, or 1,500deg. F., and if in this engine we could cool down to 600deg. above zero, or 110deg. F., we could have a possible efficiency of 70 per cent. of the whole, $\frac{2,000 - 600}{2,000} = \cdot 70$—that is, 70 per cent.—less the friction of the machine and the loss in the conversion into electrical energy, which would bring it down to something like a possible 50 per cent. or 60 per cent. The steam-engine does not even approach this. Its theoretical efficiency at 300lb. steam pressure is 33 per cent., but in actual operation this is reduced to 25 per cent. Gas-engines, internal-combustion engines, come nearer this deal. In fact, Prof. Thurston states that a cannon when being fired has an efficiency of 50 per cent. Let it be understood that this is a law of nature; it is inevitable under the conditions in which we live. No cunningly-devised furnace or feed-water heater, or cut-off, or triple-expansion apparatus, or pyro-generator can save this heat. The most that any of these devices can do is to save what would otherwise be wasted, over and above that which we must of necessity lose.

Now, the question which we naturally ask is: How are we to convert this potential energy of the carbon into electricity with the least loss? If the boiler, steam-engine, and dynamo are not available for our use economically, how shall we do it? We know that the voltaic battery does not act through the transformation of heat into electricity; it produces electrical energy direct. The zinc is oxidised and the potential energy of that zinc is converted directly into electrical energy, without the production of heat. The second law of thermo-dynamics is thus avoided, as no heat appears But the cost of this zinc and the chemicals employed to oxidise it are so expensive that we cannot afford to use them. The cheapest materials which present themselves at present to our notice are coal or carbon and the oxygen of the air. And if we could convert the energy of the coal into electrical energy direct and cheaply, we could do away with our steam motors in time, provided the apparatus was simple and practical. Now there is no known reason why a cheap substance may not yet be found which will act on coal and develop electrical currents in place of heat, but the general tendency of late has been to discard this method and to attempt to find some stable electrolyte or bath, which will act as a carrier of the oxygen of the air, conveying it to the carbon and oxidising it, as zinc is oxidised in a battery, producing electricity. This electrical energy would be the equivalent of the heat energy that would be developed by the combustion of the coal in the ordinary way.

Of course, in the construction of such a cell we must be governed by the experience which we have had with the galvanic battery in which the elements of E.M.F., internal resistance, etc, are involved and by which consequently the output of the cell is governed; such a cell must produce a large amount of energy, be simply and easily cleaned or recharged, in order to be practical. It must be as durable and as simple to use and handle as the steam-boiler and dynamo are to-day.

It may be of interest to give you a comparative illustration of what the energy of coal does to-day, through the use of the steam-engine, and what it would do provided we could oxidise it in a battery without heat. The average of large electric light plants requires 4lb. of coal for every horse-power hour of electricity delivered from the dynamos to the line. That is to say, four large stations show a consumption of 4·2lb. per horse-power hour; 49 stations, 4·6lb. per horse-power hour; and 32 small stations, 12lb. per horse-power hour. Theoretically, ·175lb. of coal will yield one horse-power hour, or allowing for ash, ·185lb., and of zinc, 1lb. used in a battery produces one horse-power hour under a potential of two volts, including the loss in internal resistance.

Of course, the subject of electricity direct from carbon has been considered from many points of view. Some have

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attempted to obtain cheap electricity by using the oxygen of the air to oxidise various substances. Others have attempted to oxidise coal with the oxygen of the air without heat, and others have attempted to oxidise coal by the oxygen of the air with the application of external heat. The evolution of this subject is most interesting. We will therefore study the question from that point of view and examine some of the most important batteries which have been constructed. We will do so chronologically. Of course, lack of time will compel me to avoid reference to many well-conceived inventions.

Passing over the carbon-consuming cells of Jablochkoff, Bard, Crumm, Edison, Wright, and Thompson, I will first describe the cell invented by C. S. Bradley in co-operation with Prof. F. B. Crocker, which was mentioned in the discussion of a paper read by the speaker on "Electricity from Carbon Without Heat," in 1888, before the American Institute of Electrical Engineers. Mr. Bradley described fully the action of fused salts on coal, and stated that the oxygen of the air was absolutely necessary for the purpose of cheap oxidation, or, to use his own language: "The cell consisted of fused sodium manganate and putting a blast of air through it and by that means supplying it with oxygen and allowing it to act on the coal which is put in another part of the vessel, a little over one volt was obtained." The cell consists of an iron vessel 2½in. in diameter and 6in. deep, which is placed inside of a retort and heated by a gas flame to nearly a red heat. The electrolyte of the cell is caustic soda, to which peroxide of manganese is added, forming sodium manganate.

The next cell to which I will ask your attention is that described by W. W. Jacques in *Harper's New Monthly Magazine* in December, 1896, which is another illustration of the same principle involved in the Bradley cell with a few practical modifications. It, like the other cell, consists of an iron vessel, which is the negative electrode, containing fused caustic soda minus the peroxide of manganese, into which is plunged the positive coal or carbon. The oxygen is supplied by a blast of air as in the cell before described, and an E.M.F. of about one volt is said to be obtained. The difference between these two cells, which I particularly desire you to notice, and the only practical difference between them, is the addition of peroxide of manganese to the bath of the Bradley cell; and, although I have described them chronologically, I will first show the Jacques cell, and then by simply adding peroxide of manganese to it we will have the Bradley cell. We will then be enabled to get their comparative E.M.F. and current in the same cell. But I may say, in passing, that experience with these cells before you leads me to believe that the theory of their action is not by any means well understood. It is most uncertain and erratic, and seems to be more so before than after the addition of the manganese peroxide. For instance, its E.M.F. seems to depend upon its temperature. If water is present when the caustic soda is first used a reverse current becomes manifest. When air is blown through the electrolyte the E.M.F. is increased. Sometimes only ·3 of a volt is obtained; sometimes about 1½ volts. But the greatest amount of current is apparent when the carbon is immersed in the bath. When the carbon rod is drawn up along the inside of the vessel the highest E.M.F. is obtained, and when this carbon electrode is replaced by another having none of the fused electrolyte on it, and brought in contact with the exterior of the vessel at different points where the temperature varies, no appreciable E.M.F. is obtained. This would indicate that as we drew the carbon up out of the bath against the side of the vessel, we approach a point where the critical temperature exists and we get the highest E.M.F.

If a nickel crucible be used as suggested by Bradley some years ago, the E.M.F. is brought up to what is considered the theoretical value. If a little nickel crucible contains fused caustic soda and carbon electrode the same as in the Jacques cell, when heat is applied the voltage goes up to 1·16, then begins to fall, and at a critical temperature above a red heat it drops to ·3 volt—a most interesting fact—and on cooling, the voltage goes up again to 1·16, and drops again when the caustic soda solidifies. Many other peculiar actions will be noticed if the carbon rod is replaced by an iron one. With this form of cell it is claimed that as high as 85 per cent. of the energy of the carbon consumed is converted into electrical energy. The following results of tests of the Jacques cell, taken from the article referred to, and from the *Engineering Magazine* of July, 1896, may be of interest. Electricity obtained from 1lb. of coal (of which 0·4lb. was consumed in the pots, and 0·6lb. was burned on the grate) equalled 1,336 watt-hours, or 32 per cent. of that theoretically obtainable.

Another cell reported in the public prints to have been built and operated by Jacques consisted of 100 iron cells 1½in. in diameter and 12in. deep, which gave an E.M.F. of about 90 volts and 16 amperes, supplying 30 16-c.p. incandescent lamps for a little over 18 hours. In this experiment it is said that about 8lb. of carbon were consumed in the cells. This, it was stated, gave an efficiency of over 90 per cent., which, of course, did not include the power to operate the air-pump and the coal consumed in heating the cells. But my experience with the cells leads me to doubt the correctness of these computations.

It has been suggested that carbon-consuming batteries would be too bulky and occupy too much space as compared with that occupied by the present central station for a given output. I find, however, that the Edison station at Duane-street has a capacity of 28,000 e.h.p. The cubical capacity of the building is in round numbers 900,000 cubic feet. The same building crowded with Jacques cells, assuming that they would perform the work claimed for them and leaving aside the question of the difficulty of their operation, properly distributed, would have an output of 60,000 h.p. The estimate is necessarily theoretical and based entirely upon statements made by Mr. Jacques—namely, that a furnace containing cells occupying a cubical space of 600ft. has a capacity of 40 e.h.p. You will thus see that this ratio is in the proportion of 28 to 60 in favour of the battery. It has been stated that the E.M.F. of the carbon-consuming cells is so low that they would be of no practical value. I think our experience with the storage battery in central stations refutes this idea, at least for potentials up to 250 volts, and by means of rotary transformers the current can, if necessary, be converted into any form and pressure.

These cells, if correct in theory, can be heated without infringing on the second law of thermo-dynamics, as the law does not apply so long as the oxidisation of the carbon itself does not produce heat, but electricity. For, as we have said, there is heat in the electrolytes and all matter down to an absolute zero, and the elcctrolyte in the practical operation of these cells is simply heated to permit the chemical affinities acting. We are governed here, as elsewhere, by the laws of evolution, and I think that this question will be solved only through many attempts and many failures. I believe that we must look at this subject from a different point. In the first place, can we not learn a lesson from nature? We certainly have a most wonderful example of the conversion of potential energy of carbon direct into work in the animal economy, which is developed at the expense of the oxidisation of the material supplied by the food, with an efficiency twice as economical as in the case of the steam-engine. One-fifth of the potential energy is converted into work; four-fifths is converted into heat. But we must remember that the human body must be able to exist in the arctic regions as well as in the tropics, that the engine-room must always be kept warm; and to insure this average temperature in all parts of the earth and under all conditions, the four-fifths of what apparently is waste energy is necessary to maintain the race.

A day's work of muscular toil is laid down by the authorities at about 1,084,950 foot-pounds. The normal daily expenditure in heat cannot be so readily determined; it is estimated at 6,148,000 foot-pounds—that is, between one-fifth and one-sixth of the potential energy of the food is expended as mechanical labour; the remaining four-fifths or five-sixths leaves the body in the form of heat. Of course eventually the work goes into heat and is dissipated. In the human economy the oxygen of the air is taken up by the blood in the lungs. It is carried through

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the arteries and attacks the tissues, giving up its oxygen and so oxidising them, and thus producing heat; and when work is done, the equivalent of the heat disappears as work, and when the work is not done, the temperature rises, perspiration and evaporation takes places, and the temperature is kept at its normal condition through this safety-valve. In other words, expressed electrically, there is local action as in a battery. I am aware that the question of the cause of muscular contraction is in dispute, but it is generally admitted that the muscular force must be derived from chemical energy. Observe, in the first place, that nature prepares the food which it consumes to perform its functions. The food is taken into the stomach and digested. A great part of it is useless; the best part is selected and is transformed into a condition in which it can be easily oxidised at a low temperature, the blood acting as the carrier of the oxygen. Does this not give us a hint that we should follow this course likewise, and prepare the material for our carbon-consuming batteries? The oxygen of the air we always have with us, so have we many carriers of oxygen, but an attempt, so far as I know, has not yet been made along this line which I suggest, except that illuminating and other gases have been used.

A cell described by me in a paper read before the American Institute of Electrical Engineers in 1887 consists of two electrodes, one of carbon surrounded by powdered carbon, in a porous cup, and one of platinum, both being immersed in an electrolyte of sulphuric acid in a glass jar about 1in. in diameter and 6in. in height. Into this electrolyte when we introduce chlorate of potash we form peroxide of chlorine, which is a very unstable gas and decomposes in the presence of carbon; its oxygen attacking the carbon, oxidises it without heat, the chlorine being set free at the platinum pole, electricity is generated with an E.M.F. of 1·3 volts, varying with the amount of oxidising agent present and with the kind of carbon used. Or, we can place these two electrodes in a vessel containing water, generating this gas outside the cell and pass it over into the cell containing the electrodes, in which case the cell will operate the same as before; its internal resistance being regulated by the amount of sulphuric acid we may wish to add to the water. You will notice that when the electrodes are immersed in the sulphuric acid, that only a slight E.M.F. is indicated, due to the combination; on the addition of chlorate of potash, the E.M.F. is about 1·3 volts per cell and the current about ·4 of an ampere.

We have been taught to believe that the E.M.F. due to the oxidation of carbon is about 1·05 volts. This value has been arrived at by assuming Andrews's determination, that the oxidation of 1lb. of carbon to CO_2 equals 14,544 B.T.U.; or that one gramme equals 24,944 foot-pounds. This determination was only approximate, and, further, it was a determination made at a very high temperature. Now you have seen that the oxidation of carbon in this cell without heat has produced 1·3 volts, and would produce even more if we chose to concentrate the peroxide of chlorine present, which is rather a dangerous operation, as the gas is an explosive one under some conditions. So it would apparently appear that there are more foot-pounds of energy in a pound of carbon than shown by Andrews, unless the additional energy in this instance comes from the peroxide of chlorine. It might be thought that the high E.M.F. obtained in this cell is due to the action of the nascent chlorine on the platinum, but careful measurements have determined the contrary. We have here, therefore, a cell in which carbon is oxidised without the application of heat and at normal temperatures; a cell in which oxygen in unstable composition is readily given up to the carbon and the product of the oxidisation is carbonic acid gas, as proved by analysis. I think we have, therefore, the right to assume that a large percentage of the potential energy of the carbon is converted into electrical energy. The point I wish to make in this connection is: we have in this cell conditions which are analogous to those taking place in the human system, at least to the extent that carbon is and can be oxidised at the normal temperatures under which we live, and its potential energy converted into electricity.

We have in the blood of the human economy a carrier of oxygen, called hæmoglobin; it absorbs its oxygen through the lungs, each gramme taking up 1·34 c. cm. of oxygen; this oxygen is in such unstable condition that it can be extracted from the blood by means of a vacuum and by means of most reducing agents; yet it has the power to oxidise carbon and hydro-carbons as the body provides them without external heat. If you have in this test-tube water containing hæmoglobin in solution, you will see that by transmitted light it is of the colour of arterial blood, as it is fully oxidised, and when a reducing agent is added to it, and the air excluded, you will see that it becomes the colour of veinous blood, and when the air is again admitted it takes up the oxygen and becomes arterial in colour. This game can be played, of give and take and oxidising and deoxidising, as many times as we like. Even carbon reduces it and gives an E.M.F. What I want to express to you is this: in this battery carbon is completely oxidised at normal temperature by oxygen, which is held in loose combination. So it is done in the human body—and we know that to be a very efficient machine—therefore I see no reason to think that it is necessary for us to use high temperatures. Keep without the second law of thermo-dynamics, search for a suitable carrier of oxygen or some cheap source of oxygen supply and hydrogen or carbon, or a carbon compound easily oxidised. Does it not seem logical that by following along this line and by preparing the material to be consumed, as nature does in the human body, we may yet be able to reach the desired end with economy? Is it not probable, judging from human experience, that within the wide range of materials some cheap means can be found? I believe it is. Like all good things in nature, it will come through many trials and failures. The struggle for existence will perfect it, but there is no known law which indicates that we are dealing with the impossible.

THE TRANSMISSION OF POWER TO LONG DISTANCES BY ALTERNATING CURRENTS OF ELECTRICITY.*

BY W. B. ESSON, M.I.C.E., M.I.E.E., ETC.

This is not the first occasion on which your attention has been directed to the subject of the transmission of power by electricity. Mr. Gisbert Kapp in 1891 delivered an excellent course of Cantor lectures which dealt very fully with what had been done up to that date, but from then till now the progress in this particular department of applied electricity has been so great that the value of the 1891 lectures has become chiefly historical. It would be quite impossible for me, in view of the enormous strides made in recent times, to deal adequately in a single paper with electric transmission of power generally, so, as implied by the title, I propose to limit my remarks at present to transmission by alternating currents and to long distances. In so doing I cut out a vast field of application, but I can in consequence deal more fully with the branch I have chosen; and it will be remembered that transmission by direct currents in its most important application—viz., to street railways—was dealt with here by Mr. Parshall only a year ago.

Starting, then, where Mr. Kapp left off in 1891, you will perhaps remember that in the last of his Cantor lectures he apologised for taking up the time of the audience with the very interesting exposition he gave of the theory of polyphase motors. He described his observations as leaving "the safe ground of solid facts and engineering practice to enter into the domain of speculation," declaring, however, his conviction that some form of alternate-current working would form the ultimate solution of the problem how to transmit power—possibly over all distances, but certainly over very long distances. Well, that prediction has been marvellously fulfilled, for all long-distance transmission work is done by alternating currents, and nearly all by polyphase motors.

The alternating-current systems at present employed for transmission work are enumerated in the following classification of generators, conductors, and motors:

	Generators.	Line.	Motors.
1.	Single-phase.....	Two wires.. ...	Synchronous or non-synchronous.
2.	Two-phase	Four wires or three wires.	Synchronous or non-synchronous.
3.	Three-phase	Three wires or four wires.	Synchronous or non-synchronous.
4.	Monocyclic	Three wires ...	Non-synchronous.

* Paper read before the Society of Arts, March 24.

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It is impossible to discuss either of these three principal factors in power transmission without some reference to the others, but it will be nevertheless convenient to divide my remarks with the headings above given, and to keep to the order indicated.

I.—Generators.

It will be seen that the generators are single-phase, two-phase, and three-phase, corresponding to the three well-known systems of power transmission. The monocyclic system, for which the fourth generator on the list is required, is an ingenious combination of single-phase and three-phase systems. The single-phase machine, as its name implies, generates one alternating current only. The two-phase machine generates two distinct alternating currents, displaced relatively to each other by a quarter of a cycle. When one of the currents has its maximum value, the other has always a zero value. The three-phase machine produces three distinct alternating currents, displaced relatively to each other by one-third of a cycle.

Every alternating-current lighting station in the kingdom is equipped with single-phase generators—you are doubtless familiar with several types—and the high-pressure distribution is effected, of course, in a two-wire system. In two-phase working the respective circuits may be kept quite distinct throughout, or one termination of both circuits may have a common junction, there being then three terminals for the line. If the circuits are independent, four line wires are employed; if joined to three terminals only three wires are used, one rather larger than the other, it being the common return to both circuits.

In three-phase working, the algebraical sum of the currents in the three circuits, provided perfect balance is maintained throughout, is nought; accordingly in a return wire, common to the three circuits, no current would flow. On this account it is usual to dispense with a return conductor for the transmission, all three circuits having a common junction at each end of the line, and three wires only being used. As we shall see later, a fourth wire for the distributive part gives advantages which are well worth consideration.

In selecting generators for power work, several very important considerations have to be kept in mind. In the first place, it is essential that the machines be of first-class construction, from a mechanical point of view, as alternators employed for power transmission have, so far as my experience goes, to work under conditions much more trying than have machines for lighting. From advices to hand while I write (November 9), for example, I learn that the two-phase generators at the Sheba mines ran all through September, night and day, from the first to the thirtieth, without once stopping. Such runs try machines severely, but not only may transmission alternators have to work continuously, but they are generally fully loaded, which further tests their staying qualities, making it imperative that nothing but designs of the soundest engineering character should, for this kind of work, be thought of.

It is essential that the armature coils be not subjected to stresses which tend to alter their shape, or to destroy, in time the insulating materials. Such substances as mica, micanite, stabilit, presspahn, etc., are quite unfitted to transmit force; accordingly, all alternators for power work have their armature coils embedded in a laminated iron core. In some cases the wire forming the coils is wound through holes in the core plates, while in others the coils, independently formed, are placed in slots punched perpendicularly to the surface of the core, but there are no conductors in the gap between the field magnet and the armature core. In the case of the coils in slots, these are machine wound on a former or mandrel, and thoroughly bound together with several wrappings of rubber-impregnated tape or other suitable insulating material before being put in place. Generally, in American machines the armature is the rotating part, while in European machines it is the fixed part. In the rotating armatures the machine-wound coils are firmly wedged into radial slots on the surface of the core. Other things being equal, a stationary armature is to be preferred, because the armature is the high-pressure part of the generator, and when stationary it can easily be protected, so that accidental contact with the circuit is absolutely impossible.

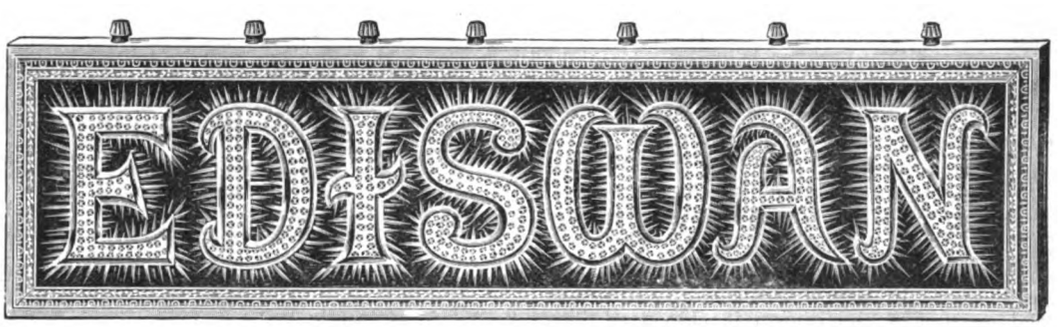
That the efficiency of the generator or ratio of electrical output to mechanical input of power should be as high as possible goes without saying, but it is, perhaps, of still more importance that the armature reaction should be very small. Armature reaction is manifested by the drop of pressure from no load to full load, and in large alternators for lighting work a drop of from 10 to 15 per cent. is not unusual under conditions of constant excitation and speed, nor does this cause any inconvenience. But for running non-synchronous motor circuits, such a generator would be quite unsuitable. These motors act like so many choking coils, the result being that the same generator, which has on an inductionless lamp load a drop of no more than from 4 to 5 per cent., will have, when working on a motor load, a drop from four to five times greater. It is very important, therefore, that any alternator intended to be used for power transmission shall have a small drop tested on an inductionless load, seeing that on the power circuits this drop is greatly magnified. High efficiency does not necessarily mean small armature reaction, but since the satisfactory working of the plant greatly depends on securing the latter and avoiding difficulties of regulation which would otherwise occur, it will be obvious that a certain amount of power may be sometimes wisely sacrificed to attain this desirable end.

Another important point, of course, is the size of the generator. In the preceding paragraph I have spoken of polyphase motors acting as choking coils, and an inductive load, as you are no doubt aware, not only causes a large drop of pressure at the generators, but also makes the current lag behind the impressed E.M.F. As their phases are not coincident, the product of virtual amperes and virtual volts does not give the power in watts going into the circuit; to get this latter the product has to be multiplied by a coefficient depending on the difference of phase. This coefficient is called the power factor, and is the fraction which expresses the cosine of the angle of lag; it is the ratio of the real to the apparent watts given to the circuit. As we shall presently see, the power factor has a different value for different sized motors, and lies somewhere between ·65 and ·85. If two-thirds of the power given by the generator were taken up by non-synchronous motors, the power factor would probably be about ·8 for the whole circuit; but if the power were nearly all taken up by motors large and small mixed, it would be less than this; certainly it would not be safe to take it as exceeding ·75 at the outside. Now what does this signify? It means that the generator working at full load must be one-third larger than it would require to be if the phases of current and E.M.F. were coincident. Because the power factor is ·75, the machine has to supply one-third more current to the circuit; in other words, if we wish to give 100 e.h.p. to the line we must provide a generator capable of giving 100 kilowatts on an inductive load. It also means that our lines must be one-third heavier because of the extra current to be transmitted, and our transformers, if we have any, must follow suit and be installed of a capacity equal to one kilowatt for every horse-power. It will be seen that an increased power factor would result in a reduced outlay for the plant all round, but of this more anon. At present I need only say that it is most desirable to provide everywhere ample margin, and plant should be provided at the rate of not less than a kilowatt per horse-power transmitted as stated above. Though some motors may have a higher power factor than ·75, many have less, and it is well always to be on the safe side.

(To be continued.)

JUBILEE ELECTRIC DECORATIONS.

The illustration herewith is of a device prepared by the Edison and Swan United Electric Light Company, Limited, for the forthcoming celebrations. The firm naturally does not expect the general public to advertise them by putting the actual sign illustrated over their premises, but any letters can be selected. The letters are about 18in. deep, and are made up with about 60 crystals to each letter, the front being covered with plate glass. The crystals are of white glass. In the case



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at the rear of the letters are placed vertical cylinders of various coloured glass about 20in. in length and 3½in. in diameter. These contain and are lighted by two 16-c.p. lamps. The cylinders are built of segments of glass of about 14 different colours, and are rotated by means of an electric motor. Thus as they revolve the colour of the letters is always changing, and several colours are often visible in the breadth of one letter. The arrangement can be used on either direct or alternate current circuits, the motor being the only variable.

Another neat device for the occasion consists of a star about 4ft. in height. The centre consists of an oval of glass, on which is transferred a coloured portrait of the Queen. The eight points of the star are hollow, framed in perforated zinc, and lined with coloured celluloid. The lamps are placed in the interior, and a few small incandescents will also be placed in the recesses formed by the points of the star. Anyone using these signs for the few nights in June will, we think, do well to considerably overrun their incandescent lamps to obtain a brilliant life, if a short one.

THE BROMPTON AND PICCADILLY CIRCUS RAILWAY.

The Bill promoted by the Brompton and Piccadilly-circus Railway Company has been before a Select Committee of the House of Commons this week, Mr. Woodall presiding.

Mr. Littler, Q.C., Mr. Pembroke Stephens, Q.C., and Mr. Lewis Coward appeared for the promoters of the Bill; Lord Robert Cecil for the Vestry of St. James's; Mr. C. Munro for the Vestry of Kensington; Mr. Cecil Chapman for the Vestry of Chelsea; Mr. E. R. Moon for the Hon. Mrs. Cholmondeley; Mr. G. J. Talbot for Mr. Dickson and Viscount Valentia; the Hon. Sydney Holland for the London County Council; Mr. R. O. B. Lane for the Rev. T. G. Osborne and Mr. R. Bingham; while the City and West-end Railway (the competing line) was represented by Mr. Worsley-Taylor, Q.C., Mr. Freeman, Q.C., Mr. C. Baggallay, and Mr. Casson.

Mr. Littler, Q.C., for the promoters, said that their scheme was to carry a line from South Kensington to Piccadilly-circus, with stations at Brompton-road, Knightsbridge, Hyde Park-corner, Down-street, Arlington-street, and Air-street. The line would have a total length of 3,476 yards, and it would be worked by electricity in the same way as was done on the South London Railway. They would have trains of three carriages, with power to take four if necessary, running every three minutes. They would perform the journey in 10 minutes, and the fare would be 2d. The railway would be a low-level line, about 50ft. or 60ft. below the roadway; and they proposed by a subway to make a connection with the Metropolitan and District lines, and so place themselves in communication with all parts of London. The capital proposed was £800,000, £600,000 in ordinary shares and £200,000 in debentures, and they expected to be able to construct the line for £750,000. They hoped eventually to get communication with Euston and King's Cross, either by a junction with the Hampstead, Euston, and Charing Cross Railway, if that scheme should be carried out, or by a short line of their own, and by a junction with the Waterloo and Charing Cross line to get connection with the south side of the river.

Among the witnesses examined during the week have been the ollowing:

Prof. Alex. B. W. Kennedy, electrical engineer to the railway, said the site of the generating station at Chelsea Creek, some distance from the terminus of the line, was very advantageous, not only because of the facilities for obtaining water for condensation, but because coal could be obtained there at about 2s. 6d. a ton cheaper than in town. Being some hundreds of yards from the river it was not likely to interfere with embankment improvements or extensions. The communication from the generating station to the railway would be by two concentric cables, each containing a go and return conductor, the whole being covered outside with an armour of steel to protect it from mechanical injury. Each of the wires inside the cables would be insulated according to the best modern knowledge. The cable would be laid at a depth of a foot or 18in., and covered over by a tarred board so as to give warning of its presence to workmen who might be opening up the road. The working of the railway would require a maximum of about 1,200 h.p. When dealing with a long cable such as the present between the generating station and the line it was better to lay it as proposed than to encase it in pipes. The current required, generated at a pressure of from 1,100 to 1,200 volts, would be transmitted direct to the terminus at Brompton, where it would be divided so that there would be a pressure of from 500 to 600 volts for each tunnel. In dividing the current it was necessary that there should be an intermediate wire, which would be either the rails or a separate conductor. There would be balancing transformers at two places on the line so as to overcome the difficulty of the varying quantity of traffic. At present it was proposed to run trains of three coaches, possibly four, each coach containing about 50 persons, and though it had not been finally settled, there would probably be only one class. The gradients on the line being very easy there would, for driving purposes, only be a motor cab on the front and rear carriages. His estimates were based on the assumption that the whole distance would be run in 10 minutes, which meant a three minutes' service each way. The total electrical equipment of the line, including rolling-stock, buildings, etc., he estimated at £113,000. The witness was cross-examined at some length with regard to the possibility of accidents resulting from laying the mains conveying such high-pressure currents in the streets, but he steadily maintained that there was practically no danger.

Sir Frederick Bramwell gave general support to the evidence already given. The use of the shield had rendered tunnelling through London clay absolutely safe, as no portion of the earth was ever left unsupported. There were a considerable number of persons passing along the Brompton-road who at present used omnibuses and vehicles and who would use this line if constructed. Those persons were entitled to consideration and would largely use the projected line. The proposed station at Air-street was most suitable, being in a street leading one way into the Quadrant and the other into Piccadilly; and its effect would be to relieve the enormous traffic in the neighbourhood of Piccadilly. He could not conceive that the working of the line would cause damage, having regard to the fact that the line was 50ft. or 60ft. deep in the London clay, and that no locomotives were used. As to the line coming to the surface at Yeoman's-row, it appeared to him that that site must have been originally built for the purpose. The site of the generating station at Chelsea Creek he considered very desirable, affording facilities in regard to coal and water; and if the dynamo engines made a little noise nobody in that neighbourhood would object.

Mr. C. H. Newman and **Mr. W. H. Marner,** surveyors and valuers, gave estimates of the cost of acquiring buildings required by the railway—Mr. Newman's figure being £130,000 and Mr. Marner's £127,000.

Mr. Charles G. Mott, chairman of the proposed railway, also chairman of the City and South London Electric Railway, said the damage caused by the construction or working of the latter company was very trifling, and in the present case there was practically no likelihood of damage to surrounding or adjacent property. He gave figures showing the progress which the South London had made and as to the dividend they paid despite the fact that their traffic was very slight in the middle of the day. In the Piccadilly line there would be a steady regular traffic throughout the day, which should insure a good return to the shareholders. He had prepared a statement showing the probable earnings in the first year, and on the basis of 10,000 passengers each way daily at an average fare of 2d., there would be a profit of about £22,000, or sufficient to return 4 per cent. on the capital. Among railway men it had been felt that Piccadilly had always rather been left in the cold; and some of the larger companies had endeavoured to get into communication with it by means of omnibuses. There was no doubt the Circus was entitled to much better communication than it had at present, and the proposed line would give it, at all events for the neighbourhood of South Kensington. One petition in favour of the Bill had 285 signatures of South Kensington householders, the first being that of the directors of South Kensington Museum. He had no doubt the capital to carry out the project could be secured on advantageous terms; and if the Bill were passed it would be easy to make a connection with the Baker-street and Waterloo Railway, thus giving residents of Kensington great convenience in going to Waterloo, with which station they had no direct connection at present.

The committee adjourned.

BRIGHTON ELECTRIC LIGHTING ACCOUNTS.

The Brighton electric lighting accounts for the year ending December 31, 1896, have just been published. We give herewith the revenue account, general balance-sheet, and statement of electricity generated, sold, etc.

REVENUE ACCOUNT.

Dr. Generation of Electricity.	£ s. d.	£ s. d.
Coal or other fuel, including dues, carriage, unloading, storing, and all expenses of placing the same on the works	£3,983 17 4	
Oil, waste, water, and engine-room stores	604 7 2	
Wages at generating station	1,996 17 1	
Repairs and maintenance as follows: buildings, £78. 7s. 5d; engines, boilers, dynamos, accumulators, and all other machinery and plant, £446. 18s. 6d.	525 5 11	
		7,110 7 6
Distribution of Electricity.		
Wages and other remuneration to linesmen, fitters, labourers	435 16 3	
Repairs, maintenance, and renewals of mains of all classes, including materials and laying the same	290 1 8	
	725 17 11	
Repairs, maintenance, and renewals of transformers, meters, switches, fuses, and other apparatus on consumers' premises	493 5 7	
Outlay for works executed on account of customers	544 17 5	
		1,764 0 11

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Public Lamps.			
Street-lighting installations	956 6 11		
Attending public lamps and repairs, including materials supplied	1,241 1 5		
		2 197 8 4	
Rates and taxes		1,222 1 4	
Management Expenses.			
Salaries	1,610 1 3		
Stationery and printing	154 1 1		
Registrar of stock and stamp duty	114 14 4		
General establishment charges	153 10 8		
		2,032 7 4	
Special Charges			
Insurance	167 9 9		
Law expenses	61 12 1		
		229 1 10	
Total expenditure		14,555 7 3	
Amount carried to net revenue account		14,680 19 5	
Balance to be carried to next account to provide for bad debts		53 2 10	
		£29,289 9 6	

Cr.	£ s. d.
Balance from last account, £86. 17s. 1d. ; less bad debts written off, £67. 0s. 5d.	19 16 8
Sale of current per meter: 478,126 units at 7d., £13,945. 6s. 10d. ; 648,875 units at 3d., £8,110. 18s. 9d	22,056 5 7
Public lighting—29,176 units at 7d., £850. 19s. 4d.; 232 644 units at 3d., £2,908. 1s. ; attending, etc., £1,241. 1s. 5d. ; installation works, £956. 6s. 11d.	5,956 8 8
Rental of meters and other apparatus on consumers' premises, £607. 9s. 11d. ; work executed on account of customers, £628. 9s. 10d. ; rents receivable, £20. 16s. 8d. ; fees for accounts sold, 2s. 2d.	1,256 18 7
	£29,289 9 6

General Balance-Sheet.

Liabilities.	£ s. d.
Capital—amount received	166,065 0 0
Less premiums, etc , on stock issued	12,450 12 9
Total debt created	153,614 7 3
Less amount appropriated for extinction of stock and accumulations of interest thereon	12,907 8 0
	140,706 19 3
Premiums on stock issued, £13,118. 3s. 1d. ; less costs and expenses of issuing stock, £667. 10s. 4d.	12,450 12 9
Sundry creditors	7,167 15 10
Customers' deposits	576 10 0
Interest accrued due	609 6 4
Proportion of appropriation in respect of sinking funds accrued due	3,093 18 4
Revenue account—balance at credit thereof	53 2 10
Net revenue account—balance at credit thereof	5,000 0 0
Treasurer—balance overdrawn	7,024 10 3
Reserve fund	3,127 16 6
Excess of assets—viz., contributions to loans fund for extinction of stock and earnings of fund to Dec. 31, 1896, £13,537. 0s. 6d. ; less premiums and costs of stock purchased for extinction, £629. 12s. 6d.	12,907 8 0
	£192,718 0 1

Assets.	£ s. d.
Capital account—amount expended for works	178,681 11 10
Stores on hand at Dec. 31, 1896—coal, £206. 13s. 11d. ; oil, waste, etc., £287. 3s. 2d.	493 17 1
Sundry debtors for current supplied to Dec. 31, 1896	10,517 14 6
Other debtors	4 16 8
Cash in manager's hands	20 0 0
Investment in Brighton Corporation stock (at cost)	3,000 0 0
	£192,718 0 1

Statement of Electricity Generated, Sold, etc.

Quantity generated in B.T. units		1,653,576
Quantity sold	Public lamps (units) 261,820	1,388,821
	Private consumers by meter 1,127,001	
Quantity used on works		32,891
Total quantity accounted for		1,421,712
Quantity not accounted for		231,864

Number of public lamps, 215 arc lamps, 564 incandescent lamps.

ABERDEEN ELECTRIC LIGHTING ACCOUNTS.

The electric lighting accounts of the city of Aberdeen for the past year have been published by the Corporation. We give herewith the revenue account, balance-sheet, and statement of electricity generated, sold, etc.

Dr. Revenue and Expenditure Account.	£ s. d.
Fuel	219 0 6
Oil, waste, water, and engine-room stores	76 2 7
Wages at generating station	514 13 11
Repairs on buildings	18 16 6
Repairs on plant	535 6 10
Main and service repairs	111 16 2
Rents and feu-duty	38 16 6
Taxes	312 14 8
Management	88 15 9
Salaries	205 0 0
General establishment charges	52 8 4
Stationery and printing	104 10 0
Insurance	13 1 0
Inspector's wages	4 11 11
Bad debts	19 5 10
Expenses in connection with hire of engine and dynamo	13 10 0
Purchase price of motors sold	31 0 6
Balance carried to net revenue account	2,219 10 9
	£4,579 1 9

Cr.	£ s. d.
Sale of current, per meter	4,126 6 10
Public lighting	209 8 5
Rental of meters	118 10 8
Hire of engine and dynamo at Ballater	92 5 10
Sale of motors	32 10 0
	£4,579 1 9

General Balance-Sheet.

Liabilities.	£ s. d.
Capital account—Amount borrowed on mortgage	23,650 0 0
Amount of temporary loans	9,500 0 0
Sinking fund and interest thereon	1,405 7 6
Reserve fund	253 3 0
Amount due to sundry creditors	949 17 6
Amount deposited in security for current	31 0 0
Balance due to bank	1,892 10 10
	£37,681 18 10

Assets.	£ s. d.
Capital account—works, £36,620. 15s. 9d.; less depreciation written off, £1,840. 10s. 4d.	34,780 5 5
Sundry debtors for current supplied to Dec. 31, 1896, outstanding, £2,096. 16s., and for service lines, etc., £137. 17s. 11d.	2,234 13 11
Stores on hand at Dec. 31, 1896: coal, £6; oils, waste, etc., £18. 19s. 11d.; engine spares, cable, etc., £641. 19s. 7d.	666 19 6
	£37,681 18 10

Statement of Electricity Generated, Sold, etc.

Quantity generated in B.T. units		236,649
Quantity sold	Public lamps 11,057	210,185
	Private consumers by meter 199,128	
Quantity used in works		3,869
Total quantity accounted for		214,054
Quantity not accounted for		22,595
Percentage		9·50
Number of public lamps		14
Price of electricity per B.T. unit		5d.

COMPANIES' MEETINGS AND REPORTS.

WEST COAST OF AMERICA TELEGRAPH COMPANY, LIMITED.

An extraordinary general meeting of this Company was held last Friday at Winchester House, E C., for the purpose of considering a scheme of reconstruction. Mr. J. D. Pender presided.

The **Chairman** said that on December 20 last he explained the unfortunate position of the Company, and also that the directors were not prepared to carry on until the last penny was gone. At the same time he told them that a scheme of reconstruction was afoot which they would be called upon to consider. They had now been furnished with particulars of that scheme, and he believed that it would be to the interest both of the ordinary shareholders and debenture-holders to accept it. The scheme was simply the outcome of a proposal from the Brazilian Submarine Telegraph Company involving a reconstruction of this Company on the following basis: the debenture-holders to receive in exchange for their present holdings an equal amount of debentures of the reconstructed company, bearing 4 per cent. interest as from January 1 last, both principal and interest being guaranteed by the Brazilian Company; the shareholders to receive one fully-paid £2. 10s. share in the new company for every £10 share held in the old. In order to relieve the Company of its present indebtedness outside the debentures and to provide for the more immediate requirements of the new company, an issue of 4 per cent. income bonds for £20,000 was to be taken by the Brazilian Company and others, the Brazilian Company to receive 15,000 fully-paid shares of the nominal amount of £2. 10s. each as consideration. He mentioned that the directors had received proxies in favour of the scheme to the extent of 15,000 shares, equal to half the capital of the Company. The resolution was adopted.

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DIRECT SPANISH TELEGRAPH COMPANY, LIMITED.

The report of the directors of the Direct Spanish Telegraph Company, Limited, for the year ended December 31 last, to be presented at the yearly general meeting to be held on Tuesday next at Winchester House, states that the accounts show, after providing for interest on and redemption of debentures, a balance to the credit of revenue of £10,818. After adding the usual sum of £5,000 to the reserve fund, the balance will amount to £5,518, and the directors recommend the declaration of dividends for the year 1896 of 10 per cent. on the preference shares, and 4 per cent., free of income tax, on the ordinary shares, absorbing £5,486; half of this amount was distributed on October 1 last as an interim dividend in respect of the half year ended June 30. A balance of £332 will remain to be carried forward. The traffic receipts show an increase of £4,564 as compared with the year 1895. This increase, due to exceptional circumstances, has enabled the directors to repay to the reserve fund the balance of amounts taken from it in former years for revenue purposes. The reserve fund will then, including the £5,000 mentioned, amount to £39,674. The ordinary working expenses are £660 in excess of those for the year 1895. The Company's cables and the land lines in connection with them have continued in good working order throughout the year. The Marquis of Tweeddale has joined the Board to fill the vacancy caused by the death of Sir John Pender. The Company was represented at the International Telegraph Conference held at Budapest in June and July, 1896, at which some reductions of the Company's rates were agreed to. The revision of the regulations and tariffs adopted at Budapest will come into force on April 1 next.

METROPOLITAN ELECTRIC SUPPLY COMPANY, LIMITED.

Directors: Sir Eyre M. Shaw, K.C.B. (chairman); Admiral of the Fleet Lord John Hay, G.C.B.; W. Harrison Cripps, Esq.; John Birkbeck Lubbock, Esq.; James Pender, Esq., M.P.; John B. Verity, Esq.; Frank Bailey, Esq. (engineering director). Secretary: E. Cunliffe Owen, Esq., C.M.G. Acting engineer: A. H. Walton, Esq., A.M.I.C.E.

Report of the directors (with abstract of accounts) to be presented to the shareholders at the tenth ordinary general meeting to be held at the Portman Rooms, Baker-street, W., on Monday, the 29th inst., at 12 noon:

The directors submit a statement of the Company's accounts for the year ending December 31, 1896, prepared in the form prescribed by the Board of Trade under the provisions of the Electric Lighting Acts, 1882 and 1888. It will be remembered that, by a resolution passed at an extraordinary general meeting, held on June 28, 1896, the capital of the Company was increased to £1,000,000 by the creation of 50,000 new shares of £10 each; 12,500 of these shares were issued on July 4, 1896. The capital expenditure, which at the end of 1895 amounted to £675,484. 3s., now shows a total of £757,035. 13s. 11d., having increased during the year by the sum of £81,551. 10s. 11d. It will be seen that the principal items on this account consist of new machinery, mains, and apparatus rendered necessary through the growth of the Company's business. Attention is directed to the item of £4,168. 18s. 3d., which mainly consists of compensations and expenses resulting from the litigation which took place in connection with the works at South-street, Manchester-square. The reinstatement of the buildings and machinery at the Sardinia-street works, rendered necessary after the fire which occurred in 1895, has been completed, but as a portion of the original plant is still undisposed of it has not yet been found possible to close this account, which therefore remains in suspense. In close connection with this subject it will be noted that a serious increase appears in the revenue account under the heading of insurances, due to the high rate of premiums demanded by the insurance companies. The Board have, however, been able to obtain more satisfactory rates for the present year. The gross revenue for the year amounted to £116,459. 4s., against £106,447. 8s. 9d. in 1895, being an increase of £10,011. 15s. 3d. The fact that this increase is less than usual is wholly due to the reduced rates of charge which the Board, after careful consideration, introduced early in the year. The cost of generation, which in 1895 was £52,536. 14s. 11d., amounted in 1896 to £52,619. 4s. 9d., or an increase of only £82. 9s. 10d. The Board regard these figures as satisfactory. The balance to the credit of the revenue account, before providing for depreciation, is £46,191. 16s. 1d. The directors have set aside £12,000 as an addition to the depreciation account carrying to the credit of the net revenue account (No. 5) the sum of £34,191. 16s. 1d., which, with the balance brought forward from last account and other receipts, makes a total of £37,314. 4s. 5d. After deducting debenture interest and other charges, and providing for the interest on the new issue of shares, there appears a balance of £17,080. 12s. 2d., of which the directors have appropriated a further sum of £1,052. 10s. 4d. to finally writing off the preliminary expenses account. An interim dividend of 4s. per share on the ordinary share capital was paid on October 15, 1896, amounting to £9,980, and the directors recommend that a further dividend of 6s. per share be now paid, making a total of 10s. per share for the year, or 5 per cent. on the capital. This will absorb a further sum of £14,970, and leave a balance of £1,058. 1s. 10d. to be carried forward to the next account. The number of 8-c.p. lamps supplied by the Company increased during the year 1896 from 260,000 to 308,000. The present number of lamps connected is 316,000, and the applications show no signs of decrease. A report from the Company's engineering director is appended, showing that the satisfactory condition of the stations, machinery, and plant has been maintained. The directors have to record with the deepest regret the death of two of their valued colleagues, Sir John Pender and Admiral Sir G. H. Richards, both of whom had been members of the Board from the commencement of the Company. In consequence of the pressure of other engagements, Mr. J. Denison Pender and Mr. J. C. Parkinson have found it necessary to retire from the Board. On account of vacancies thus created the directors have elected Mr. James Pender, M.P., Mr. W. Harrison Cripps, one of the largest shareholders, and Mr. John Birkbeck Lubbock, of Messrs. Robarts, Lubbock and Co., to seats on the Board, and have appointed Sir Eyre M. Shaw to the office of chairman. They have also appointed Mr. Frank Bailey, their late chief engineer, to a seat on the Board as engineering director. In accordance with the articles of association, the following directors—viz., James Pender, Esq., M.P., Sir Eyre M. Shaw, K.C.B., and John B. Verity, Esq.—retire from the Board, and are eligible for re-election. The auditors, Messrs. Deloitte, Dever, Griffiths, and Co., also retire, and are eligible for re-election.

Report of Engineering Director.—I have pleasure in certifying that the Company's stations, machinery, and plant are being maintained in an efficient condition, and have worked satisfactorily up to the present date.—FRANK BAILEY, Engineering Director.

REVENUE ACCOUNT, YEAR ENDED DEC. 31, 1896.

Dr.				£	s.	d.
Generation of Electricity.						
Coal or other fuel, including dues, carriage, unloading, storing, and all expenses of placing the same on the works	£29,811	3	2			
Oil, waste, water, and engine-room stores	3,587	12	10			
Salaries of engineers, superintendents, and officers	2,684	1	8			
Wages and allowances at generating stations	6,288	4	9			
Repairs and maintenance as follows: buildings, £836. 7s. 8d.; engines and boilers, £5,436. 19s. 11d.; dynamos and exciters, transformers, motors, etc., £1,499. 13s. 10d.; other machinery, instruments, and tools, £707. 13s. 2d.	8,480	14	7			
Purchase of current	1,767	7	9			
				52,619	4	9
Distribution of Electricity.						
Repairs, maintenance, and renewals of mains of all classes, including materials and laying the same	49	11	4			
Repairs, maintenance, and renewals of transformers, meters, and other apparatus on consumers' premises	770	6	8			
Royalties	25	0	0			
				844	18	0
Rents payable and rates and taxes				4,502	7	9
Management Expenses.						
Directors' and trustees' remuneration	2,275	0	0			
Salaries of management, secretary, engineers, accountants, clerks, etc.	4,246	13	0			
Wages of meter readers and wiring inspectors	461	5	6			
Stationery and printing	618	13	2			
General establishment charges	2,072	11	6			
Auditors—Board of Trade, £87; Company's auditors, £157. 10s.	244	10	0			
				9,918	13	2
Law and Parliamentary Charges.						
Law expenses	99	17	9			
Parliamentary charges	784	13	2			
				884	10	11
Insurances				1,497	13	4
Depreciation in buildings, plant, machinery, etc.				12,000	0	0
Total expenditure				82,267	7	11
Balance carried to net revenue account				34,191	16	1
				£116,459	4	0

Cr.	£	s.	d.
Sale of current, £108,623. 0s. 8d.; less provision for bad and doubtful debts, £800	107,823	0	8
Rental of meters and other apparatus on consumers' premises	8,421	9	10
	116,244	10	6
Rents receivable	94	0	0
Net proceeds of work done for and goods supplied	70	6	1
Surplus properties—rents and profits, after deducting cost of repairs, rents, rates, taxes, and expenses of management	50	7	5
	£116,459	4	0

Dr. GENERAL BALANCE-SHEET.	£	s.	d.
Capital account—amount received	805,669	6	9
Sundry tradesmen and others, due on construction of plant and machinery, fuel, stores, etc.	29,992	14	5
Sundry creditors on open accounts	1,491	14	4
Depreciation account	31,270	16	5
Net revenue account—balance at credit thereof	16,028	1	10
	£883,452	13	9

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Cr.	£	s	d.
Capital account—amount expended for works	757,035	13	11
Stores on hand—coal, £530. 10s. ; oils, waste, etc., £218. 16s. 8d. ; general, £5,478 1s. 4d.	6,227	8	0
Sundry debtors for amounts paid on account of contracts in course of completion	2,062	0	9
Preliminary expenses, £1,052. 10s. 4d.; less charged to net revenue account, £1,052. 10s. 4d.	0	0	0
Sundry debtors for current supplied	48,105	19	6
Other debtors	1,200	16	5
Suspense accounts waiting adjustment, including Sardinia-street fire account	3,137	18	7
Deposits (provisional orders, vestries, etc.)	1,015	0	0
Investments at cost	27,043	18	6
Cash at bankers on deposit and current accounts...	37,623	18	1
	£883,452	13	9

DOVER ELECTRIC LIGHTING COMPANY.

The report of the directors for the year ending 1896 says: "The directors beg to submit their report, with balance-sheet and accounts for the year ended December 31, 1896. As shown thereby, the capital expended during the year has been £2,644. 18s. 6d., making the total to December 31 last £50,904. The directors expect that for the lighting plant no large addition need be made for some time to come. During the past year the working of the machinery at the station has been satisfactory, improvements in details desirable for greater perfection and economy having been introduced with good results. The directors are gratified to state that the service of current to consumers has been satisfactorily maintained throughout the year. The directors have to report that there has been a small loss on this, the second year of the Company's working, although for a considerable period the revenue has been in excess of the expenditure. In order to reduce the interest charges appearing in the balance-sheet, the directors, at the end of last year, arranged for the placing of the debenture stock to the amount of £25,000, bearing interest at 4½ per cent. A considerable portion of this has already been taken up at a substantial premium, which it is proposed to apply to the reduction of the preliminary expenses and suspense accounts. This operation will result in a considerable saving in interest during the current year. . . . Several churches are now using or installing the light, and most of the leading hotels, including the Lord Warden, the Grand, the Metropole, and the Shakespeare, have been connected during the past year. The Burlington Hotel and the new Tivoli Theatre also propose to take a supply from our mains. The directors are glad to report that further public lighting has been entrusted to this Company, nine additional lamps being on order in replacement of existing incandescent gas lights. An important step has been taken by the directors in contracting with the Dover Corporation to supply the power necessary for the tramway service to be commenced in the summer. The contract provides a minimum supply of 160,000 Board of Trade units, and it is hoped that, with the economy effected by more fully utilising the present building and the superintending working staff, it will yield a reasonable profit."

SHEFFIELD ELECTRIC LIGHT AND POWER COMPANY, LIMITED.

Directors: George Franklin, Broomfield, Sheffield (chairman); Joseph Gamble, Southbourne, Sheffield; William Samuel Laycock, Oakbrook, Sheffield; George Senior, Elmfield, Sheffield; William Tasker, 1, Parker's-road, Sheffield. Manager and secretary: William Johnson, M.I.E E.

Report of the directors to be submitted to the sixth ordinary general meeting of shareholders to be held on Wednesday, March 31, 1897, at the Cutlers' Hall, Sheffield, at 12 noon:

The accounts, made up to December 31 last, show the balance of profit as follows:

	£	s.	d.
Balance from last account.....	87	18	11½
Net profit for the year	7,635	4	8
	7,723	3	7½
From which must be deducted:			
Interest on debentures £1,125 0 0			
Balance of formation expenses written off 445 9 0			
Transfer to depreciation fund 1,000 0 0			
	2,570	9	0
Leaving a balance of	5,152	14	7½
The directors recommend the payment of a dividend after the rate of 7½ per cent. per annum, free of income tax, which will absorb.....	4,053	1	8
Leaving a balance of	£1,099	12	11½

Out of this the directors have set aside a reserve fund of £1,000, leaving a balance of £99. 12s. 11½d. to be carried forward. The issue of shares referred to in the last annual report was wholly taken up, and realised a premium of £1,739. 10s., which it is proposed to transfer to the credit of the depreciation fund, making a total of £4,739. 10s. now standing to the credit of that fund. The whole of machinery and plant of the Company is in excellent order and condition. Of the 14,000 shares into which the Company's authorised capital is divided there only now remains unissued 1,896 shares, and these the directors propose at once to offer to the shareholders in proportion to their present holdings; but in view of the present market price of the Company's shares it is proposed to offer them at £2 per share premium. The growth in the demand for electric light is indicated by the following statement of the Company's revenue from the sale of current during the four complete years of its operation: 1893, £3 555. 11s.; 1894 £4,849. 9s. 4d.; 1895, £6,935. 4s. 1d.; 1896, £11,257. 15s. 4d. Whilst the Company's business is thus steadily increasing, great economies have been effected in the costs of production and in the working costs. In consequence of the satisfactory results of last year's working the directors, on January 1 last, reduced the price of current from 6d. to 5d. per Board of Trade unit, and they hope that the increased demand following upon this reduction will justify their policy of sharing with consumers the results of the prosperity and growth of the Company's business. During the past year a sum of £18,394. 12s. 1d. has been expended upon machinery, mains, and other appliances. In order that the Company's business may be more satisfactorily dealt with a building site at the corner of Commercial-street has been purchased, and upon which offices, showrooms, and other necessary accommodation are now being constructed. The proposed issue of shares will exhaust the Company's nominal capital, and as the rapidly increasing demand for the supply of electricity will require further capital expenditure, it is proposed to ask the shareholders to pass the necessary resolution for increasing the capital from £98,000 to £280,000. The directors retiring by rotation under the Company's articles are Mr. George Senior and Mr. Wm. Tasker, who, being eligible, offer themselves for re-election. The Company's auditors, Messrs T. G. Shuttleworth and Son, also retire at this meeting, and are also eligible for re-election.

LEGAL INTELLIGENCE.

CLAIM BY AN ELECTRICAL ENGINEER.

In the Westminster County Court on Wednesday his Honour Judge Lumley Smith, Q.C., had before him the case of Rogers *v.* Chamberlyn by way of a default summons, in which the plaintiff, an electrical engineer, carrying on business at Wych-street, Strand, sued the defendant to recover the sum of £6 for work and labour done.

When the case was called on the defendant failed to answer to his name, and judgment was entered for the plaintiff for payment of the amount due in a week.

CLAIM FOR ELECTRIC FITTINGS.

The case of Gooch *v.* Rhodes was before his Honour Judge Lumley Smith, Q.C., in the Westminster County Court on Wednesday.

It was an action by the plaintiff, a dealer in electrical goods, to recover payment of a balance of £6. 15s. for fittings supplied to the order of the defendant, who lives at Victoria-street, Westminster.

The defence was that the goods were sent on approval, but after hearing the evidence his **Honour** gave judgment for the plaintiff for the amount claimed with costs.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Amsterdam.—The Netherlands Railway will receive tenders in Amsterdam on March 29 for 1,182 telegraph posts.

Charleroi (Belgium).—Tenders will be wanted on March 30 at the Charleroi station for the construction of a telephone building.

Brussels.—Tenders will be received on April 7 at the Brussels Bourse for two lots of telegraphic instruments (specification No. 51), for the Belgian Government. Particulars at the Brussels Bourse.

Warrington.—Tenders are required for laying private telephone wire from Mersey-street to Longford Works (length, 1½ miles). Full particulars may be had on application to Mr. W. S. Haddock, engineer.

Brighton.—The Corporation invite tenders for the supply and delivery of armoured lead-covered electric cables and jointing sundries at the Corporation electricity works. Full particulars are given in our advertisement columns.

Paris.—The French Posts and Telegraphs Department want tenders for the supply of packing cases for the telegraphic service for the next four years. Tenders are to be in on April 13, but preliminary application must be made at Paris, rue de Grenelle 103, before April 4.

Hamburg.—Tenders will be received on April 5 for installing the electric light in the Collection of Hamburg Antiquities in the Johanneum. Particulars for 1·50 marks (1s. 6d.) from the Secretary's Office, Finanz Deputation, at the Rathhaus, Hamburg. A local security will be required.

Glasgow.—Tenders are invited for supplying and fixing in the Olympia, New City-road, during the month of April, a 25-h.p gas-engine, together with 20 arc lamps, each of 2,000 c.p., and a

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quantity of small incandescent lights, together with all the necessary wire cable, switches, etc. Address tenders to E. H. Bostock, care of Lithgow and Son, printers, 76, West Howard-street, Glasgow.

Wakefield.—Tenders are required by the Corporation for the erection of an electric lighting sub-station in Westgate. Plans and specifications may be seen, copies of forms of tenders, bills of quantities, and any other information may be obtained, on application to Mr. R. Porter, city surveyor, Town Hall, Wakefield. Sealed tenders, endorsed "Tender for Sub Station," to be sent to the City Surveyor by 9 a.m. on April 5.

Cardiff.—The Corporation invite tenders for the wiring and fixing of fittings for the electric lighting of the judge's lodgings, The Walk, Cardiff. Plans may be seen, and specifications and particulars obtained, at the office of the Electrical Engineer, Town Hall, Cardiff, upon the deposit of £1. 1s., which will be returned on receipt of a bona fide tender. Sealed tenders, endorsed "Wiring of Judge's Lodgings," must be delivered at the office of Mr. J. L. Wheatley, town clerk, Town Hall, by 9.30 a.m. on 29th inst.

Edinburgh.—The Lord Provost and Magistrates and Council are prepared to receive tenders for the wiring of the City Observatory, Calton Hill. Specification, form of tender, and plans of the building can be obtained at the office of the Resident Electrical Engineer, 5, Dewar-place, Edinburgh, on deposit of £2. 2s., which deposit will be returned on receipt of a bona fide tender, unless same is late. Tenders must be sent to Mr. Thomas Hunter, W.S., town clerk, City Chambers, not later than 10 a m. on April 9. See advertisement.

Portsmouth.—The Corporation invite tenders for (*a*) the supply and erection of three motor-generators and switchboard arrangements; (*b*) a battery of accumulators, with stands. Specification and forms of tender can be obtained from Mr. Alexander Hellard, town clerk, Town Hall, Portsmouth, on payment of £2. 2s., which will be refunded on return of the same accompanied by a bona fide tender. Further information can be obtained from the engineers, Messrs. Kincaid, Waller, and Manville, 29, Great George street, Westminster, London. Sealed tenders must be sent to the Town Clerk, endorsed "Motor-Generators and Accumulators," by 5 p.m. on April 2.

Bristol.—The Electrical Committee of the Council are prepared to receive tenders for the supply, delivery, and erection of condensing plant, steam and exhaust piping, etc. Plans, specification, and form of tender may be obtained at the office of the Secretary on payment of £3. 3s., which will be returned on receipt of a bona fide tender. Any further information required may be obtained from Mr. H. Faraday Proctor, city electrical engineer. Tenders must be delivered not later than noon on April 7, 1897, addressed to Mr. Frank Wm. Prosser, secretary, Electricity Department, Temple-back, Bristol, and endorsed "Tender for Condensers."

Wells (Somerset).—The Corporation require tenders for the supply and erection of the plant required for the complete equipment of an electric light station and for the underground conductors, etc. Copies of the specification may be obtained, and plans inspected, at the offices of the Town Clerk, Wells, Somerset; and of the engineer, Dr. John Hopkinson, F.R.S., 5, Victoria-street, Westminster, upon the payment of a cash deposit of £25, which will be returned on receipt of a bona fide tender. Tenders, sealed and marked "Tender for Electric Lighting," must be delivered to the Lighting Committee, Town Clerk's Office, Wells, Somerset, by 27th inst. Mr. Regd. L. Foster, town clerk.

Hull.—Tenders are required by the Electric Lighting Committee for the supply and erection of the following plant: Section A—Lancashire boilers; Section B—Babcock-Wilcox boiler; Section C—Green's economiser; Section D—Overhead travelling crane; Section E—High-speed engines; Section F—Condensers, pumps steam-pipes, etc.; Section G—Continuous-current dynamo (high and low tension), transformers, switchboards, etc; Section H—Storage batteries; Section I—High and low tension mains, casings, junction-boxes, etc. Specification for the above (the whole bound up in one specification), with conditions of contract, may be obtained at the office of Mr. A. S. Barnard, borough electrical engineer, Dagger-lane, Hull, on payment of £2. 2s. for each copy. This sum will be refunded on the return of the specification, with a bona fide tender for one or more of the sections. Tenders, sealed and marked "Electric Lighting—Tender for New Works," must be delivered to the Chairman of the Electric Lighting Committee, Town Hall, Hull, by noon on April 8.

West Ham.—The Town Council require tenders for the erection of electric lighting buildings at the Abbey Wharf, Stratford, London, E Plans may be seen, and specification, form of tender, and further particulars obtained, at the office of Mr. Lewis Angell, engineer to the Corporation, Town Hall, Stratford, E, on deposit of a £5 Bank of England note, which will be returned on the receipt of a bona fide tender. Tenders, endorsed "Tender for Buildings," to be sent to Mr. Fred. E. Hilleary, town clerk, Town Hall, West Ham, by 4 p.m. on April 13. The contractor will be required to enter into a bond, with two sureties, for the performance of contract, and no work will be ordered under the contract until such bond has been duly executed. The contractor whose tender is accepted, and with whom a contract is entered into, will be required to pay the whole of his workmen such rate of wages and observe such hours of labour as are recognised by the workmen's trades unions and in force at the time of signing the contract. In the event of any breach of such agreement the Council will enforce the penalty clause in its entirety.

BUSINESS NOTES.

Luton.—The Town Council have decided to spend £50 on electric light during the ensuing year.

Western and Brazilian Telegraph Company.—For the past week the receipts were £2,282.

Dusseldorf.—In a great storm on the 18th inst. the great electric crane at the harbour fell into the water and smashed a barge.

Postal Telegraph Clerks.—General dissatisfaction is being expressed with the report of Lord Tweedmouth's Committee and its recommendations.

Electric Lighting on the Barry Railway.—The carriages on this railway have been fitted with the electric light by Messrs. J. Stone and Co., of Deptford.

South Shields.—A Local Government Board enquiry has been held by Colonel Langton Coke into the application of the Corporation for power to borrow £12,000 for electric light extensions.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended March 21 amounted to £1,360, as compared with £1,149 in the corresponding week of the previous year, being an increase of £211.

Eastern Telegraph Company.—The Eastern Telegraph Company announce the usual interim dividend of 2s. 6d. per share on the ordinary shares, free of income tax, in respect of profits for the quarter ended December 31 last.

Bristol Tramways and Carriage Company, Limited.—The traffic returns for the week ended March 19 were £2,053. 7s. 5d., compared with £1,864. 17s. 4d. for the corresponding period of last year, being an increase of £188. 10s. 1d.

Fraser's Condenser.—We have to acknowledge the receipt from Messrs. Fraser and Sons, of Millwall, of particulars of a new evaporative condenser and a new boiler they have just brought out, and hope to give these a further notice immediately.

Nalder and Hilton, Limited.—This is a new Company, registered March 11, with a capital of £20,000 in £1 shares, in order to enter into an agreement with N. F. Nalder and J. G. M. Hilton, and to carry on the business of electricians, engineers, boiler-makers, etc.

Wolverhampton—An enquiry has been held with regard to the application of the Town Council to borrow a loan of £1,555 for electric lighting. Of this £602 was for an additional transformer at the art gallery sub-station and the necessary switch arrangements and alterations.

City and South London Railway.—The returns for the week ended March 21 were £1,012, compared with £952 for the corresponding period of last year, being an increase of £60. The total receipts for the half-year 1897 were £12,818, compared with £11,738 last year, being an increase of £1,080.

Coventry Electric Tramway Company's Bill.—When the Select Committee of the House of Commons, over which Sir Stafford Northcote is presiding, met, it was announced that the petition of the Hon. Cecil Saumarez Irby had been withdrawn, and the Bill would be referred to the Committee on Unopposed Bills.

Teheran.—The Teheran correspondent of the *Times* writes under date February 8: "Beetroot sugar is for the first time being manufactured in Persia, a Belgian company, which for the last two years has been erecting a magnificent factory on the newest principles with electric motors, having last week begun work."

Oriental Telephone and Electric Company, Limited.—The directors of this Company have resolved to recommend to the shareholders, subject to final audit of the accounts, a further dividend of 8d. per share, free of income tax, making, together with the interim dividend paid in October last, 5 per cent. for the year ended December 31, 1896.

Padiham.—The District Council seem rather inclined towards the electric light. A discussion took place at the last meeting on the proposal to borrow £24 000 for extensions of the gasworks, and it was adjourned for two months. The opinion was expressed that if they went in for any extension of the lighting it should be in putting down an electric light installation.

Plymouth.—At the meeting of the Borough Council, Mr. J. Willoughby presented the report of the Electric Lighting Committee, and mentioned that the Local Government Board had granted the money for the purpose of proceeding with the work, and they had accordingly invited tenders. He hoped to submit them at the next meeting for their decision.

Wall Sockets.—Mr. A. P. Lundberg, of Bradbury-street, Kingsland, N., informs us by letter of the great success of the "Dot" two-pin wall sockets. On completion of a first order for 3,800 for a well-known Continental firm, he has just received a repeat order for 8,000 "Dot" wall sockets and 2,000 "Improved Pioneer" combined switch and wall sockets to take "Dot" plugs.

Direct Spanish Telegraph Company, Limited.—The report for the year ended December 31, 1896, shows, after providing for interest on, and redemption of debentures, a balance to the credit of revenue of £10,818. After adding £5,000 to reserve, the directors recommend a dividend for the year of 4 per cent., tax free, on the ordinary shares, and a balance of £332 is carried forward.

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Arc Lamp Patents.—Messrs. Drake and Gorham inform us that the Jandus Arc Lamp and Electric Company have purchased from Mr. Marks the whole of the interests and rights for the United Kingdom of the Electric Arc Light Company, U.S.A., covering the Marks and Pioneer enclosed arc lamps and other controlling patents, and have thus settled what promised to be a long and costly litigation.

Lambeth.—The clerk to the Vestry, Mr. H. J. Smith, reported at the last meeting that the electric lighting order was that afternoon transferred to the new company. He had received £1,000 in respect of the expenses incurred by the Vestry in the past, and £5,000 as a deposit for the company carrying out faithfully the new order. These sums had been placed to the Vestry's credit at the London and Westminster Bank.

London Lighting Extensions.—The London County Council have sanctioned applications for extensions from the Metropolitan Electric Supply Company, the Notting Hill Electric Lighting Company, the Vestry of St. Pancras, and the House-to-House Electric Light Supply Company. They have also given permission to the Metropolitan Electric Supply Company to alter the present high-tension supply in several streets to a low-pressure distribution.

Birmingham City Tramways.—Petitions on behalf of the following, praying to be heard by counsel against this Bill when the committee stage is reached, have been deposited in the Private Bill Office of the House of Commons: (1) Rural District Council of King's Norton, (2) Birmingham and Aston Tramways Company, (3) Handsworth Urban District Council, and (4) Mr. Vincent Alexander Jones. In the House of Commons the Bill has been read a third time.

Diamond Jubilee Decorations.—According to the *City Press*, the design for the decoration of London Bridge itself consists in the erection of a number of poops of old vessels on the piers on either side of the bridge, which will at night be lighted up with ships' lamps. The arches spanning the roadway over the bridge will be outlined at night by means of rows of small electric lamps, and the approaches will be brilliantly illuminated with large electric arc lamps placed at intervals.

Canterbury.—The vacillating policy of the Canterbury Town Council in the matter of the electric lighting scheme continues to be the subject of much criticism in the city. As a consequence of the decision of the Whole House Committee an application has to be made to the Board of Trade with the view of securing an extension of the time authorised by the provisional order for the carrying into effect of its provisions, and this action is very severely commented on in the local Press.

Stock Exchange Notices.—The Stock Exchange Committee have appointed Wednesday, March 31, a special settling day for the London Electrical Cab Company, Limited, 62,768 shares, Nos. 1 to 62,768; and they have ordered the undermentioned securities to be quoted in the official list: Chelsea Electricity Supply Company, Limited—further issue of 12,000 ordinary shares, Nos. 20,501 to 32,500; House-to-House Electric Light Supply Company, Limited—10,000 ordinary shares, Nos. 101 to 10,100.

A Motorcart List.—We have received from Messrs. New and Mayne, 8, Bridge-street, Westminster, a four-page price list of motorcarts. No. 1, a dogcart (three-wheeled), is not electric, but in general Messrs. New and Mayne give you a choice between batteries or oil. As to electric carts, the compilers state that "in nearly every town and village in this country continuous current for charging can be obtained at from 1½d. to 4d. per Board of Trade unit." Surely this is a little premature at present.

The Tudor Accumulators.—Mr. A. B. Pescatore, of Manchester, writes to say that owing to the numerous important orders that he has recently secured, he is at present doubling his works, and putting down extra plant, so as to be able to still deliver with reasonable promptitude. Among the orders at present in progress he mentions the large batteries for Glasgow and Edinburgh Corporations, for the Northampton and Llandrindod Wells electric supply stations, for the War Office, and numerous smaller batteries for private plant.

Business Change.—Messrs. Conze and Simon, 52, Queen Victoria-street, E.C., inform us that they have taken into partnership Mr. Herbert Berry, who lately represented Messrs. Siemens Bros. and Co., Limited, of Woolwich and London. The name under which they have hitherto done business will in future, dating from March 1, 1897, be altered to Simon, Berry, and Co., and all debts due to Conze and Simon will be taken over by the firm under the new style, and likewise all liabilities will be paid by the new partners.

Sunderland.—This town has been rather unfortunate in its experience of municipalised electricity. Last year the revenue the town derived from electricity amounted to £3,007 and the expenditure to £3,795, so that the community is nearly £800 to the bad. That, however, is not the most striking feature of the year's working. It is contended by the opponents of municipalisation that had the business been in private hands a dividend of 2½ per cent. would have been declared, whilst the consumers would have got their current at the same price.

The Brighton Rebate System.—In common with a good many other places, the lay mind of Dewsbury cannot grasp the principles of what is known as the "Brighton" system of charging, and the chairman of the Lighting Committee, Mr. G. A. Fox, has written to the local newspaper to explain it. Does not this constant need for explanation point to the necessity for a carefully drawn-up statement which people who are not electrical engineers can understand? That the system is not so simple as it may seem has been discovered even by more than one electrical engineer.

Coventry.—The General Works Committee have come to an agreement with the General Traction Company in regard to the proposed extension. The extensions are to be carried out within three years, and will involve the erection of a new and much-needed bridge over the canal on the Stoney Stanton-road. The city is fast extending in this direction, both in respect of manufacturing concerns and places of residence. The cost of the new bridge will be £1,500, and if the agreement with the company be ratified by the Corporation the former will contribute £500 towards this amount.

Rockhampton.—The report of the Gas and Coke Company states the consumption of electricity has fallen, but the directors hope to provide for this shrinkage by pushing the use of large arc lamps for public purposes, and also by the introduction of electrical fans and small motors. The electrical operations show a return of £219. 5s. 6d., which has gone towards the payment of debenture interest, amounting to £300, the whole of which has been charged to the electric light operations, leaving a difference of £80. 14s. 6d. represented in the debit balance of the profit and loss account of this section of the business.

Balderton.—At the meeting of the Parish Council, a resolution was passed by seven votes to three giving consent to the Newark Gas Company to supply the parish with gas. Mr. Eddowes opposed the motion on the ground that it was the duty of the Parish Council to refuse consent to the gas company unless they agreed to supply gas on satisfactory terms. He had been in communication with some of the best men in England on electricity and electric lighting, and it was very probable they could get that illuminant at Balderton. Mr. Ellwood said there was nothing put in the way of the supply of electricity by giving consent to the gas company.

Littlehampton.—The whole electric light arrangements of the convalescent home have been carried out by Messrs. Drake and Gorham, 66, Victoria-street, Westminster, S.W. They consist of two Cornish boilers, each capable of working up to 33 h.p., and two engines each of 33 h.p., either of which sets is capable of meeting all the requirements both of lighting and transmission of power. There is also an electrical accumulator of the D. P. Company's make, capable of supplying 172 lamps of 16 c.p. for nine hours after the engines have ceased to run. Feed-water heaters have been fixed, and the total number of lamps is about 250, in addition to which about 150 lamps are furnished for driving the pumps for water supply, power transmission, and other purposes.

Electric Mining Plant.—Messrs John Davis and Son, of All Saints' Works, Derby, 118, Newgate-street, London, and Cardiff, have forwarded us a copy of their new catalogue of electric mining plant and accessories. This has been got out with great care, and goes into details with regard to the various features of electric mining including hauling, pumping, coal-cutting, blasting, etc., and Messrs. Davis and Son count on it being appreciated in the mining world as exclusively devoted to mining. Dust and damp proof work is, of course, extremely important in mines, and in coal-pits there is, of course, sparking to be considered. Much of the work has therefore to be special. The catalogue includes prices for the "Safety" concentric system of wiring (outer earthed).

Copper.—The *Mechanical World* says that with the present demand for copper for electrical purposes—which is increasing week by week—and the lowering of the visible stocks, it will not be surprising if the electrical industry has to pay greatly enhanced prices in a very short time. It is a fact which may cause people serious thoughts, that the stocks of copper in this country are lower than they have been for over 20 years. There are not more than 28,000 tons at the moment, which, judging from the present demand, would barely amount to three months' supply. The extensions which are being rapidly carried out in most electric lighting systems will necessitate a great deal of copper, and if electric tramways are built, according to anticipation, the demand for wire will be greater than the supply.

Clerkenwell.—At the meeting of the Vestry Mr. Walton brought up a proposal from the Works Committee to light Pentonville-hill with incandescent burners. Mr. Hale opposed this on the ground that the incandescent gas lighting was in its infancy so far as street-lighting was concerned. The vibration of the traffic would soon break the mantles. If they had a new light let them go for electricity at once. Mr Wildbore supported the proposal, and added that the parish was sufficiently advanced to get a system of electric lighting. There was no doubt London was badly lighted, and Clerkenwell was not an exception. There was no system of electric lighting sufficiently near to Clerkenwell to allow them to take advantage of it, and, therefore, he thought they should take this proposal to go on with. The committee's recommendation was adopted.

Hampstead.—At the meeting of the Vestry it was reported that a jointer's labourer named Henry White had been killed by an electric shock in an electric sub-station of the Hampstead electric lighting works at Lyndhurst-gardens, that the vestry clerk had been directed by the Lighting Committee to see that deceased's funeral was carried out at the Vestry's expense, and that the widow's immediate necessities were relieved. Mr. Reed, the chairman of the Lighting Committee, said that the accident was totally without precedent in the annals of electric lighting, but steps were being taken to make such accidents in the future practically impossible. Already 20 out of the 24 sub-stations in the parish had been altered so as to prevent further accidents, and the others would be altered during the week. The action of the committee was unanimously approved.

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Changes of Address.—Messrs. Willans and Robinson inform us that the offices of the company have been removed from Thames Ditton to Rugby, Warwickshire, where all letters and other communications should be addressed. The works at Thames Ditton will be used only for the manufacture of certain standard parts of the engines. Engines will be erected and tested at Rugby, and no correspondence will be conducted from Thames Ditton.—The traffic offices of the Tramways Department of the Bristol Tramways and Carriage Company, Limited, have been transferred from Bristol Bridge to the Tramways Centre.—In view of the constant increase of their business, Messrs. Wilhelm and Co. have been compelled to take larger and more suitable premises, and all communications should be addressed to 11 and 22, Westmorland-buildings, Aldersgate-street, London, E.C.

Johannesburg.—The annual report of the Johannesburg Tramways Company says that it is to be regretted that the company has found itself restricted in its efforts to expand the service and extend its sphere of usefulness by the hostile attitude of the local sanitary board, which has withheld its sanction to any extensions of the tramway lines pending the active exploitation of the Lombaard Concession for electrical traction. This concession, besides being a great injustice to the existing company, which possesses, on the assurance of the president, the pre-emptive right to adopt the electric mode of locomotion, is a considerable thorn in the side of the tramway company, as it is unable to obtain from Government any defined statement of its rights and privileges, or any assurance that the Lombaard Concession will not be actively exploited to its detriment, and to the injury of its monopolistic rights.

Nantwich.—A communication was read at the Urban District Council meeting from Edmondsons Limited, London, with regard to the question of electric lighting. Adverting to a previous communication, in which the Council's assistance was sought to enable the company to obtain a provisional order from Parliament, the letter stated that Edmondsons would be prepared to bear the expense of any application made by the Council to Parliament for a provisional order provided the Council would eventually transfer the powers conferred to Edmondsons. The charge to the Council for electric light would be at the rate of 4d. per unit. Mr. Hy Harding, in proposing that the matter be further considered by the Lighting Committee, remarked that the use of the electric light was no longer an experiment, but an established fact. Mr. John Harding seconded, and the matter was referred to the committee.

The Dublin and Lucan Tramway.—Mr. Robert Haire, inspector under the Board of Works, has held an enquiry in connection with the reconstruction of the Dublin and Lucan Tramway Company's lines, which it is intended to work in future by electricity instead of as at present by steam. The enquiry was held at the offices of the company, Conyngham road. The scope of the enquiry was confined to the merits from an engineering point of view of the reconstructed tramway, the character of the gradients, curves, and crossings, and any peculiar engineering difficulties of the scheme, with the modes proposed for overcoming them. Mr. Richard Shiel (instructed by Messrs. D. and T. Fitzgerald) appeared for the promoters. There was no appearance in opposition to the scheme. Mr. F. C. Scarr, secretary and manager of the company, and Mr. H. J. Fuller, C.E, engineer to the company, were in attendance.

South London Electric Supply Corporation, Limited.—We have received a prospectus of this Company, which has been formed, with a share capital of £325,000 in £5 shares, to undertake the supply of electric energy for lighting and other purposes in the parish of Lambeth, London, under the powers of a provisional order confirmed by Act of Parliament. The Vestry to whom the order was granted have, with the sanction of the Board of Trade, transferred the order to this Company. The list of subscriptions will open on Saturday, March 27, and close on or before Tuesday, March 30, for both town and country. The entire capital will be called up within about 18 months. Shareholders will have the right to pay up in full on allotment or any date fixed for payment of calls, and will have a preference on any further issue of share capital Full particulars are published in our advertisement columns.

Brighton.—The electric lighting under Mr. Wright's management is still going ahead by leaps and bounds, and the applications are 50 per cent. more they were this time last year. The Corporation have resolved to apply to the Local Government Board for power to borrow £43,300 for the necessary increase in plant and machinery during the next 12 months. Thirty-one additional arc lamps are to be erected along Madeira-road and Madeira-terrace. At the last meeting of the Corporation Mr. Wright reported that out of 141 consumers who last year did not derive any benefit from the sliding scale no less than 74 consumed less than 25s. worth of electricity in the half-year, and in all only £41, while the mere cost of holding the plant, etc., in readiness to supply these 74 consumers was quite £224. On his recommendation the Corporation have decided to give the necessary month's notice to all consumers that in future a minimum charge of 30s. per annum for the electricity consumed will be made.

The Telephone Exchanges.—In the House of Commons Mr. Provand asked the Secretary to the Treasury, as representing the Postmaster-General, whether the Post Office officials would make any separate return, actual or approximate, of the sums which they had expended in the construction and maintenance of telephone exchanges and of the amounts earned by the exchanges Mr. Hanbury replied that the sum expended in the construction of telephone exchanges was £107,000, of which three-fourths was expended on the telephone exchanges of Glasgow. It was not possible to give the amounts earned by the exchanges in the hands of the Government nor the amounts spent on the maintenance of the telegraphs and telephones. The headquarter's charges were the same, the offices the same, the clerks the same, and the engineering staff the same. If the accounts could be separated, it would not be desirable to give the information, having regard to the relations of the Government and the National Telephone Company.

Bath.—At the meeting of the Urban Sanitary Authority Alderman Sturges moved the adoption of a report from the Electric Lighting Committee, stating that they had applied to the Local Government Board for sanction to borrow another £6,000 for an extension of the system. The report referred to the Local Government Board enquiry into the city's purchase of the electric light works, to the transfer of those works to the city, and mentioned that they had submitted the name of Mr. Gatehouse to the Board of Trade as an inspector. Alderman Sturges said Mr. Gatehouse had since been appointed. Mr. Silcock moved an amendment instructing the committee to prepare a detailed statement of the extensions now proposed. He protested against the committee doing work on their own authority without consulting the Council. Mr. Rickette seconded, and the amendment, despite Alderman Sturges's suggestion that the Council might take a more charitable view of a young committee's procedure, and be content if future extensions were submitted, was carried by 10 votes to 9.

Legal.—In the Admiralty Division last Friday, before Mr. Justice Barnes, was heard the case of the owners of the "Medway" and others *v.* the owners of the "Scotia." This was an action for damages as the result of a collision on November 28 between the screw steamship "Medway" (Newcastle to London, with coals) and the twin-screw telegraph-cable steamship "Scotia" (bound to Borkum and Brest for the purpose of laying a submarine cable which she had on board). The "Medway" is owned by Messrs. Cory and Co., of Mark-lane, City, and the "Scotia" by the Telegraph Construction and Maintenance Company, of Blackwall, which place she had just left when the collision happened. Mr. J. P. Aspinall, Q.C., and Mr. Lewis Noad were counsel for the plaintiffs, and Mr. L. E Pyke, Q.C., and Mr. L. Batten for the defendants. One of the witnesses created a laugh when, in reply to Mr. Pyke, as to whether the blow was a right angle one, he said, "No sir, it would be more like a left-angle blow." His lordship held that the "Medway" was alone to blame, and gave judgment for defendants, with costs.

Colwyn Bay.—The Urban District Council at the last meeting were interviewed by Mr. Clirehugh and Mr. Bennett, of Manchester, the gentlemen whom Dr. Hopkinson had recommended to carry out schemes for lighting Colwyn Bay by electricity, and the provision therewith of a refuse destructor. Mr. Clirehugh, whose scheme was preferred by Dr. Hopkinson, said that electric lighting if carried out by the local authority ought to be made a profitable undertaking. Mr. Bevan asked if it was thought in a small town like Colwyn Bay sufficient demand would exist to make a profit on £10,000 outlay. Mr. Clirehugh said it was invariably the case that the electric light was profitable where the gas company was a paying concern. He did not think any nuisance would be caused by having the refuse destructor at Groes Mill, as was stated by a deputation at the Council. Mr. Bennett proceeded to explain his scheme, and compared it with Mr. Clirehugh's. He sought to prove that as to the mains, illuminating power, and steadiness, his scheme was preferable. After a protracted interview, it was decided to refer both schemes to a committee.

Accumulators v. Overhead Wires.—The directors of the Hanover tramway system have published an important report, in which they narrate their experiences with accumulators as the source of the power for their cars. In Hanover, both overhead wires and accumulators have been used for a considerable time, so that the managers are in a position to institute a reliable comparison. Taking everything into account they pronounce in favour of the storage cell. The cost of maintenance, they say, has been determined with the utmost exactitude possible for the year 1896, and the average comes out at 40 marks per wagon per month, equivalent to 75 groschen per kilometre. The estimate includes the cost of renewing the plates. Having regard to the expense involved in the maintenance of the overhead line and its accessories, as well as to other circumstances, the managers reach the conclusion that the additional cost of accumulators does not exceed one groschen or one-tenth of a penny per mile. Consequently it has been decided that the entire system shall, as soon as the requisite arrangements can be made, be driven by secondary batteries.

Crompton and Co.—We have received from Messrs. Crompton and Co., Chelmsford, four illustrated price-lists relating to different departments of work. Those sent are issued in brown, grey, pink, and blue covers respectively so as to be easily distinguished. The first deals with alternators and transformers, and comprises mainly the Crompton-Brunton machinery. Messrs. Crompton claim to have worked out a complete system of alternating-current machinery by "avoiding the salient errors and disadvantages which have attended other alternating-current systems." There is a telegraph code for ordering machines. The second list deals with the direct current dynamos and motors of the well-known Crompton type. The details of size and weight for packing and the particulars of information required in order that the firm may supply a machine which will meet a particular want, are careful and full. Number three covers arc lamps and accessories for continuous and alternating currents. A new type is the "S" pattern—a short and compact lamp not intended for long hours of

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burning and at a moderate price. The last list relates to voltmeters, ammeters, and other instruments.

Llandudno.—Mr. Marks moved at the Urban District Council meeting, "That it be an instruction to our electrical engineer (Mr. A. H. Preece) to further consider the question of electric tramways as contained in his report of March 3, 1896, page 21, etc., with a view of the plant and apparatus now being designed for this Council being further developed so as to provide power for working the tramways proposed to be laid down by the Council." He said that probably in the history of the town they never had such an important crisis as at present with regard to street locomotion. He believed it was pretty sure that tramways would have come to Llandudno, and, in moving his resolution he upheld the principle that such concerns, as was the case with the gas and water concerns, should be under the control of the local authority. Mr. J. O. Thomas seconded the resolution. It might be said by some that he had changed his attitude on the tramways question, but as it was proposed that the Council should have control of the matter, and that the words "light railways" disappeared entirely from the resolution, he felt bound to support Mr. Marks. The resolution was carried.

Dover.—At a recent Town Council meeting a letter was read from the secretary of the electric light company stating that the arch opposite the Tivoli would have to be moved and the lamp would not be alight for a couple of nights. The minutes of the Tramway Committee held on March 9 were read as follows: "Contracts.—(1) A letter was submitted from Mr. S. Sellon stating that he had appointed Mr. H. T. Haws as clerk of the works for the equipment contract at a salary of £3 a week and it is approved. (2) The surveyor is instructed to retain the services of Mr. Hookham, now in the employ of the Corporation, to assist in superintending the works of the permanent-way and rails contract at a salary of £3 3s. per week. (3) The surveyor reported a letter from Messrs. Dick, Kerr, and Co. announcing the despatch of the first cargo of rails (which have now arrived). (4) The surveyor also reports that the contractor was prepared to start the permanent way on the 15th inst Loan.—The surveyor submitted an estimate of the cost of the whole tramway scheme, and the Council are recommended to apply to the Board of Trade for sanction to borrow £31,000." The minutes were approved.

The Building Trades' Exhibition.—At this exhibition, which is now being held at the Agricultural Hall, Islington, there are a few stands devoted to electricity as it is applied to particular branches of construction. Messrs. Matthews and Yates Limited, Cyclone Works, Swinton, Manchester, and London, exhibit some ventilating and heating appliances, consisting of electric air propellers, blowers, radiators, etc, for continuous and alternating currents. A large number of the fans are used by the City of London Electric Lighting Company. Callender's Cable and Construction Company, Limited, 90, Cannon-street, E.C., show specimens of electric light cables of various types, and other appliance for electric lighting. Messrs. Thos. Green and Co., Limited, of Smithfield Ironworks, Leeds, have three Smithfield gas engines (4 h.p., 3 h.p., and 1 h.p.). Messrs. Green do not intend to suffer from want of light, for one of their engines runs a dynamo with about 15 incandescent lamps and an enclosed arc lamp in the circuit. The Blackman Ventilating Company, Limited, besides showing examples of their well-known fans, some of them combined with electric motors in motion, show a very useful combination, exhibited for the first time, for supplying fresh warm air into any building under complete control as to its temperature on entering.

Clerkenwell.—The Fire Brigade Committee reported as follows at the London County Council meeting: "Being of opinion that the Clerkenwell station, which is being considerably enlarged and altered, should be lighted by electricity, we gave instructions for tenders to be obtained for the wiring and the necessary electric light fittings. Six of the seven firms invited to tender quoted the following prices, £50 being included in each case for contingencies:

Russell and Russell	£308	10	0
Private Wire and Telephone Installation Company	336	18	5
F. A. Glover and Co.	366	10	0
Laing, Wharton, and Down, Limited	374	2	6
Pritchett and Gold	404	0	0
Rashleigh Phipps and Co.	456	0	0

The specification for the work of enlarging and altering the station provides for the supply of gasfittings, but we have determined that where stations are lighted by electricity it is not expedient to go to the expense of new gasfittings, inasmuch as in the event of the temporary failure of the electric light the occupiers can rely on lamps and candles. The cost of the installation of the electric light will be greater than the sum provided for gasfittings, but it is hoped that the total cost of the work at the station will be covered by the estimates already adopted by the Council. We recommend that the tender of Messrs. Russell and Russell to execute for £308. 10s. the wiring and to supply the necessary electric light fittings at the Clerkenwell station be accepted."

Manchester.—At a meeting of gentlemen interested in the New Mutual Telephone Syndicate, Limited, a deputation was appointed to wait upon the Lord Mayor with the following requisition: "That your memorialists regard an efficient telephone service at a reasonable charge as a need of first-rate importance to the commercial interests of the district; that in order to secure the best possible service at the lowest remunerative charge competition is essential; that under a Treasury minute dated May 23, 1892, and ordered by the House of Commons to be printed August 7, 1894, the Post Office, as a condition precedent to granting a license for an independent local telephone service, require that the municipal and other local authority shall pass a resolution in favour of the proposed new company; that in order to provide an independent telephone service for Manchester and district the preliminary steps have been taken for registering a company with sufficient capital; that already orders for about 1,000 telephones have been received by the organisers of this company, and it is intended to secure 2,000 subscribers before the exchange is opened; that, in the opinion of your memorialists, it would be unreasonable to expect the organisers of the company to incur the serious expense of registering the company until the first condition of obtaining a license from the Post Office is secured—viz., a resolution in favour of the company from the local authority. Your memorialists therefore respectfully urge that you will pass such a resolution, and that, apart from such general resolution of approval, you may stipulate for such conditions as in your wisdom you may deem necessary for the protection of all interests concerned."

Leicester.—Alderman Lennard, in moving the adoption of the electric light portion of the Gas Committee's report, said he would not go through all the details of the balance-sheet, but would merely deal with two or three points, showing how much profit had been made. Turning to the profit and loss account, the Council would see that after allowing for sinking fund charges they had made a net profit of £457. 14s. 6d. on the half-year, and that after £579. 14s. 8d. had been transferred to the sinking fund. The net result of the working of the department up to the present, that was up to the end of two years, was, as stated in the report, a loss of £1 603. 3s. 7d. on the revenue account, whilst they had placed to their credit in the sinking fund £2 500, which was practically profit put by for the repayment of capital. He had often made a general forecast as to what he thought the department could do, and his original estimate was to make a considerable loss on the first year, an even balance in the second year, and a profit in the third year, which would retrieve the loss sustained during the inaugural years. The first year brought a loss, but the second year the accounts nearly balanced, a small loss only resulting. Although the price for current had since been reduced, he had hopes that at the end of 1897 they would be able to retrieve the losses sustained at the end of the first two years' working. Proceeding, Alderman Lennard gave some interesting statistics relating to the working of the department. Four half years had now passed, and their revenue accounts had been as follows: first half-year, £671; second half-year, £1,273; third half-year, £1,467; fourth half-year, £2,774. These figures still showed a steady increase, and as things were going on at present they would, he believed, be able to double the figures during the coming half-year, corresponding to the same period of last year. Councillor Billings seconded the adoption of the report. Councillor F. W. S. Clarke enquired if anything was intended to be done in reference to the lighting of the streets of Leicester with the electric light. He asked the same question last year, when the state of the revenue of the department was different to what it was to-day. He thought if the lighting of the streets by electricity was gone in for it would swell the department's exchequer, inasmuch as the Corporation would be large consumers Councillor Royce observed that the Watch Committee, who had to deal with street-lighting, had very carefully considered the question raised by Councillor Clarke, and they had come to the conclusion not to entertain any proposal for the lighting of the streets of the town by electricity. Alderman Lennard also explained that what would be put into the pockets of the Electric Lighting Committee by electric street lighting would be taken from the Watch Committee. There were some towns which had taken up the electric lighting in the streets and made a profit out of it. He had looked into these accounts, and whilst he would not say that they were "cooked," yet certainly they were extraordinary. The Leicester Electric Light Committee had endeavoured to make their department a commercial success, and his opinion was that electricity was not an economy for street-lighting, and that gas could be improved. The resolution was carried.

Glasgow.—At the meeting of the Corporation Mr. D. M. Stevenson, in terms of notice, moved: "That (after the expiry of the current financial year) the administration of the electric lighting department of the Corporation be under the control of a separate general committee, instead of being controlled as at present by the Gas and Electric Lighting Committee." He pointed out that Manchester had taken a similar step on the previous day, and that the arrangement had long prevailed in Edinburgh. His argument was that if the department were under the control of a committee directly responsible to the Corporation it would be more efficiently managed. Mr. Finlay seconded. Mr. R M. Mitchell, convener of the Gas and Electric Lighting Committee, concurred in the proposal. He did not admit, however, that the Gas Committee had hindered electric lighting. Large extensions had been made gradually and regularly, and the committee were engaged in maturing schemes for a large development, which would naturally fall on the new committee. He would not like it to go forth to the public that their works were in any way inferior; they were among the most complete in the United Kingdom. The Watching and Lighting Committee would naturally have a large representation on the new committee. He hoped a great extension in street-lighting might take place because it would be greatly to the interests of the future of the committee and greatly to the benefit of the citizens. In fairness to the members of the Gas Committee and the officials, he desired to say that the electric lighting enterprise was very much the better for the sound and able advice which had been most disinterestedly given by the Gas Committee and its officials. No gentleman connected with the Corporation was more anxious for the success of the electric light than Mr. Fowlis, the gas manager. The borrow-

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ing powers of the Gas Committee were very nearly exhausted. In the near future a large gasworks must be erected to keep pace with the extraordinary demand, which, instead of being lessened by the use of electric light, had greatly increased in recent years. Application would therefore have to be made, probably in next session, for an extension of borrowing power. He hoped that under an energetic committee the electric lighting would be as successful in the future as in the past. Considerable discussion took place as to the time at which the change should come into effect. Ultimately it was agreed that as far as concerned the works the new committee should take charge as soon as possible, but it was understood that the financial arrangements should, until the end of the year, be controlled by the Gas Committee. Appointment of the Electric Lighting Committee was deferred for a fortnight. At the meeting of the Corporation the Chairman stated that it had come within the knowledge of the magistrates that in certain buildings which were being erected the wiring for the electric light was being done in a way which, in the opinion of the electrical engineer, was inimical to the safety of the public. In view of the fact that the magistrates might have to refuse to license a certain place of entertainment, he asked whether the Buildings Regulations Committee had any control in the matter. Mr. Primrose the convener, stated that the committee had power to frame regulations, and would proceed to do so. Messrs. D. Stewart and Co., Limited, London-road Ironworks, are driving a considerable portion of their works by means of electrical motors, and have found them very satisfactory. The firm fitted up the installation themselves.

New Swindon.—The Electric Lighting Committee recommended at the Urban District Council meeting that Mr. Aldridge should be requested to give an estimate of cost of lighting the whole district. Mr. Churchward said that before they took that course the Council should ask Mr. Aldridge to give an estimate of the charge of drawing out the plans and specifications of the whole district. He would remind the Council that on several occasions they had unpleasant differences with professional men on the subject of charges. Probably Mr. Aldridge would charge £100 for the work. Mr. Longland said Mr. Churchward was under a misapprehension. They had never paid Mr. Aldridge 100 guineas. Mr. Aldridge had been paid 25 guineas for the plan he prepared, and another 15 guineas for his services when obtaining the provisional order. Mr. Churchward said he quoted £100 because that was a figure named by a member of the Council. Mr. Brain pointed out that the Council already had a gauge as to what Mr. Aldridge's charges were likely to be. Mr. Aldridge came down four years ago and prepared a plan of the district, although without any former knowledge of it, and for that he charged 25 guineas. But now he would not come as a total stranger to the district, and all that would be necessary would be for him to prepare an extra report with regard to the Rodbourne and Gorse Hill district. He was prepared to trust to Mr. Aldridge's fair-mindedness in regard to his charge. Mr. James suggested that an addition be made to the report allowing the work to be done provided the charges were satisfactory. Several other members also dealt with the subject, and Mr. Churchward then explained that his object was to make sure that the Council should not commit themselves to any expenditure the extent of which they would not know. The plain meaning of his amendment was that Mr. Aldridge should make a definite cost of his charges before any instructions were given to him to carry out the work. Mr. Churchward's amendment was then put and carried, but Mr. James said he should move that in place of the amendment that had been carried the clause in question should be added to as follows: "that Mr. Aldridge be asked to give an estimate of lighting the whole district, subject to the charge being satisfactory to the Council." In seconding this amendment, Mr. Brain said the very resolution about which they had been debating was moved as an amendment to a resolution in the Electric Lighting Committee by Mr. Sewell and seconded by himself. The difference between the two amendments differed in principle. If they accepted Mr. Churchward's amendment, Clause 13 would disappear from the sheet altogether. Several members having enquired the contents of the letter received from the Board of Trade, the Clerk read it as follows: "Sir,—In reply to your letter of the 4th inst., requesting that the time prescribed by Section 17 of the above-mentioned order, within which certain works should be completed, may be extended for a period of two years from June next, I am directed by the Board of Trade to point out that they do not appear to have any power to extend the time referred to. I am to add that, while the Board are not disposed to bind themselves to postpone revoking the order for so long a period as two years from June next, they will, in the circumstances referred to by you, defer consideration of the question for a period of one year from that time.—THOS. R. MANN." The subject was then further debated, but finally Mr. James's amendment was put to the Council and declared lost, and Mr. Churchward's motion was therefore declared carried. As an additional clause to the report, Mr. Churchward moved that Mr. Aldridge be first asked to make his charges before the Council proceed. This was seconded by Mr. Lawson, and carried.

Edinburgh.—A meeting of the Edinburgh Town Council was held on Wednesday last, when the electric light reserve fund was discussed. Mr. George Auldjo Jamieson moved the disapproval of the draft minutes of the meeting of March 9, which recommended the setting aside of £4,050 as an instalment to the electric light reserve fund. In the report now submitted he thought the convener of the Electric Light Committee had hardly kept faith with the terms of the report of the joint committee formerly approved of, which distinctly said that a statutory reserve fund should be gradually formed out of revenue as soon as convenient. They had laid out at the end of 1896 about £165,000, and by the terms of the Act of Parliament the reserve fund could not therefore exceed £16,500. He asked any gentleman to say whether it was a fair interpretation of the word "gradual" to make 25 per cent. of the total reserve fund the first contribution out of the second year's working? He asked what was the purpose of laying aside this money in this manner? Was it not to provide for contingencies? Was "renewal" a "contingency"? They had been told that within the next 15 years they might have to meet an expenditure for renewals of £40,000, and that it was necessary to have money for that as they could not reborrow. Mr. Auldjo Jamieson went on to argue upon this that it was evident that their reserve fund of £16,000, which was all they could raise on £165,000 of outlay, would not be sufficient, and that the Corporation had the power to borrow. They could only lay aside one-tenth of their total outlay as a reserve fund; and they were further tied down so that they should not have a surplus of more than 5 per cent. on the outlay. Suppose they had a surplus shown of £11,000, were they to strike off this £4,000 and call the surplus £7,000 and say they were within the statutory 5 per cent.? It would be a fraud on the consumers, who were entitled to a reduction of the rate so soon as 5 per cent. was earned on the capital. He further argued that they should pay off their debt, and thereby save the interest on the capital, and when the time came for renewals to borrow afresh. Mr. Mitchell, in seconding, said the ground of his dissent was this, that he thought in the circumstances of the remit and the decision given, that their successors would be deceived about their opinion as to the legality of putting the renewals on this statutory reserve fund. Mr. Mackenzie, in moving the approval of the report, said about 3½ years ago the Council decided to keep the electric light undertaking in its own hand. It wanted a few weeks of two years since the station was opened, but the demand had been so great that the total expenditure sanctioned up till now was close upon £250,000. At the beginning of the financial year 1895 96, when the station began running, the undertaking was owing the rates £5 900. This money was used in paying interest and contribution to sinking fund up till the opening. When the accounts were made up after 13 months' working, up to May 15 last, it was found there was a balance of income over expenditure of £3,900 This sum the committee intended to formally hand over to the treasurer's department in part payment of the debt of £5,900, leaving £2,000 still against them. The balance of income over expenditure for the current year was estimated five weeks ago by Prof. Kennedy at £6,850 They had good reason for believing this estimate was likely to be exceeded, and that in all probability the balance would be £7,000. Out of this balance they propose to set aside £4,050 to reserve fund, in terms of the Act of Parliament, leaving £2,850 to be disposed of, and in due time, when the accounts were made up, they should propose to pay back to the treasurer's department the £2 000 still owing. which, along with the £3 900 from last year, would put them in the position of not having cost the ratepayers one penny. That would still leave £850 or £1 000 to be disposed of as the Council might think fit. He was not personally against a reasonable contribution to the rates, as circumstances might admit. but their first duty was to the undertaking; they must not allow present success to blind them to what was sure to happen in the near future. At present their machinery and mains were new, and everything was going smoothly, with very little expenditure on maintenance, but they knew that maintenance must become heavier and heavier every year, because of the inevitable tear and wear of plant and mains, and that in all probability the expenditure might be equal, if it did not exceed in some years, their income. In these circumstances he asked the Council if it was not wise and reasonable that they should make this reserve fund as large as possible in the early years of the undertaking out of surplus revenue. The Electric Lighting Committee thought that, in terms of the order, £4,050 was a reasonable sum to set aside this year to form the fund, and he did not think any business man, looking at the interest of the undertaking, with a debt of nearly a quarter of a million on it—a debt which was bound to increase—would think their proposals unreasonable. He wished the Council to remember that they had already tapped the best-paying districts of the city; that extensions in the future would not pay them as well as in the past; that they were face to face with a large expenditure which would not be directly remunerative; they must, before the end of the century, erect another station in the east end of the city, and they must at once secure land and erect buildings for stores. He would not be surprised if these works and the necessary extensions of mains would mean, with what was already expended, a capital expenditure altogether of £400,000 within the next five years, which would allow of the reserve fund being made up to £40,000. When that point was reached, those in charge of the undertaking would be able to judge what further provision should be made. Mr. Menzies seconded the adoption of the report, which was carried by 38 votes to 8. The Cleaning and Lighting Committee recommended the lighting of 10 additional streets with the electric light during the present year. Mr. John Jamieson moved the recommittal of the report, on the ground that it did not embrace all the motions on the subject that had been remitted to the committee. Bailie Robertson seconded. Mr. Cranston, in moving approval of the committee's report, said they had gone over all the streets in the city, and they had selected the particular streets mentioned in the report because they were either badly lighted or were in congested districts. Mr. Mackenzie seconded the motion. Mr. Auldjo Jamieson complained that a large part of the north-west district of the city, which was very badly lighted, and in which there was a deal of

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traffic, had been ignored in the proposals of the committee. After some further discussion, the approval of the committee's report was carried by 23 votes to 8.

PROVISIONAL PATENTS, 1897.

MARCH 15.

6720. A new or improved electrical apparatus for perforating designs. Pierre Emile Glorget, 128, Colmore-row, Birmingham. (Complete specification.)

6743. The Mayes electric accumulator plate. Alfred Herbert Mayes, 51, Upper Westbourne-vilas, Hove, Sussex. (Complete specification.)

6751. Improvements in electric bells. Bernhard Dakes, 226, High Holborn, London. (J. G. Mehne, Germany.)

6773. Improvements in connections of telephonic and telegraphic instruments to conducting lines. Louis Maiche, 28, Southampton-buildings, Chancery-lane, London.

6774. Method and appliances for brazing or soldering by electricity. Walter Claude Johnson, 28, Southampton-buildings, Chancery-lane, London.

6778. Improvements in electric current conducting apparatus for electric railways with underground feed. Carl Friedrich Philipp Stendebach and Oskar Hermann Linker, 18, Buckingham-street, Strand, London. (Complete specification.)

6782. Improvements in insulated electric conductors. Henry Edmunds, 47, Lincoln's-inn-fields, London.

MARCH 16.

6818. An improved storage battery. Joshua Entwistle, of the firm of E. K. Dutton and Co., 5, John Dalton-street, Manchester. (Cornelius Thomas Barret, United States.) (Complete specification.)

6820. Improvements in and relating to arc lamps. Douglas Neale, 21, Rutland-square, Edinburgh.

6825. Improvements in connection with the supply of current to and governing arc lamps. Frank Michael Lewis, 30, Park-row, Leeds.

6868. Improvements in electric arc lamps. Thomas Edgar Adams, 18, Buckingham-street, Strand, London. (Complete specification.)

MARCH 17.

6929. An improved diaphragm for separating the gases in electrolysis of sodium chloride and other salts and other improvements. Frank Taylor, Alexander Cooke, and Boughey William Dolling Montgomery, 20, Calender-street, Belfast.

7005. An improved system of current supply for electric railways. Arthur Petzenbürger, 6, Lord-street, Liverpool. (Complete specification.)

7012. Improvements in supplying electrical energy to electrically-propelled aerial machines and balloons. Rudolf Diesel, 28, Southampton-buildings, Chancery-lane, London. (Complete specification.)

7020. Improvements in or relating to the conversion of electric currents. Frederick Charles Parkhurst, 53, Chancery-lane, London.

7024. Improvements in electric welding. George William de Tunzelmann and Cecil William Baker, 27, Martin's-lane, London.

7027. Improvements in and relating to secondary batteries or accumulators and the manufacture thereof. Augustus John Marquand, 1, Queen Victoria street, London.

7030. Improvements in electrical signalling apparatus. George Keith Buller Elphinstone, 101, St. Martin's-lane, London.

MARCH 18.

7034. An improved electrical terminal. George Henry Congdon, "Homecot," Hitherfield-road, Streatham, London.

7096. Improved method of regulating the speed of series electric motors. Horace Field Parshall, 70, Chancery-lane, London. (Complete specification.)

7113. Improvements in primary batteries. Frederick Hanson Perry, 6, Lord-street, Liverpool.

MARCH 19.

7189. Improved current supply for electrical railways. Michael Ott, jun., and Albert Silbermann, 111, Hatton-garden, London. (Complete specification.)

7212. An improved rheostatic apparatus particularly applicable to the starting of electromoters. George Edwin Dixon, 45, Southampton-buildings, Chancery-lane, London.

7235. Improvements in switching apparatus more especially adapted for use with electric motors. Henry Edmunds, 47, Lincoln's-inn-fields, London.

MARCH 20.

7272. Improvements in junction-boxes for electric cables. John Edwin Stewart, Imperial-chambers, Albert-street, Derby.

7309. Improvements in fittings for electric lighting. Henry Clark Brown, 322, High Holborn, London.

7305. Improvements in brushes for the commutators of electric dynamos and motors. Edward Lionel Joseph, 65, Chancery-lane, London. (Complete specification.)

7314. Improvements in or relating to accumulator plates or electrodes for secondary batteries. Frederick Edward Everard, 31, Southampton-buildings, Chancery-lane, London.

7315. An electric circuit-hour meter or automatic cut-out. Charles Orme Bastian and Francis Malger Staunton, 31, Southampton-buildings, Chancery-lane, London.

SPECIFICATIONS PUBLISHED.

1896.

5874. Carbon pencils for the electric arc light. Hepworth.

9349. Electrical measuring instruments. Rowland. (Date applied for under International Convention, October 2, 1895.)

10095 Electric batteries. Schmidt.

13690. Electrolytic apparatus. Le Royer, Bonna, and Van Berchem.

15860. Speed-regulating devices chiefly intended for use with dynamo-electric machines. Consett.

20086. Armature for dynamo-electric machines. Offermann.

22704 Apparatus for controlling electric motors. Lake. (Sperry.)

23868. Electric insulating compound. Honig.

25948. Electric accumulators and the manner of their use. Clerc and Pingault. (Date applied for under International Convention, August 8, 1896.)

26053. Electric controllers. Morgan.

29615. Electric contact bars for electric cars. Haddan. (Piguet.)

1897.

129. Dynamo-electric machines. Siemens Bros. and Co., Limited, and Lauckert.

272. Secondary battery supports or grids. Rooney.

606. Couplings for incandescence electric lamps. Mavor, Coulson, and Mavor.

2106. Closed-conduit electric railways. The British Thomson-Houston Company, Limited. (Rice.)

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	9½-9⅝
Brush Company, Ordinary	2	¾-1
—— Non. Cum., 6 per cent. Pref.	2	1½-1⅝
—— 4½ per cent. Debenture Stock	100	104-108
—— 4½ per cent. 2nd Debenture Stock	100	95-99
Callender's Cable Company, Debentures	100	105-110
Central London Railway, Ordinary	10	9½-10
——	6	5½-6
Charing Cross and Strand	5	10½-11¼
Chelsea Electricity Company	5	9-9½
—— 4½ per cent. Debentures	100	112-115
City of London, Ordinary	10	19½-20½
—— 6 per cent. Cumulative Pref.	10	16½-17½
—— 5 per cent. Debenture Stock	100	132-136
City and South London Railway, Consolidated Ordinary	100	59-61
—— 4 per cent. Debenture Stock	100	139-141
—— 5 per cent. Pref. Shares	10	15½-16
County of London and Brush Provincial Co., Ordinary	10	11½-12
—— 6 per cent. Cum. Pref.	10	14½-15
—— 4½ per cent. 2nd Debenture Stock	10	14¼-14¾
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	1¾-2¼
—— 5 per cent. Debentures	—	96-98
Edison and Swan United Ordinary	2	1¾-2¼
—— 5 per cent. Debentures	5	3-4
—— 4½ per cent. Debentures	100	105-110
Electric Construction, Limited	2	1½-1⅝
—— 7 per cent. Cumulative Pref.	2	2¾-3⅛
Elmore's Copper Depositing	1	¾-1⅛
Elmore's Wire Company	2	⅞-1
W. T. Henley's Telegraph Works, Ordinary	10	19½-20½
—— 7 per cent. Preference	10	18½-19½
—— 4½ per cent. Debentures	100	107-112
House-to-House Company, Ordinary	5	7-7½
—— 7 per cent. Preference	5	9-9½
India Rubber and Gutta Percha Works	10	20½-21½
—— 4½ per cent. Debentures	100	106-109
Kensington and Knightsbridge Ordinary	5	11-11½
—— 6 per cent. Pref.	5	8-8½
London Electric Supply	5	1½-1⅝
Metropolitan Electric Supply	10	15½-16½
—— 4½ per cent. First Mortgage Debenture Stock	100	120-124
National Telephone, Ordinary	5	6¾-7⅛
—— 6 per cent. Cum. First Pref.	10	16-18
—— 6 per cent. Cum. Second Pref.	10	16-18
—— 5 per cent. Non. Cum. Third Pref.	5	6-6½
—— 3½ per cent. Deb. Stock	100	102-105
Notting Hill Company	10	12-13
Oriental, Limited, £1 shares	1	1½-2
—— £5 Shares	5	8½-9
—— £4½ shares	4½	7½-8
Oriental Telephone and Electric Company	1	¾-1
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	103-105
St. James's and Pall Mall, Ordinary	5	14-15
—— 7 per cent. Pref.	5	9-10
Telegraph Construction and Maintenance	12	38-39
—— 5 per cent. Bonds	100	103-106
Waterloo and City Railway, Ordinary	8	10¾-11½
Westminster Electric Supply, Ordinary	5	13-14
Yorkshire House-to-House	5	8½-8

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NOTES.

Sir Henry Mance.—The president of the Institution of Electrical Engineers was present at the levée held on Tuesday afternoon at St. James's Palace by H.R.H. the Duke of York, K.G., on behalf of her Majesty.

Surface Coal.—The open colliery is a thing forgotten, but the *Yorkshire Post* says that, while digging the other day in Briggate, Leeds, at a depth of about 5ft., in connection with the underground wires for the electric tramways, the workmen came across a thin seam of soft coal.

The Camera Club.—Mr. A. Campbell Swinton is to give a paper at the Camera Club on the evening of April 12 on "Recent Investigations relating to the Röntgen Radiations." The paper will be illustrated by original experiments, and a new form of Crookes tube for practical Röntgen ray work designed by Mr. Swinton will be shown. With this tube the penetrative quality of the rays can be varied at will.

A Telephone Building.—The new Dey-street telephone building in New York is described in the Transatlantic Press. The original building had only six storeys; the new one has 12 (or 13, according to the way you count). It is of "steel-cage construction," with a terra-cotta front. "The style of architecture is classic in detail, resulting in a general simplicity and distinction of tone which are in the best of good taste and admirably suited to the character of the building." Elsewhere we are informed that the building has attracted much attention by the "elegance of its architecture." There is an old proverb about tastes and their difference.

Measuring Frequency.—Mr. G. S. Moler, writing from Cornell University to the *Physical Review*, describes a method of measuring the frequency of an alternating current. The apparatus consists essentially of a synchronous motor with a speed counter. There is an arrangement by which a clock starts the counter and stops the motor after it has been running for a minute. It then obviously remains only to read the result, the gearing being such as to make the reading be the cycles per second. The result is said to be accurate to one-five-hundredth of an alternation. The minimum current required is 1½ amperes at 10 volts. The length of the apparatus is about 14in., and it weighs about 8½lb.

Phosphor-Bronze Wire.—Writing in *L'Electricien* some time ago, Mr. Pierard remarked that it was a well-known fact among constructors that for overhead lines of phosphor-bronze wire long spans were better than short ones; and it was therefore wrong to limit the span to 60 or 100 yards, like iron wire. To adopt spans of 200 yards would require increasing the height of the poles only about 6ft., which increases the price of the poles about 40 per cent., but there would be an economy of 30 per cent. on the poles. The saving in insulators, supports, transportation of materials, and erection at first sight appears to be 50 per cent., but is really less. The wire considered is bronze wire of 30 per cent. conductivity and a breaking strain of 80 kilogrammes per square millimetre, such as is suitable for telephone lines.

A New Tesla Apparatus.—In the forms of high-frequency apparatus heretofore devised by Mr. Tesla, and in high-potential generators generally, a cessation of flow has, says the New York *Electrical Engineer*, naturally been caused during the interruption of the circuit necessary to obtain the "break." In order to produce a continuous high-frequency discharge Mr. Tesla has recently designed an apparatus, which, briefly stated, "consists of the combination of two condensers with a circuit controller so operated by a motive device as to charge and discharge the condensers alternately, whereby one will be discharging while the other is being charged, and conversely." The effect of such an arrangement would appear to be simply to double the number of discharges per second, and to complicate a necessarily somewhat delicate arrangement of apparatus.

The Physical Society.—The apparatus shown at last week's meeting at the Finsbury Technical College were decidedly interesting. Dr. Silvanus Thompson's way of making the familiar row of bullets on strings transmit transverse instead of longitudinal vibrations is a good instance. It is a help to most people to have some mechanical analogy, if only to prevent their mathematics running away with them. Mr. Appleyard's experiments on liquid "coherers" open out the possibility of explaining quite a quantity of ill-understood things. Next Friday's meeting at Burlington House is entirely electrical. The papers are on "A Nickel Strap Telephone," by Mr. T. A. Garrett and Mr. W. Lucas; "On Alternating Currents in Concentric Conductors," by Mr. W. A. Price; and "On the Effect of Capacity on Stationary Electrical Waves in Wires," by Mr. W. B. Morton.

American Research.—The University of Wisconsin has issued a circular signed by Prof. Jackson, in which it is stated that the university has endeavoured to guide the experimental work in the department of electrical engineering in such a way that it should be of service to the electric light and power stations of the state. It is believed that the idea may be further developed with advantage to the electrical interests, without injury to the efficiency of the instruction given to the students, and suggestions are invited as to what direction investigation should take. It is further added that there is now in preparation a series of tests on meters to determine their accuracy, sensitiveness, and continued reliability, which will cover a large number of meters of the different makes, and ageing tests are also being made on transformers. Information would be gladly received upon either of those subjects.

Electric Tramways in Europe.—In *L'Industrie Electrique* are published annually some useful statistics as to the electric lines in work or in construction in Europe. Both in number and length of line and quantity of cars, Germany easily heads the list; France comes next (a long way off), and England and Italy nearly tie for a bad third place. It is noted that there has been a greater increase in the power of the stations and the number of cars than in the number of lines, and the inference is drawn that the line of development is that of large networks in great towns. Of course, the overhead trolley still reigns supreme. In fact, the number of conduit systems, in which is included the Claret-Vuilleumier closed conduit, is only eight, but last year it was five. Central-rail and accumulator systems remain stationary. Overhead lines have increased from 91 to 122. Judging by the list of lines in course of construction, there is no probability of France or England much improving their relative position in the list when the statistics are next published.

Cable Interruptions.—The official list of cable interruptions for last month published in the *Journal Télégraphique* shows that communications were not re-established up to March 24 on the African Transcontinental line beyond Mazoe, a failure which dates back to March 11, 1896; on the Cartagena and Barranquilla lines in Colombia, which failed on July 4; the Santa Cruz and Trinidad cable (November 29), the defective Catherina and Larissa line (November 5), the Amazon cable (November 7), the Jamaica and Aspinwall cable (February 5), the Asaab and

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Massowah cable (February 20), and, lastly, the Tenedos and Dardanelles and the Malta and Alexandria cables, which broke down on the 24th. The Hong Kong and Macao cable was mended on March 18, having been out of action from January 5. On March 8 the Grenada and Trinidad cable was mended after rather more than a month's intermission, and the Pernambuco and Ceara cable repaired on March 5 had been out of action nearly as long. There was a week's failure on the Baghdad and Fao line; and the other suspensions listed are quite short ones, mostly in Siberia and Siam.

Simultaneous Jubilation.—The *Daily Telegraph* has been making a great deal of a suggestion that at the Jubilee celebration "Her Majesty, seated in her carriage, could press a button fitted to an apparatus close to the Royal vehicle, and thus set in motion a current connecting that portion of the route to be traversed direct with the office of one of the submarine telegraph companies, whence the signal would be flashed to every British possession." Some of them are not in telegraphic communication with the rest of the world, but that is doubtless a detail. Although "this notion of so arranging matters that the subjects of the Queen in the Mother Country and in Australia shall, regardless of the thousands of miles of water which roll between them, join at one and the same moment in choral thanksgiving," seems to an unnamed Colonial representative "to be a most happy inspiration." Synchronous working of this kind is not without its drawbacks in the case of an Empire on which the sun never sets, and the time goes all round the clock. It may be safely presumed that the Colonial representative, unless he is a very early riser, did not come from the Pacific slope of the Dominion of Canada.

Three-Phase Transmission.—Mr. F. C. Armstrong, in the *Canadian Engineer*, gives a description of the three-phase transmission plant in the Montreal Cotton Company's Mills, Valleyfield, in the province of Quebec. The water power is obtained from a dam erected by the Dominion Government to increase the depth of water in Lake St. Francis, and which connects Grande Isle de Beauharnois with the south shore of the St. Lawrence River. For the electrical plant, as has been stated, the three-phase system of the Canadian General Electric Company has been adopted, and a 400-kilowatt generator has been installed and in satisfactory operation for about two months. A second machine will be in operation shortly. These generators have 36 poles within a steel yoke about the periphery of the revolving iron-clad armature. A point to be noted is the armature speed of 200 revolutions per minute, which admits of direct coupling. The generator voltage, on account of the short distance over which the power is to be transmitted, has been fixed at 550 volts, thus admitting of the current being used directly at the motors without the use of step-down transformers. The motors are of the Canadian Company's induction type, varying in size from 50 h.p. to 100 h.p., and are, where a saving in the floor-space is desirable, inverted and bolted to the ceiling. They are self-starting under full load, and "as they are without collector rings or brushes, are especially suited for operation under the conditions favourable to combustion which exist in a cotton mill."

Dynamos in Multiple.—In a paper read before the Franklin Institute, at Philadelphia, on the subject of equalising connections for compound-wound dynamos coupled in parallel, Mr. E. R. Keller begins by remarking that the successful operation of stations for electric lighting and power depends largely on the automatic regulation, not only of the speed of the prime movers, but also of the E.M.F. of the generators. "In both of these essential features the last few years have brought forth marked development, in consequence of which we are now enabled to install plants for electric lighting and power, in which the speed of the engines will not vary more than 1½ per cent. from the normal, when the full load is suddenly thrown on or off, while the builders of dynamo machinery can and do supply us with generators which are almost absolutely self-regulating as to E.M.F. A modern constant-potential generator will not only compensate automatically for the variable losses due to armature reaction and internal resistance, but it can be made to give an E.M.F. at the brushes which, under varying conditions of load, will be such as to compensate not only for the variable losses in the machine itself, but also those due to the resistance of the external circuit. The success which has thus been attained in the automatic regulation of constant-potential generators is largely due to the careful study and application of compound winding; and while but a few years since nearly all of the large stations were equipped with plain shunt-wound generators, we find that these have now been superseded by the compound-wound type, in almost every class of service."

Motor-Driven Printing Presses.—Yet another example of the way in which electric transmission of power is being adopted in place of shafts and belts, is seen in the reports of the chief engineer and chief electrician of the Government printing office at Washington. These show that the entire office is now lighted by electricity, and all the machinery, except about 20 printing presses, are being operated electrically. The application of electric motors to the machinery, owing to its great variety, presented many problems as well as complicated conditions, which were successfully met and solved. There are now being electrically operated printing presses of all sizes and sorts, from large web presses, printing at the rate of 11,000 per hour, down to an eighth medium Gordon press; also cutting, indexing, stabbing, folding, and case-making machines, signature presses, blowers, ruling and sewing machines. The latter are operated by a ⅛-h.p. motor connected direct to worm-gear reducing motion. A reduction in some cases is required of from 1,800 revolutions per minute down to 35. There are now in daily use 117 direct-connected and 10 belted motors, varying in size from ⅛ h.p. to 30 h.p. During the year there have been no shut-downs or delays in work during the installation of the various motors. All the power necessary for the entire work of the office at night, including the running of the large web presses on which the *Record* is printed, did not amount to within 15 to 20 per cent. of the friction load of the press-room engine and shafting. The chief electrician strongly recommends that the power plant be supplemented by the addition of a large direct-connected unit of, at least, 300 kilowatt capacity, or the installation of a storage battery sufficient in size to supply the office with light during the hours the electric plant is not running.

Rontgen Rays and the Retina.—If you irritate the end of the optic nerve by Röntgen radiation effects or anyhow else, a sensation of light is produced. Dr. F. S. Kolle, after experimenting in America on the action of Röntgen rays on vision, has reported that of seven persons more or less blind (amaurosis) subjected to the Röntgen rays, six were made to "see stars." Four of the patients could count the individual stars, ranging between six and 32 in number. These four were not totally blind—that is, they could locate a 16-c.p. electric light, with one or both eyes, at variable distances of from 3ft. to 8ft. The patient counting 32 of these spark-like sensations, using both eyes could distinguish and locate a lighted lamp at a distance of 5ft. The patient who did not respond to the rays had been injured early in life, and both globes had been removed.

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It is needless to say that none of the patients was enabled to see with the aid of the rays. After cutting off the rays by the interposition of a steel plate an eighth of an inch thick, no sensation was experienced. A sheet of aluminium one-twentieth of an inch thick was used to eliminate the possibility of light or heat. It is inferred that the sensation depends, as regards its magnitude, upon the better or less atrophied condition of the retina. That the lenses of the eye are not opaque to the radiations, as had at one time been asserted, is shown by similar phenomena appearing in the normal eye after a long exposure. They are usually attended by headache and deep-seated pain in the globes of the eyes, and, one would think, are probably not to be undertaken without danger or mischief to the sight—at any rate, in the case of a retina at all predisposed to go wrong.

An Electric Cab.—From America comes the description of an electric cab which "is shortly to be in use." It is called a "hansom," but has also affinities to the four-wheel dogcart. The thing may be a good enough vehicle, but it ought not to be called a hansom, which is essentially a two-wheel affair, which would be top-heavy without the horse. The present cab is the invention of Messrs. Morris and Salom, who were responsible for the "electrobat." To a hansom cab body a battery-box is attached, forming an extension in the rear. Upon this is situated the seat for the driver. The weight of the carriage is about 2,500lb., the weight of the batteries alone being from 800lb. to 900lb. The diameter of the large wheels is 43in., while the diameter of the small wheels is 32in. The wheels run on ball bearings and have tangent wire spokes, steel rims, and thick pneumatic tyres. Each of the front wheels is connected with a motor of the Lundell type, of 1½ n.h.p. Each motor is enclosed in an iron case and drives its wheel independently. The pinion from the armature shaft meshes with the internal gears of the wheels. The storage batteries which are used are supplied by the Electric Storage Battery Company, of Philadelphia, and are chloride accumulators of 70 ampere-hours capacity. It is arranged so that automatic connection is made when the cells are placed in position by means of contact plates. Fuses are provided as a safeguard. The controller is situated at the left side of the driver's seat, so as to be manipulated with the left hand. There are three speeds forward and one speed backward. The first notch of the controller gives a speed of five miles per hour; the second notch, eight to ten miles; the third, 13 to 15 miles. Fifteen miles may be regarded as about the maximum speed which is desired or can be obtained. These speeds are obtained by various groupings of the cells and motors in series and parallel. Directly in front of the driver is a lever which controls the steering mechanism. The steering is accomplished by turning the rear wheels parallel with each other from a point directly over the tread of the wheel. The wheels are connected by rods to a vertical lever of a convenient height to be operated from the front seat of the carriage. In reality the steering mechanism looks like an enormous hollow hub which turns freely, horizontally, upon the vertical rod which supports the body of the carriage. There is the usual company and syndicate to bring the thing out.

Man as a Conductor.—Lecturing last week on electro-therapeutics, under the auspices of the Swansea Scientific Society, Dr. Knight gave some particulars as to the resistance of the human body which, if not very new, may yet be of interest. The resistance varied widely. If two small metal electrodes were placed on the dry skin the resistance would be nearly 100,000 ohms. If, however, they used larger electrodes, covered them with leather, and placed them on the skin, after having well soaked them in warm salt water, the resistance would not be more than 3,000 ohms, and would get less within a short time under the influence of the current itself. It was principally the skin which offered the great resistance, whereas the blood and some of the inner tissues conducted comparatively well Still, they had at any rate 100, and in most cases 1,000 to 5,000, ohms resistance to deal with, and therefore a large number of cells was indispensable in order to obtain currents varying between 1 and 100, or even more, milliamperes. From experiments made in America in connection with the execution of criminals it was found that the average resistance of the human body was 2,500 ohms, and 3,000 (alternating) volts applied between the head and spine caused instantaneous death. As to the effect of a continuous current, when metallic electrodes of moderate diameter were applied on the skin, slightly moistened, small pale vesicles appeared at the negative pole. These vesicles contained fluid and layers of epidermis. With a stronger current blisters were formed and a red areola appeared. The serum of the blisters was alkaline. At the positive pole, when a strong current was used for some time a blister appeared, the serous fluid of which was acid. (The maximum effect would naturally be in the skin, where the resistance is greatest, and the current density also). When the "faradaic" current (the peaked alternating current from a magneto) was applied the dominant phenomenon was a series of muscular contractions, following on one another so rapidly that the muscle had no time to become relaxed, and was thrown into a condition of continuous contraction. By means of these currents they were enabled to judge of the severity of a case of paralysis and the prospects of recovery. If the muscles responded to "faradism," the case was mild and recoverable. If the muscles, failing to respond to "faradism," were yet excited by "galvanism"—*i.e.*, strong continuous current—the case was one of only moderate severity, and the prospects of recovery, under suitable electrical treatment, were favourable. If the muscles failed to react to "faradism" and "galvanism" alike, then the case was a very serious one, and the prospects of recovery doubtful.

Stimulated Seed Growth.—The Hatch experiment station of the Massachusetts Agricultural College has issued a bulletin on "Electro-Germination," which describes an extended series of experiments carried out by Mr. Asa S. Kinney. The experiments have followed in many instances those of Mr. Speknef in Russia, and the objects have been mainly to determine whether the seed germ responded in any way when subjected to electrical influence, and, if so, the effect of different strengths of current. The batteries used were four Leclanché cells in series giving an E.M.F. of from four to five volts, and two Samson cells giving an E.M.F. of 2¾ volts. In order that a large variation in tension might be obtained, an induction coil was employed. This was a Du Bois-Reymond inductorium, in which the secondary coil (it is a favourite instrument with investigators in animal electricity) is quite separate from the primary coil and slides in a groove in the wooden stand. In this way the secondary coil may be brought over the primary coil or removed quite a distance from it. In some of the experiments hourly treatment was desired, and was brought about by passing the wires from the battery to an electric clock and thence to the induction coil. Each hour the clock formed a connection completing the circuit, and a current was passed through for a period of about 30 seconds. As for the results, it would appear to have been shown that the electric current exerts an appreciable influence upon the germination of seeds, and that the application of certain strengths of current to seeds for short periods of time

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accelerates the processes of germination. The range in the strength of current which accelerates germination is, however, exceedingly limited, and the effect of electricity upon the germination of seeds shows that there is a certain current strength which is the best. The minimum strength of current which just perceptibly accelerates germination when an interrupted induced current is used appears to have been obtained with an E.M.F. of less than one volt. (It appears perfectly hopeless to expect quantitative measurements from the biological man or to get him to understand that he conveys no particular information when he talks of a "current of one-tenth of a volt.") The maximum current which the seed germ can withstand wi hout being destroyed has not been ascertained in these experiments, but "probably represents a comparatively high voltage." Seeds subjected to but one application of electricity show the effect only for a few hours, and when applied hourly to germinating seeds or growing plants, the stimulation does not lose its effect, but acts as a constant promoter of growth and development. No theory is presented as to the cause of the action of the current.

The Institution.—At last week's meeting everyone was taken by surprise by the announcement that Mr. Webb was going to retire from the office of secretary. That event, however, it is understood, will not take place until after next Christmas. Then after further information as to the increase of premiums for papers read, we got to the discussion on Mr. Benest's cable breaks. The discussion was long, but the attendance was very small. It is constantly urged that the Institution ought to devote more attention to the telegraphic side of electrical engineering, but whenever there is a purely telegraphic paper there is also a small attendance. Mr. Bright began the discussion, and finally, in a guarded manner, adopted the theory of a submarine earthquake or landslip. There were digressions on indiarubber insulation, and, by Mr. Preece, on the impropriety of talking of "knots per hour." "A knot is a speed," said Mr. Preece. In these days of patent logs it is, however, not very wonderful that it should have been forgotten what heaving the log was like in the days of the sandglass, and actual knots counted as they passed the fingers while the line ran out. So far, of course, Mr. Preece is correct, but it may be doubted whether people at sea talk much about "nauts." Many people related experiences of submarine outflows which show that such things may be. The difficulty is to suppose a violent outbreak at great depth and the cable just over it. Some kind of slip seems simpler. The two suppositions do not oppose but assist each other, since a varying underground water circulation is just the thing to produce slips. Prof. Milne could not come (serious illness), but though his communication was not read it appeared that he had an earthquake that would fit Mr. Benest's 1895 break so far as the day was concerned, and he consequently asked for the precise hour of the failure. As has been mentioned in these notes before, Prof. Milne spots earthquakes to the minute. Mr. Preece seemed to think that the Pacific cable if laid would be liable to interruption by volcanic action. Mr. R. Gray, on the other hand, believed there was nothing in Mr. Preece's fears, as really deep-sea cables proved safe. Throughout there seemed to be some confusion between "deep water" and the very deep ocean bottoms, and except Mr. Gray no one in any way referred to the very different conditions as to danger from slips of any kind of a cable laid more or less parallel to a slope and one going straight down the slope to the deepest water. It is quite clear that the danger of the first or coast-following line is very much the greater, even though it may be at a relatively considerable depth. The president suppressed his speech to allow Mr. Benest to reply, but even then that gentleman did not get through in time. Next week we are to have Mr. Baylor on recent developments in electric traction appliances.

Surfacing Tram Wheels.—A proof has been sent us of a paper read by Mr. R. Atkinson before the Canadian Society of Civil Engineers on the method of dressing railway and tramcar wheels and axles by the Sibbald machine. In this machine a ring about 33in. diameter of mild steel (about ·65 per cent. carbon) is fixed like the tyre of a locomotive driving wheel on a suitable centre, which is mounted on a heavy shaft, and has its periphery turned to produce the proper profile on the wheel to be operated upon, and very carefully balanced. The disc thus formed is driven at a speed of about 3,000 revolutions per minute. The wheel is set in a suitable carrier and is revolved slowly, about two or three revolutions per minute, so that the surface when brought against the operating disc will move in an opposite direction. The wheel and disc are then pressed together with a force sufficient to cause friction enough to consume a great part of the power which is driving the disc, and thus convert the power into heat. The disc cuts or rubs off the metal of the wheel operated upon, and leaves a smooth finished surface, which by the pressure and heat is closed and hardened to a considerable degree and to a depth of $\frac{1}{100}$in. or more, depending on the grade of the steel worked upon. The principal constructive feature in the machine is the manner in which the friction on the journals of the disc, which would result from the combined great pressure and high speed, is overcome by a system of forced lubrication. In the latest form of this machine as operated at the works of Messrs. Easton, Anderson, and Goolden at Erith, it has been found that by sending an electrical current through the point of contact of the fusing disc and wheel, so as to heat the wheel at that point, a very great reduction in the power could be made, or much more material removed by the same power in a given time. The result is due to the heating effect of the current on the wheel, and it is further suggested that a saving can be made by applying a large percentage of the power electrically, sufficient power only being applied to the disc to remove the metal heated by the electrical current. The effect of the current upon the rotating disc is not destructive owing to the distribution over its whole peripheral surface. "The current applied in very small quantities appears to greatly increase the coefficient of friction, and thus less pressure between surfaces is required to consume the power and generate its equivalent in heat, consequently a gain is made in reduced frictional resistance throughout the journal bearings of machine, in addition to the heating effect of the current." When an ordinary steel tyred wheel is turned in a lathe the effect of the tool is to break or open up the surface to a greater or less depth beyond the point of the cutting tool, the depth so disintegrated being very variable, and depending upon the hardness of the tyre, shape, and condition of cutting tool, and so on. "The obvious result is that the surface of a turned tyre is not solid material, but is more or less spongy, and must be hammered or rolled down to a smooth face when put into service by the effect of the load carried, consequently the actual useful diameter of a turned tyre is appreciably less than the apparent diameter. On the other hand, the surface of a tyre submitted to the process of dressing by fusing or grinding is as perfectly smooth as if it had rolled on the track for months, and its hardness is not approached by anything so nearly as by the process of case hardening, which is so well known as producing the most perfect

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surface to withstand friction." The effect of this is to cause a corresponding increase in the mileage of the wheel before even signs of wear are to be detected.

Lord Rayleigh at Albemarle-street.—In the fourth of his lectures on "Electricity and Electrical Vibrations" at the Royal Institution last Saturday, Lord Rayleigh said he would refrain from discussing the practical construction of transformers, because that had been dealt with by others very fully. He would, however, remark that some of the writers of treatises on the design and working of commercial transformers made it a little difficult to see the wood for the trees, owing to the mass of details of doubtless practical importance with which they overlaid the question. Passing onward from alternations of 100 or so per second to those of 1,000 per second and upwards, he showed the increasing prominence taken by induction as compared with resistance, and demonstrated with a telephone that if a circuit carrying an induced current was made to branch into two parts, one of which passed through one wire of a coil carrying three windings, while the other passed through the other two wires connected in series, the telephone showed that the current in the shorter branch was greater than that in the main before it separated into two parts. The principle was that the current should be such as produced the minimum charge in the magnetic field, and as the frequency increased indefinitely the limit approximated to was a double current in the short branch and a current in the long branch equal to the current in the main, but of an opposite sign. Lord Rayleigh then described the use of a Wheatstone bridge with a telephone instead of a galvanometer as a means of measuring self-induction. The next point was the correlation of the stoppage of electrical vibrations by conductors with the fact that with very rapid alternations the current is almost entirely confined to the surface of the conductor. This led to a characteristic digression on Mr. Heaviside (some of the best parts of these lectures are Lord Rayleigh's digressions). The theory of it was, indeed, contained in Maxwell, but the first person to make it clear was Mr. Heaviside. "Mr. Heaviside," said Lord Rayleigh, "usually talks with great exaggeration, and with much abuse of the Post Office, and of 4π, and of a great many other things which he does not like, but some things he gets very plainly." If they considered that the effect was really in the non-conducting medium, and pictured the current as a closing in of tubes of force along the conductor, it was evident that the outside of the wire was the part that was first reached, and if the alternations were quick enough the middle of the wire might never be reached. Lord Rayleigh then passed to higher-frequency waves. Electric waves of this character were no new thing. They were almost always obtained when a Leyden jar was discharged. The frequency might be 1,000,000 a second, and 10,000,000 might be reached—this was too fast for their purposes. To diminish the frequency it was necessary to use a source of electricity of large capacity and make the discharge pass through a coil of considerable self-induction. This was equivalent to increasing the inertia of a mechanical system. Lastly, Lord Rayleigh showed the Tesla effects obtained with an oil insulation high-tension transformer, fed from discharging Leyden jars supplied from an ordinary coil. All the conductors gave the characteristic purple glow of an air discharge, and a vacuum tube held near, but not in any electrical connection glowed green. Lord Rayleigh rather indicated than described the theory of the matter, but seemed inclined to accept Mr. Tesla's conclusion that the effect depended on the very high frequency of the oscillatory discharge. It is, however, believed that with a similar apparatus the Tesla effect has been obtained when the oscillations fell off very rapidly, so that of the half-dozen or so only the first need be regarded. If this is so, the effect would be a result of very rapid change of potential. In any case the difference is more verbal than real.

Animal Electricity.—It was explained in the previous lecture by Dr. Waller that if four connections were made to a nerve and the first two were taken to the terminals of a battery, the second two, though outside the circuit, gave indications of a current of the same sign when connected to a galvanometer. The explanation suggested is that the physiological activity is altered in the neighbourhood of the terminals. Last Tuesday, at the Royal Institution, Dr. Waller began by showing Bernstein's law of electrotonic decrement, which amounts to this, that when the nerve is excited by an intermittent current the secondary current described above is weakened. Dr. Waller then referred to his new nomenclature of zincative and zincable, and so forth; expressed his inability to give the facts intelligibly without it; and threw out the inference that because the electrical Press had not supplied him with better and preferable terms that the new nomenclature was a good and necessary one. There cannot be the slightest objection to Dr. Waller using any terms he finds convenient for recording the results of his laboratory work, but until these terms are definitely adopted by physiologists it does not seem desirable to spend time in explaining them to electricians. The writer has seen nothing to alter his opinion that the terms are not a happy choice. Moreover, if Dr. Waller's views are correct, the analogy of the state of things in nerve or muscle after current has passed is not a galvanic couple, but rather the condition of a polarised voltameter or even a charged storage cell, so that the "zinc" part of the nomenclature becomes misleading at once. But when the results of the investigations come to be embodied in a definite theory, it will be quite time to decide on the most convenient nomenclature in which to express it. The facts appear to be that at the anode the activity is diminished during the passage of the current, and energy in some way accumulated so as to give increased after-action. At the cathode it is the reverse; activity is increased during the current, and the after-results are smaller. Dr. Waller's idea, if the writer correctly understands it, is that most of the effects are due to the (chemical) action on the nerve of the products of electrolysis (polarisation products). In explaining the phenomena on this ground it should be remembered that contact is made to the sheath of the nerve, which is a relatively bad conductor compared with the actual nerve fibres within it, so that the actual polarisation products which act on the nerve are just opposite to what at first sight it appears they ought to be. So far as the writer knows, all the nerves experimented with contained sensory as well as motor fibres, and were capable of physiological action (non-electric) in both directions. In conclusion, Dr. Waller showed the curious experiment made, it is believed, first in France about a year ago of passing a current through a vessel of water containing tadpoles. The tadpoles arranged themselves so as to meet the electric current just as a fish will in an actual current of water. Dr. Waller also added that he had obtained the same result with (adult) salamanders. In this case there were marks of a skin secretion on the head, and if the animal was reversed so that the current passed from tail to head, instead of the other way, it appeared uneasy. From the figures given by Dr. Waller it would appear that the proper current density to get the best effect should be (very roughly) about ·2 milliampere per square centimetre. The next lecture is the last of the sessional course, and will be a summary of results, and probably some anticipations

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THE MECHANICAL CONSTRUCTION OF ELECTRICAL MACHINERY.

BY F. M. WEYMOUTH.

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THE DYNAMO.

(Continued from page 392.)

RAILS.

We now approach another branch of our subject. Having dealt with various types of bed-plate both for combined and single plant, we propose here to deal with methods for holding down belt-driven machines.

A difference between direct-driven and belt-driven machinery exists in the fact that means for keeping the belt tight, and for doing this in spite of its persistently stretching and increasing its length after having been put into use, require to be adopted. The importance of this point arises largely from the very high speeds required in dynamos, combined with the difficulty that accrues from the great reduction from the comparatively slow speed of the engine to the high number of revolutions of the dynamo armature. Hence, while a belt will ride without trouble on the periphery of an engine flywheel, great care is needed to avoid loss of power through the tendency of the belt to "slip" on the much smaller pulley of the dynamo. For, as is obvious, there is much less surface for the belt to "grip" on with the small pulley.

This latter point, however, may not appear so obvious. For it might be argued that as the total pressure of the belt is the same on both pulleys, therefore the friction, and consequently the grip, on both should be the same. This may be correct according to the laws of friction; but the conclusion assumes that the coefficient of friction is the same with both pulleys. The failure of this argument, however, is to be explained in a somewhat simple manner. A belt being required to stick and not to slide, is sprinkled on its rubbing side with powdered rosin, or belt-grease, or other composition of like nature, to increase in fact its "stickiness." Now any sticky substance so used, to be effective, must adhere to *both* surfaces—that is, in the case before us, to both the belt and the pulley.

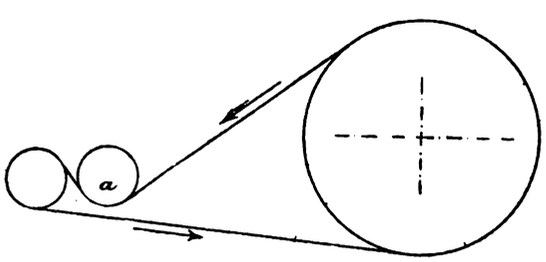

FIG. 129.

On the other hand, if it be required to wipe off any sticky substance from a hard polished surface, common experience teaches that to do so it is necessary to rub it hard with some soft material, such as cloth or leather. The result is then that the substance will leave the hard and cleave to the soft material, which latter, though under the same pressure, will subsequently move with much more freedom over the hard polished surface. It is here, therefore, that we find an explanation of the extra slipping on a small pulley. The pressure of the belt per square inch of the gripped surface is much greater on the small than on the large pulley, hence there is more of this "wiping" action, and the small pulley will become cleaner as regards the rosin. In other words, the coefficient of friction on the small pulley will become less than that on the large pulley, and thus there will be more slip on the small pulley.

Viewed from this latter standpoint, therefore, it seems obvious that the best way of preventing slip is to reduce the pressure per square inch of the belt on the pulley, and to this end to increase the angle of grip. In common engineering practice this is done by means of an idle pulley; and is a method adopted with the generating plant of the City and South London Railway. This is sketched diagrammatically in Fig. 129 herewith, where the idle wheel, *a*, will be seen close against the dynamo pulley. It will be observed that the pulley, *a*, is put on the slack belt, and not where the latter is tight. If put on the tight side—as might be seen by supposing the belt to travel in direction opposite to that shown by the arrows—the vastly increased pressure on the bearings of the idle pulley would cause a loss of horse-power in making it rotate, which is thus avoided by putting it on the slack side.

An idle pulley, or "jockey," as it is sometimes termed, is best fitted against the belt with a spring adjustment. If kept down simply by weight it will tend to jump, an effect specially due to the joints in the belt. If fixed immovable it cannot then "take up" any extra slackness that might momentarily arise in the belt through extra work putting additional stretch on the tight side. A sufficiently stiff spring introduced will thus allow a certain amount of "give" conserving toward an efficient and easy riding of the belt, but without jumping.

The above method of tightening belts has not found general favour in the management of dynamos. It is plain, in fact, that though some further 30 or 40 per cent. perhaps may thereby be added to the gripping surface of the dynamo pulley, its total of such gripping surface will still be very small as compared with that on the engine flywheel. Hence the wiping effect above alluded to, and consequent decrease of coefficient of friction, will still arise. Regarding the question broadly, moreover, general simplicity combined with small prime cost is a desideratum. Thus, to erect the necessary standards and efficient bearings for an idle pulley, together with the means of adjusting its pressure on the belt, form a complication also attended with expense. Common practice has decided that it is more simple and cheap to shift the dynamo bodily away from the engine, and thereby to tighten the belt. It is necessary to have a reasonable tightness of belt in any case so as to obtain sufficiency of grip on the pulleys. Yet too great tightness is to be avoided, inasmuch as this would

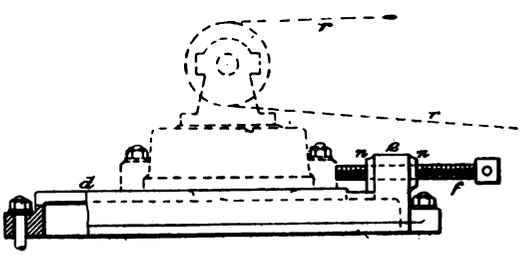

FIG. 130.

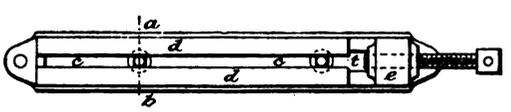

FIG. 131.

bring such an increase of pressure on the bearings that these latter would heat and seize; besides that the increase of friction within them would cause a loss of power to overcome it. Judgment and experience must decide. It may, perhaps, be safe to state an example thus. With an engine-pulley flywheel and dynamo pulley respectively 5ft. and 1ft. in diameter, their centres must not be less than 13ft. apart; and when running, the tight side of the belt should appear perfectly straight and, so to speak, rigid; but a slight droop, just easily visible to the eye, should be allowed on the slack side. Under such conditions thus there will be a minimum of slip without trouble at the bearings, these latter not becoming more than just warm, with efficient lubrication. It is usual, as shown in Fig. 129, to let the tight side be below: for the belt is then more easily kept off the floor; and the droop or "sag" in the slack side above tends slightly to increase the angle of grip on the pulleys.

We may now, however, turn our attention to means that are adopted for moving the dynamo itself away from the engine. This is accomplished by mounting the machine on smooth slide rails, usually two, but sometimes three or four in number, and by means of screws to shift it along these to the desired extent. The dynamo is bolted down to the rails, which latter in turn are bolted down to the founda-

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tions. Figs. 130 to 132 show a rail which possesses generally the points and qualities most frequently to be met with. Fig. 132 is a section on *a b* to an enlarged scale. The rail will be observed to consist of a narrow cast-iron box, open at the bottom, and having a narrow slot, *c c*, at the top. There are raised facings, *d d*, for the dynamo (shown dotted) to rest on, and the bottom also is machined. A short pedestal, *e*, is cast on one end through which passes a horizontal pinching screw, *f*. The two end rails under a dynamo are fitted thus, any intermediate rails usually being merely carriers without screws. The heads of these screws may either be circular, with "tommy" holes through them, or else be hexagonal for use with a spanner. Sometimes these methods are combined, and tommy holes put through hexagonal heads. The screw ends impinge on flats cast on the bosses or other parts of the bed-plate for the purpose, as, for instance, at *s*, in Fig. 126, and as were to be observed in other bed-plates for belt-driven machines that we have illustrated. Thus, the bed-plate can be moved by turning the screws to any extent limited by their length, thereby tightening the belt shown dotted at *r r* in Fig. 130.

The inside of the slot, *c c*, requires planing so as to fit loosely the square necks of the dynamo holding-down bolts, as indicated in Fig. 132. For this purpose the slot is cast wider at *t*, so that the planing tool can pass off freely. The pinching screw, *f*, is best made with a square thread for the sake of wear, and the hole through the pedestal may be "bushed" with either steel or gunmetal to take the screw threads. For cast iron is not so good a material for threads, especially when exposed to much wear. It would seem none the less, however, that many makers, if not perhaps most, do not put in such bushes, deeming, no doubt, that the wear is not sufficient to justify the expense. Decrease of wear is attained by adding bosses, *n n*, either on one or both sides the pedestal as shown, which thus lengthens the screwed hole.

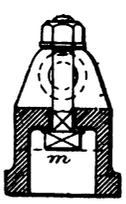

FIG. 132.

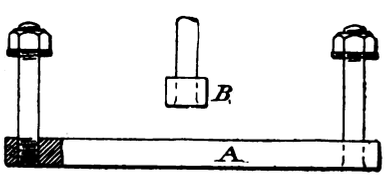

FIG. 133.

Fig. 133 illustrates an alternative method that has been adopted for dealing with the dynamo holding-down bolts. Instead of these being separate they are, each in the form of a stud, screwed into the ends of a wrought-iron bar, A, shown in the end view at B, with their lower ends rivetted over to fix them permanently. The view B would then appear in Fig. 132, in place of the bolt head, *m*. This arrangement, however, is most applicable in cases where the bosses in the dynamo bed-plate are not of full depth, and consequently separate bolts would be liable to stick in the manner illustrated on an early page in Fig. 4. But with deep bosses, the expense of the bar, A, and of fitting the studs therein, would not be warranted.

(To be continued.)

THE LOCAL DISTRIBUTION OF ELECTRIC POWER IN WORKSHOPS, ETC.

BY ERNEST KILBURN SCOTT.

PART I.

(Continued from page 362.)

A large cable is unlike a long and heavy shaft in that it does not involve a proportionately heavy driving cost; thus a small motor may be driven through a large cable and yet its efficiency of working be every bit as good as if the cable carried current up to its safe limit. Every motor that is added simply produces a loss in the cable proportional to the work it is doing.

A few remarks on some of the *practical details* involved in applying motors may be interesting. The simplicity of the lines of the electric motor enables it to be coupled up to its work in many ways. In driving a group by belting, as the motion is simply rotary, it is generally sufficient to place the machine directly on the ordinary workshop floor with a couple of coach screws or Lewis bolts to keep the shafts in line. Sometimes, in order to save space, the motor is placed immediately beneath the countershaft, but naturally a vertical drive does not give such good results as an oblique one.

If the building is several storeys high the motor may be attached to the ceiling, and in this way an excellent horizontal drive is secured. The only things needing alteration are the bearings, which must have the oil reservoirs reversed.

Mr. C. E. L. Brown uses two-phase motors for driving the shops of Messrs. Brown, Boveri, and Co., and the motors are attached to the side of the building in slides, so that the weight of the motor always keeps the belt taut: and in jointing up a new belt exact length is not important.

Mr. Adamson, of Hyde, has observed the interesting fact that in driving through belting from an electric motor, the wear and tear on the belt is not so great as when driven through a series of shafts from the shop engine, this being apparently due to the greater steadiness of running of the motor.

With reference to the question of gearing, experience has shown that the ordinary cast-steel double-helical wheels have not been quite a success; the vibrations of the ordinary cast wheels having been the cause of many armatures breaking down either mechanically by the armature core or commutator becoming loose, or electrically by the insulation of the conductors becoming abraided. These vibrations are not only circumferential, but also axial, because it is difficult to get a casting with the angles or V's of the teeth all exactly in the same plane. One method of getting over the latter difficulty is to make the spindle extra large in diameter, and allow the pinion to slide on two deep feather keys; this protects the armature somewhat, but in time, of course, the keyways become enlarged and the feathers worn, necessitating refitting. Machine-cut helical gears can be bought, but they are very expensive. A cheap machined double-helical wheel may be made by placing two skew-toothed wheels together, so that the obliquity of the teeth is in opposite directions, as shown in Fig. 12. A pair of such wheels is practically the same as one double-helical wheel, but the expense of milling out the teeth is not nearly so great. The end thrust common to simple pairs of skew wheels is done away with. Pinions made of raw hides, in layers pressed tightly together, are sometimes employed where noiselessness is important, whilst cases where the total reduction in speed is great will be best met by the employment of worm-gears, at any rate for the first reduction. By employing a large diameter of worm with several threads and the angle of pitch about 45deg., a very high efficiency can be attained when running in an oil-bath. End thrust can be neutralised by employing two worms (a right and a left hand) and two worm-wheels meshed into each other. Such an arrangement reduces friction and wear on the teeth, and it is much used in electric elevator work.

Cranes form a field which the electric motor has particularly marked as its own, and in the United States the success of the *electric overhead traveller* has been so phenomenal that square-shaft and running-rope types have practically ceased to be built.

The first electrically-driven travellers were fitted with one motor only, and the three motions of lifting, traversing, and travelling were transmitted from it by friction gear and clutches. There was one advantage in this, inasmuch as the motor was practically always running, and, therefore, the flywheel action of its armature and attachments helped it to start doing work without taking much extra current. All the later cranes have, however, been built with *three motors*, each geared direct on to one of the three motions. Cranes having two crabs are, of course, supplied with five motors. It has been found that the current at starting a heavy lift can be materially reduced by having a slip gear or belt, so as to enable the motor to get up speed. Although it is the most expensive in first cost, practical experience seems to point to the three or five motor method as the best. The three largest electric cranes in the world are built in this way; they are—one of 60 tons at the Seraing Works, Belgium, one of 75 tons at the Watervliet Arsenal, U.S.A., and one of 100 tons at the Baldwin Locomotive Works, U.S.A. The

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last-named has girders 7ft. deep and 74ft. span, and carries two crabs. The motors run at 500 revolutions per minute and work at a voltage of 220, there being one for each motion—lifting, travelling, and traversing. This crane will pick up a 65-ton locomotive, carry it the whole length of the erecting bay and deposit it on the rails in less than five minutes.

Electric cranemen may be chosen from the ranks of unskilled labour, and are soon taught the simple movements of the switch levers, to actuate which much less force is needed than with the old-fashioned cranes The levers can also be so arranged that the necessary as well as the natural movements of the operator are in the direction he wishes to travel, thus relieving him of any embarrassment or uncertainty.

One of the chief advantages of the electric traveller is the high speed—250ft. per minute—which can be attained in travelling. As a rule, a slow motion is required when the crane is hoisting and transporting heavy weights; but the more rapidly the crane can travel from one locality in the building where its work is completed to another where its help is needed, and the more rapidly it can perform the preliminary operations of attaching chains to the object to be lifted (which tedious work may be said to occupy usually nine-tenths of the time during working hours), the more efficient does the apparatus become.

The steady starting and stopping when travelling along the gantrys is important, because a swinging load is very objectionable besides being dangerous. The following experience of Messrs. Joseph Adamson and Co., of Hyde, is interesting in this connection: This firm had originally rope-driven cranes in use, and thinking to improve them they altered the gear, so as to give them a quicker speed. The result was, however, that it had to be altered back again, as the men considered the speed dangerous, owing to the sudden start causing the load to swing. Since then this firm has erected five three-motor cranes, and although they are running at speeds varying from 2½ to 3 times that of the old cranes, yet the men do not complain. Moreover, four of the above cranes are controlled from the floor.

A development which is likely to be taken advantage of in foundries, arsenals, stockyards for pig iron and steel rails, etc., is that the ordinary crane hook and sling may be replaced by a powerful electromagnet, which has simply to be switched on or off (through a piece of apparatus to neutralise the self-induction effect), in order to attach itself and let go respectively. The craneman may therefore move a large amount of material with very little assistance, the whole of the operations being performed from his place on the crane by the mere turning of a few switches. The ammeter on the lifting motor circuit will let him know if too much weight has been attached, and thus there is the added advantage of security in working.

For lifting pig iron or steel rails about in a stockyard this arrangement should be exceedingly useful. Major Holden has designed one which is in use at the arsenal, Woolwich, for lifting shot, which will lift 3,600lb. The current varies from three to four amperes at 20 to 30 volts, and the extra current at breaking is shunted through a water resistance by a simple form of single-pole switch.

The *hoisting efficiency* at full load of an electric crane varies from about 47 per cent. with a five-ton crane to about 57 per cent. with a 50-ton crane; but it is not so much in efficiency that there is an advantage as in the fact that with a running rope or a square shaft a considerable amount of power is always running to waste; and, moreover, this waste is not harmless, but is continually at work wearing out the rope, rope sheaves, shaft, bearings, etc. Mr. John Barr, in a paper read before the West of Scotland Iron and Steel Institute, stated that in two very favourable cases the amount of power required to drive the rope alone varied from 5·9 to 6·31 i.h.p. per 100ft. length of shop, the ropes running at 2,200ft and 1,570ft. per minute respectively. In a shop 200ft. long, therefore, which is a usual length, upwards of 12 i.h.p. would be continually wasted with a rope-driven crane, the actual power for which would probably never exceed 8 h.p.

With an electrically-driven traveller the *consumption of power* at the crane, stops as soon as the motors stop; it is therefore easy to understand that this method commends itself to all practical men.

Not only has the electric motor worked a revolution in the ordinary overhead traveller, but it has also successfully encroached on the domains supposed to be sacred to the hydraulic crane, and also the outside navvy or dock crane, fitted with its own self-contained boiler and engine.

In the United States, electric overhead cranes are being used for handling ladles of molten metal from open-hearth steel furnaces. With such furnaces it has been customary to use hydraulic swing cranes, one to each furnace; but owing to the length of the heating the cranes have to stand idle a large proportion of the time. With this new arrangement, one overhead traveller is made to serve several furnaces, and is therefore nearly always at work, and consequently gives greater economy.

Probably the largest installation of electrically-worked cranes and hoists in the world is that at the Free Docks, Copenhagen. This installation has been running since November, 1894, and the total power required at the motors is over 170 h.p. It would take too long to go into the various details, but the gain by using electricity is well shown by the fact that 2,800 tons of grain in bulk was discharged from a cargo boat, weighed over, and stored in 31 hours. Had this shipload been handled in the old-fashioned way—namely, the grain carried by hand from the quay to the granary after being, as usual, weighed on deck and filled into sacks, even with four hatchways in use simultaneously—the work would have taken eight to ten days, and cost a considerable sum for wages. An analysis of the costs showed that the electrical method only occasioned a small expense for current, the energy required being 700 kilo-watt-hours, which, at 2d. per unit, comes to £5. 16s.

A striking advantage of the electric motor which is valuable is that the speed may be kept practically constant under all loads within its capacity. A machine electrically driven is therefore always running at *full speed* and in a condition for producing the maximum amount of work. By means of an ammeter, the workman in charge can tell at a glance the exact amount of power in use; any great increase in current at once indicates to him waste on friction, etc., whilst a decrease would also indicate that the machinery is not working at its full power. The arrangement is thus one which exactly fulfils the requirements of maximum economical production.

In some of the large spinning mills in the North of England indicators are fixed in the manager's office, which give the exact speeds of the machinery in the different departments. With electric driving this idea can be extended, and by means of recording ammeters the manager may know what amount of work has gone on at any moment, or what is then actually going on in any part of the factory.

Probably the most difficult work which the electric motor has so far been called upon to perform, has been in operating tramcars and electric railways. When starting under a heavy load, motors in these situations are subject to a rush of current which almost amounts to a short-circuit. Yet we find such motors running their thousands of miles without any attention; for example, a Siemens motor on the City and South London Railway ran over 60,000 miles without any appreciable wear on the commutator and the wearing out of only one set of brushes. The tremendous extension of electric traction within the last few years is conclusive proof that reliable motors can be built which will work under the most trying conditions—much more trying indeed than anything likely to happen in a workshop or factory.

Automatic lubrication is now very generally used whether the motor is in an inaccessible place or not, and it usually takes the form of a ring or chain revolving loosely on the shaft, its underside dipping continuously in the oil-well. By this means a film of oil is carried up and shedded over the spindle, after lubricating which it runs back through a strainer into the well again. It is not unusual to leave machines fitted in this way for months without any attention.

The old trouble of sparking has been practically eliminated by improved design and the use of carbon brushes, so that now the only limiting factor is that due to the heating of the armature conductors.

The rule for the maximum output is determined by passing a steady current through the machine for a definite length of time, varying from about four hours with small machines to eight to twelve hours with the largest. The load should be such that the maximum rise of temperature at the end of the

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rise shall not exceed 75deg. F. for dynamos, and 95deg. F. for motors. These figures would be slightly lower for machines which are intended to work in hot places—say, near an economiser or over a boiler, or, again, when they are exported to hot countries. A good deal depends on the manufacturers. A firm with a reputation to lose will always keep a good 10 per cent. below the specified test.

Although the shunt-wound continuous-current motor is the one most generally used, other *windings* are sometimes employed. In cases, for instance, where the motor has to run for a long period on a fixed load or where a very good starting torque without shock is required, the series-wound motor is usually employed. The torque in these motors may be as high as six or seven times the running torque, and great steadiness in starting is attained by the fact that both the current in the armature and the field coils build up together. It is, however, liable to race should it at any time lose its load. A shunt motor, on the other hand, cannot race, but has only about half the starting power. By combining the two in a compound-wound motor, their respective good qualities are partially attained.

It has generally been supposed that the Gramme form of armature was better than the drum type, especially for the higher voltages, on account of the facility for repair and less liability to short-circuit. Experience, however, has shown that in actual running the drum (especially if the end windings are made symmetrical, as with the Eickemeyer armature) is much the best. There is less liability to sparking; the mechanical construction is better, because the armature stampings are keyed direct on to the shaft, and the armature runs cooler. This latter point is important in the case of enclosed machines. Motors are often enclosed in a framework of expanded metal or iron netting arranged with a door, so that the brushes can be conveniently adjusted. Iron netting has the advantage of permitting a free circulation of air, but it is probable that the motor most extensively used in the near future will be completely enclosed by a cast-iron or cast-steel jacket, which will form part of the yoke or return circuit to the magnets. Such motors are now being made, and whilst not so neat-looking as the ordinary type, there is the advantage that they can be placed anywhere—in the open air, or amongst dust, grit, and iron filings—whilst any part can be handled with impunity. Such a motor made by Messrs T. Parker, Limited, is shown in the accompanying figure.

It has long been thought that enclosing a motor in a metal shell would lead to abnormal heating, but this is now known not to be the case. A motor which would give a temperature rise of, say, 55deg. F., with a certain load after a six hours' run, would only rise to about 85deg. F. under the same conditions when enclosed. The efficiency need not be any lower than in an ordinary machine, because the leakage of magnetic lines is not nearly so great as is generally supposed.

Where the motors are required to be worked near machine tools, it is advisable to always have them enclosed, and to so dispose the field poles and the yoke that there shall not be any stray magnetism. The four-pole magnet lends itself very neatly for this purpose, as, in fact, do all multipolar machines.

(To be continued.)

ELECTRIC CRANES AND LIFTS.

At the ordinary meeting of the Institution of Civil Engineers on Tuesday, March 30, Mr. John Wolfe Barry, C.B., F.R.S., the president, in the chair, the paper read was on "Electric Lifts and Cranes," by Mr. Henry W. Ravenshaw, A.M.I.C.E.

This communication referred to the application of the electric motor to the working of lifts and cranes. Where hydraulic power was available, its simplicity afforded many advantages, although in the ordinary form of hydraulic motor as great an amount of water was used with a light load as with a heavy one. The electric motor, however, only absorbed current in proportion to the work developed, and this fact alone justified its application in certain cases. The chief requirements of the motor were sparkless commutation, self-adjusting brushes, and automatic lubrication. Shunt machines were generally used on account of their regular speed with varying loads; a few turns of series winding were, however, sometimes added to give prompt starting Worm-gearing was employed, and gave compactness and silent running, with a quick pitch for the worm; ball-bearings and an oil-bath were recommended. To give good results, however, the ball-races must be of high-class steel, and be ground perfectly true after hardening. A special form of rope-drum made by Messrs. Easton, Anderson, and Goolden, Limited, and the Sprague screw elevator with ball-nut were described.

The regulating gear should provide prompt and accurate control, absence of jerks, small current consumption, and regular speed. Resistance was necessary in the circuit of the motor at starting to prevent a great rush of current; and this should be controlled automatically, as it was impossible for the attendant to tell the position of the switch when a hand-rope was used. The automatic controller used by the Otis Company was described, as well as an arrangement controlled by a centrifugal governor which had been designed and used by the author. Magnetic brakes were advocated, the cage being automatically stopped when the current was accidentally broken. The magnet should be fitted with non-conductive resistances to prevent sparking on breaking the circuit. Tests of an Otis elevator and a curve showing the energy consumed under varying loads were given, the cost per return trip with four persons to a height of 36·5ft. being 0·101d. at 4d. per Board of Trade unit. The cost of an average trip with two persons to a height of 24·75ft. was 0·060d. at 4d. per unit.

Electric cranes presented several marked advantages over those driven mechanically, owing to the flexibility of the control of the motor and the simplicity of the conductors for transmitting the power. The relative advantages of the use of a separate motor for each motion, and of a single motor and friction clutches were discussed, the mechanical simplicity in the one case and the electrical simplicity in the other enabling either system to be used with good results. Tests were given of a 20-ton electric crane at Woolwich Arsenal arranged on the single-motor principle, friction clutches being used to actuate the various

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movements. The collectors for the current with the method used for insulating them were described. Owing to the special requirements of this crane, much gearing was necessary, and a heavy chain block, weighing nearly two tons, was fitted. The efficiency was thus reduced, especially at light loads, and the horse-power delivered to the load, as well as that delivered to the block, was given to enable the mechanical losses to be more readily obtained. A total efficiency of 53·42 per cent. was obtained when the load on the hook only was considered, and of 58·28 per cent. when the weight of the block was included in the load. To drive the outer carriage at the rate of 54ft. per minute 8·4 e.h.p. was required, and 10·2 e.h.p. to traverse the load radially at the rate of 32·4ft. per minute, both with a load of 20 tons.

The paper was illustrated by drawings of the lifts and cranes described. It will be discussed on Tuesday next.

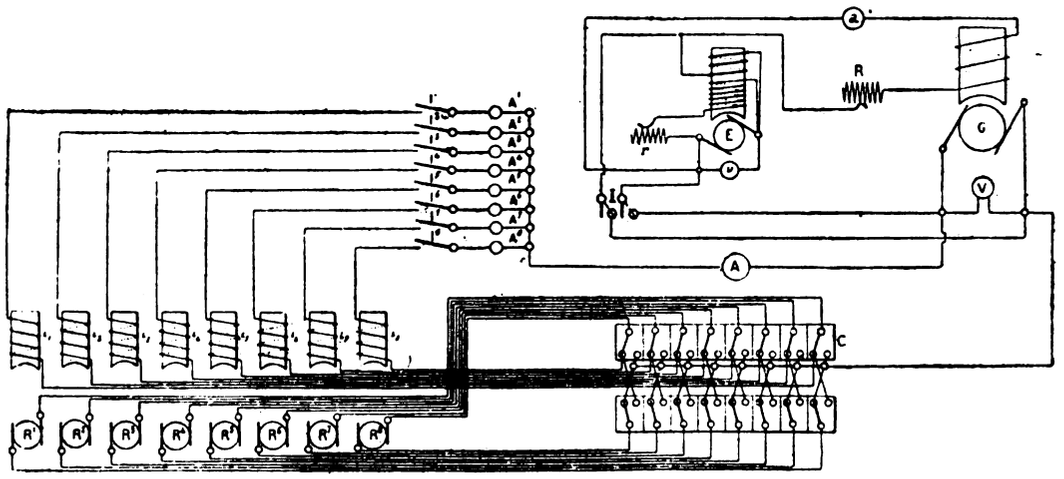

FIG. 1.—Diagram of Connections of the 1893 Heilmann Locomotive.

THE NEW HEILMANN ELECTRIC LOCOMOTIVE.*

The old locomotive designed by Mr. J. J. Heilmann gave results which were perhaps more interesting than useful. It suggested to those who had designed and manufactured it that various improvements could be made in the structure and arrangement of the locomotive. Mr. F. Drouin, in describing the new locomotive, briefly summarises the leading characteristics of the older combination. Thus the locomotive tried in 1893 had a boiler of the Lentz type with 289 tubes. The total heating surface was 1,560 square feet, and the grate area 242 square feet, the pressure being 170lb. per square inch. The engine was of the C. Brown horizontal compound double-acting type, developing 600 h.p. at 300 revolutions, the diameters of the high and low pressure cylinders being 16·8in. and 25·6in. respectively. The dynamo was a six-pole machine, designed by Mr. C. E. L. Brown, giving 1,024 amperes at 400 volts. The diameter of the iron armature core was 47·25in., and the length of the core 17·5in. This dynamo was separately excited by a small dynamo driven independently, and required about 95 amperes at 50 volts. The motors were of the C. E. L. Brown four-pole type, series wound, with toothed armatures. The cores were 25·6in. diameter and 15·6in. long. The motor, when taking 128 amperes at 400 volts, gave a normal torque of 900 foot-pounds and ran at a speed of 410 revolutions per minute. There were eight of these motors. The principal dimensions of the complete locomotive were as follows:

Length between buffers	53ft. 6in.
Total wheel base	38ft. 6in.
Wheel base of bogie	13ft. 1in.
Diameter of wheels	3ft. 9¾in.
Breadth of frame	9ft. 10in.

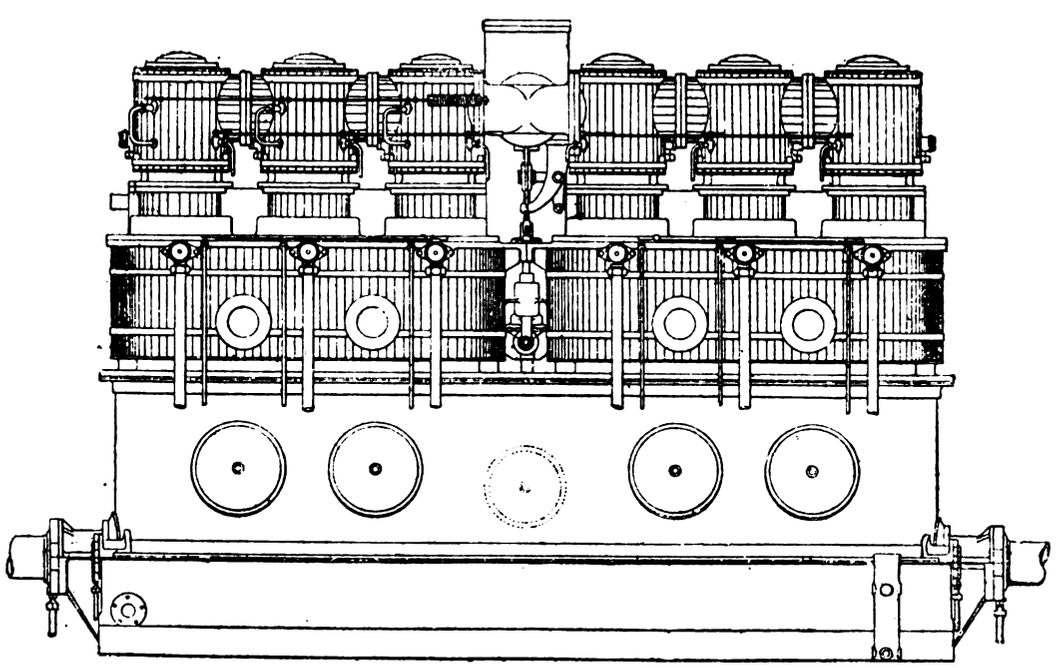

FIG. 2.—View of the Willans Engines used on the New Heilmann Locomotive.

This first locomotive was able to give a normal effort of 2,820lb. to the wheel, or at the speed of 63 miles per hour a pull of 2,100lb. It was not designed to give exceptional power, but rather to find out what the system was capable of doing. The author states that this first locomotive showed that the stability was independent of speed, and

* From *L'Electricien*.

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that the deteriorative effects on the permanent way was less than with a steam locomotive. The double transformation of power caused losses equal to about 15 per cent. of the indicated horse-power of the engines. In drawing a train weighing about 65 tons the consumption of coal was under 14lb. per mile. The electrical connections used are shown in Fig. 1. G is the main generator, E the exciter. The rheostat, R, controls the field strength of the generator on the Ward Leonard system.

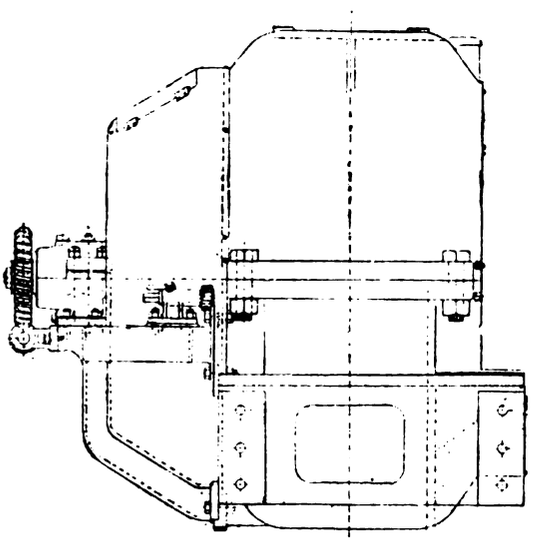


FIG. 3.—View of the Motor.

The results obtained from this first locomotive determined the directors of the Compagnie de l'Ouest to construct two new machines of greater output and power. The designs were got out by Messrs. M. Mazen and G. Damoiseau, and embodied the following differences: (1) the substitution of an ordinary locomotive boiler for the Lentz boiler; (2) the use of more compact electrical apparatus and of generators with toothed armatures. In fact, everything tending to reduce weight was carefully considered. The double-acting engine is replaced by single-acting ones without diminishing the output per weight, but the steam pressure is increased by one-sixth and the speed by one-third. The following details of the new locomotive will interest our readers.

Boiler.—The boiler, as stated above, is of the locomotive type, with a Belpaire furnace and copper fire-box. The heating surface of the furnace is 178 square feet, and that of the tubes 1,820 square feet. The grate area is 36 square feet, and the working pressure 198lb. per square inch. The feed is supplied by two Friedmann injectors.

Engines.—The engines are of the Willans and Robinson type, with six lines of cylinders (Fig. 2), which arrangement gives a good balance in turning moment, etc. In each engine the three cranks are inclined at 120deg. to each other. The ordinary features of the electric lighting engines are included, the working parts running in oil. The principal dimensions of these engines are as follows:

Indicated horse-power	1,350
Speed (revolutions per minute)	400
Diameter of high-pressure cylinder	11·8in.
Diameter of low-pressure cylinder	19in.

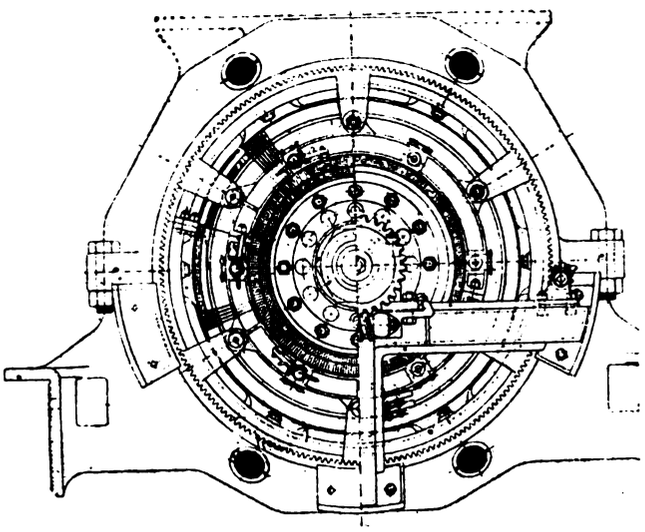
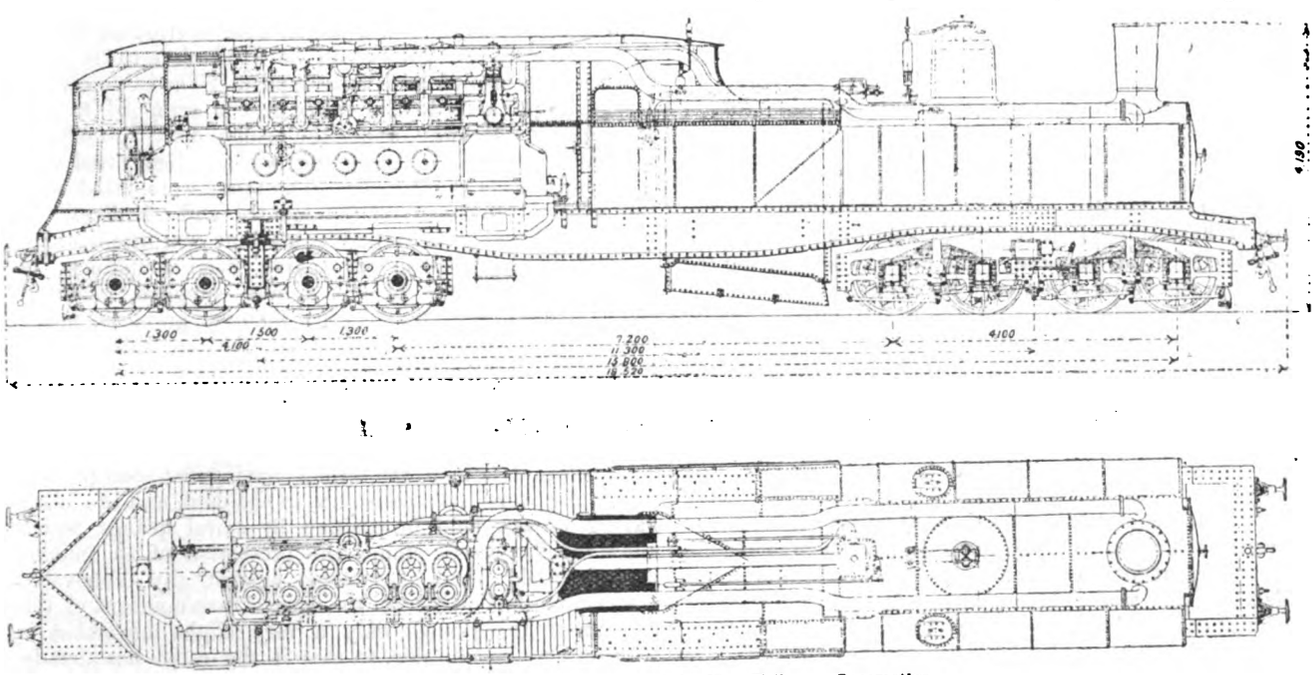


FIG. 4.—Front Elevation of the Brown Four-Pole Motor.

These engines have coupled to each extremity of their common shaft a direct-current dynamo, the armatures of which act as flywheels.

Dynamos.—Each of these dynamos (Figs. 3 and 4) is able to give 910 amperes at 450 volts. They are of the six-pole type constructed by Messrs. Brown and Boveri. The field magnets are of cast steel. The armatures have toothed cores, and the current is collected by carbon brushes. The dynamos are cased in, except for a few openings for ventilation. The dynamos rest direct on the frame of the locomotive, and also form supports for the two ends of the engine bed-plate. They are excited by a smaller dynamo giving 140 amperes at 110 volts, but only 10·0 amperes are required for the dynamo field magnets.



FIGS. 5 AND 6.—Plan and Elevation of the New Heilmann Locomotive.

Motors.—These are of the four-pole enclosed type with toothed armatures mounted on a hollow shaft connected with the driving axle. The axle is thus able to follow the inequalities of the road without transmitting shocks to the armature. The approximate concentricity of the axle and armature shaft is obtained by three double steel springs

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connected to one of the wheels. The frame of the motor consists of four essential parts. The lower part has the two feet which fix the motor to the frame of the bogie, and carries also the two bearings in which the hollow shafts revolve. These bearings are automatically lubricated. The two horizontal cores carrying the series exciting coils form the next two parts, and the upper piece completes the structure. The exciting conductor is formed of copper, tape wound in two sections.

Controlling Gear.—The locomotive can be worked from either of two positions, depending on which way the train is running. The general arrangement of the complete locomotive can be seen in Figs. 5 and 6, the over-all dimensions being as follows:

Length between buffers	60ft. 7in.
Total wheel base	50ft. 6in.
Wheel base of bogie	13ft. 5½in.
Diameter of wheel	3ft. 9½in.

The first of these locomotives was subjected to a preliminary trial in January last, but no trial of speed was made. As reliable figures are likely to be obtainable shortly we refrain from giving our readers calculated figures only. The designers expect to get a full load efficiency of 73·4 per cent.—that is, 73·4 per cent. of the indicated horse-power of the engines is expected to be available on the axles. The locomotive without tender weighs about 120 tons.

THE SS. "PORTENA."

Messrs. Johnson and Phillips, of Charlton, have just completed the equipment of the above cable steamer to the order of the Compagnie Française des Cables Télégraphiques, of Paris, making the third carried out by this firm within 12 months. The work consisted of transforming a merchant vessel into a cable laying and repairing steamer, and although the vessel was not a new one it adapted itself fairly well to the purpose, especially as regards the cable-tanks, though it had high forecastle bridge and poop decks, and a comparatively small beam—viz., 33ft.—while it was 320ft. long. The picking-up and paying-out machine was built very much on the lines of that for the steamer "Tutanekai" (*Electrical Engineer*, August 21, 1896, page 211), lately fitted by this firm for the New Zealand Government, but was much more powerful, being equal in strength to that recently fitted on the ss. "Okinawa Maru" for the Japanese Government. Owing to the vessel having a high forecastle and bridge deck it was necessary to instal this machine on the upper deck, and therefore it had to be self-supporting. For this reason the frames of the machine, which were constructed of steel plates and angles, were tied fore and aft by strong wrought-iron diagonal stays, whilst additional stays were fitted in the nature of flat and angle bars, and various fixed shafts were also utilised for this purpose. The method of securing the machine in the vessel was a very rigid one. Channel bars 12in. wide were bedded on to the steel deck so as to present a perfectly level surface, and the machine was levelled up on this by means of cast-iron wedge chocks, large pitch-pine baulks being fitted between and below the beams under the deck. The deck itself was stiffened by two plate girders 2ft. deep at centre, fixed underneath right across the vessel and attached to the shell plating, and these girders and the deck beams under the gear were stayed by stanchions right down to the keel and floor of the vessel. This made a splendid job, as even with the gear running at full speed not the slightest vibration could be felt at the trial. The gear is driven by a pair of horizontal engines having cylinders 15in. diameter by 15in. stroke, which, running at 220 revolutions per minute, are capable of developing 210 b.h.p., with steam at 70 initial pressure. The engines are fixed at the after end of the machine, and over them is erected a platform from which the attendant can work and regulate the whole of the machine, the stop-valve handwheel, reversing lever, drain cocks, main brakes, draw gear, brakes, and water service, all being within easy reach. Ladders are fixed at each side of the platform, which is also provided with polished handrails, and the whole forms a very neat and compact arrangement. As in other gears now made by this firm, the parts are constructed mostly of steel to ensure lightness and strength. The total weight of this machine is 23 tons.

The main drums are internally geared and a rim is cast on for the brake, so that the drums can revolve under the control of the brake independently of any other gear. The geared pinions are made to draw out of gear when not required for working so as to avoid rattling. The "hauling off" gear is driven by special silent pitch chain when picking up, but when being used as "holding-back" gear for pay out, the sheave (which also has a brake rim cast on) is arranged to run loose on a sleeve being controlled by its own brake. A small Worthington pump is provided on the platform to work the water service, which is fitted to all the brakes. A special feature of the main brakes, which are actuated by screws, is that they are worked through worm-wheels and worms so as to give finer adjustment for paying out as well as great power for holding. It will be readily seen that with the intervention of the worm-wheel and worm, a very fine movement of the brake screw can be obtained with very little power exerted at the handwheel on the worm spindle, and when it is necessary to release or apply the brakes quickly, it is only necessary to spin the handwheels round two or three times, which can be readily done. The bow gear consists of three steel sheaves running loose on a steel shaft, which is carried in dead bearings attached to steel girders, which are very rigidly built into the head of the vessel, considerable alterations having to be done to this part to make it suitable for the bow gear. The plating of the ship is made up to the girders, and "whisker guards" give it a very neat appearance. The stern gear consists of one steel sheave running loose on a shaft and carried on a pair of steel girders secured to the poop desk.

The dynamometers (of which three were supplied) are of extra heavy pattern, having two cylinders each, which act as dashpots, an adjustable by-pass being provided between each cylinder by means of pipes and cocks so as to steady the movement of the dynamometer sheave. Owing to the vessel having wells between the forecastle and bridge deck, and bridge deck and poop, it is necessary to provide special leads for the cable, and these consisted of strong cast-iron bases secured to the upper deck, and having a wrought-iron tube vertically in their centres, which could be adjusted in height, and the usual deck leads, consisting of base-plate with rollers and guards for cable, were carried on top of these. Where the leads could be fixed close to the deck the usual pattern of lead was supplied. The cable coming from the after tank to the cable gear is arranged to pass through the alley-way, under the bridge deck, and for this purpose about 80ft. of troughing was supplied, fitted with bell-mouth leads at intervals. The tanks were fitted with the usual arrangement of bell-mouths and crinolines. A "Lucas" patent steam sounding machine was fitted on the after end of the poop for taking deep soundings. A complete equipment of stores was supplied, including chains, ropes, chains and rope fittings, grapnels, mushrooms, centipedes, buoys, lamps, blocks, cable leads, messenger sheaves, steam and hand hauling gears for turning over cables, sounding shot, tubes, etc., tools, and all necessary accessories. The outfit of grapnels included Claude Johnson's patent mud and rock grapnels, which we have before described, the former having flat steel prongs, which offer very little resistance to the mud, and the latter having prongs held in position by spiral springs, which allow them to recede under the protection of an annular conical shield when they come against any immovable obstruction, but owing to the special arrangement of the fulcrum of the prongs only a very slight movement is necessary to ensure this, so that if the cable has already been hooked there is no risk of losing it.

The vessel was fitted throughout with electric light, the generating plant being in duplicate, and each set capable of maintaining 150 16-c.p. lamps continuously. There was also a large Admiralty-pattern projector, 20in. diameter, with mirror, and an arc light for the rigging, as well as mast and side lights and deck clusters for the deck when working the cable. The dynamos were of Johnson and

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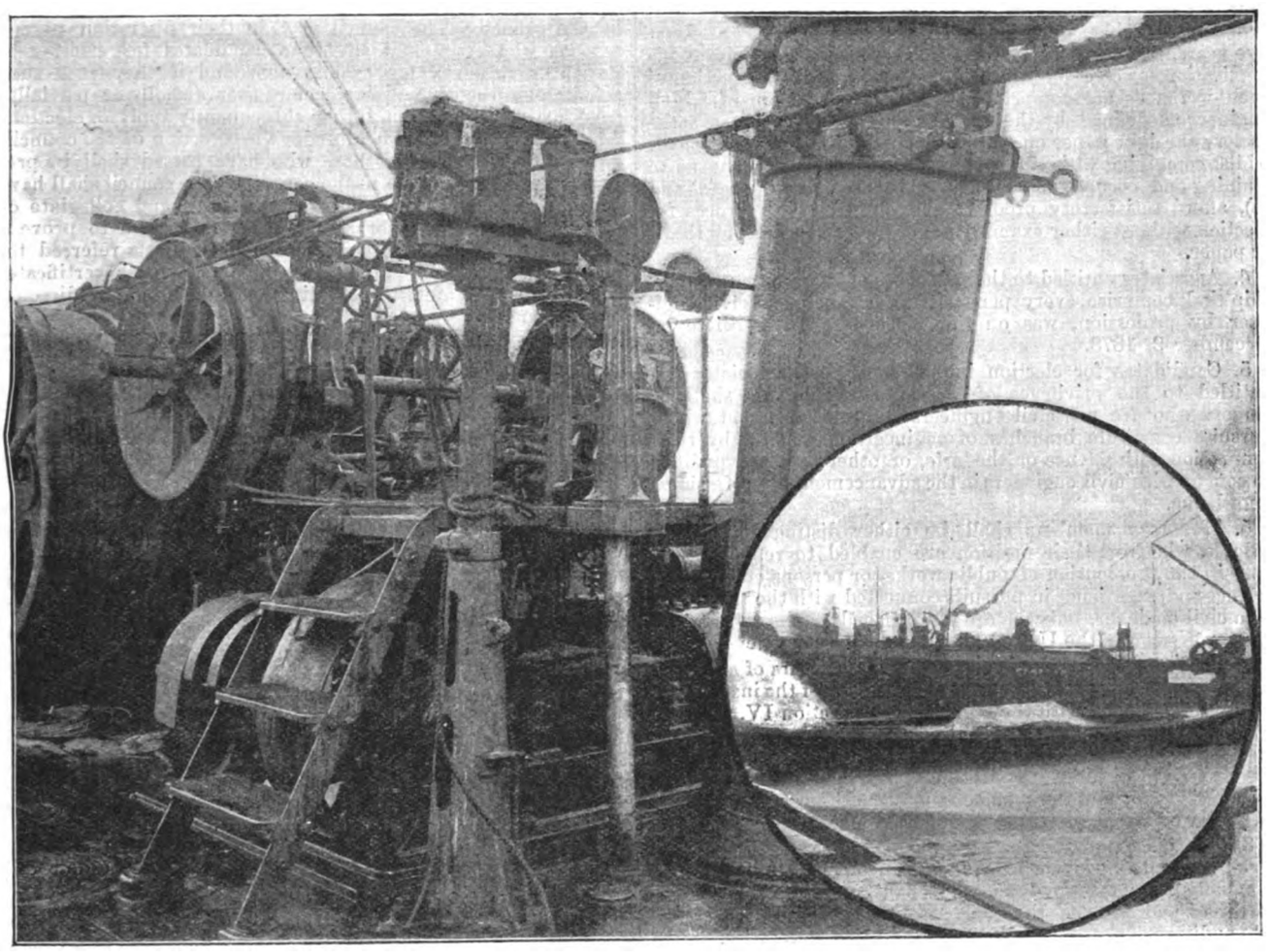
Phillips's two-pole inverted pattern, compound wound, having an output of 140 amperes at 60 volts when running at a speed of 300 revolutions per minute, and they were direct-coupled to Robey engines. The contract for the whole of the work was placed with the above firm, including the alterations to the vessel, which were most extensive, but this part of the work was executed by Messrs. Dunlop and Co., of Port Glasgow, under contract. The fore and aft holds had to be entirely cleared out in order to allow for water-ballast tanks and the cable-tanks being fitted. The work of building in the ballast-tanks was very difficult, owing to the construction of the hull, and it involved a great deal of work, especially aft, where it was necessary to renew the whole of the tunnel, which necessitated the lifting of the propeller shaft and the after



View of the Cable-Laying Gear on the ss. "Portena.

mast. The cable-tanks were built directly on top of the ballast-tanks, the forward tanks being 30ft. diameter, 18ft. deep, and the after tanks 29ft. diameter 14ft. 6in. deep respectively. The tanks were firmly secured at the sides to the hull of the vessel by vertical gusset plates, and to the deck by means of strong steel stringer plates. A large Worthington pump is fitted in the engine-room to work the ballast and cable tanks, and this also has connections to the main condenser, so that it can be used as an auxiliary circulating pump when the main engines are stopped or moving slowly, and the cable gear is exhausting into the condenser. A large saloon was fitted up under the poop, the total length being 54ft., and it contains 12 cabins of various dimensions for captain, officers, electricians, engineers. The main saloon is 54ft. long by 14ft. wide. New accommodation for the crew and cable hands (50 in all) was also fitted up forward. A portion of the bridge deck had to be cut away to allow for a hatch over one of the cable-tanks, and some existing cabins had to be dismantled and formed into a testing-room. This room was fitted up by Messrs. Johnson and Phillips with a complete set of testing instruments, etc., by the very best makers. Part of the forward hold, under the cable gear, was fitted with platforms and cones on which to coil the grapnel and buoy ropes. There are four of these platforms, two on port side and two on the starboard side—one of each being on the floor of the vessel, and the others on the level of the lower deck and immediately over the lower ones. The cones of the upper ones are fitted with bell-mouths in the centre, so that the ropes can be taken right through them to the lower platforms, and there are similar bell-mouths in the upper deck, immediately under the holding-back sheave of the cable gear, so that the rope can be led directly on to them. The necessary ladders are provided for access to these platforms. A new capstan windlass was supplied and fitted in the forecastle, and a new steam winch forward. The dirty state of the ship, as shown in the engraving, is eloquent of the condition following the stowing of cable into the tanks in bad weather; the whitewash off the cable playing sad havoc with the appearance of the deck and gear.

INSTITUTION OF CIVIL ENGINEERS.

The following are the by-laws and regulations of the institution—Sections II. III., IV., and V.—as amended on March 30, 1897:

SECTION II.—CONSTITUTION.

1. The Institution of Civil Engineers shall consist of members, of associate members, of associates entitled to the privileges of corporate members, and of honorary members. All such members, associate members, associates, and honorary members may hereafter be referred to as corporate members. The institution may also have attached to it associates who are not entitled to the privileges of corporate membership, and students.

2. Members shall comprise every person who on December 2, 1878, was on the register as a member; and every person thereafter elected or transferred into the class of members. Every candidate for election or transfer into the class of members shall be more than 30 years of age, and shall come within one of the following conditions: He shall have been regularly educated as a civil engineer, shall have had subsequent employment

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for at least five years, and shall be actually engaged, at the time of his application for election, in responsible situations as resident engineer, or otherwise, in some of the branches defined by the charter as constituting the profession of a civil engineer, or he shall have practised on his own account in the profession of a civil engineer for at least five years, and shall have acquired a considerable degree of eminence in the same.

3. Associate members shall comprise every person who, being a civil engineer by profession, was on the register as an associate on December 2, 1878, and every person thereafter elected into the class of associate members. Every candidate for election into the class of associate members shall be more than 25 years of age; (*a*) he shall have been regularly educated as a civil engineer, shall have passed such examination or examinations as are appointed or are recognised by the council, and shall be actually engaged at the time of his application for election in the design or in the construction of such works as are comprised within the profession of a civil engineer as defined by the charter; or (*b*) he shall satisfy the council that he has had a sufficient training, that he has been engaged for at least five years, and that he is actually engaged at the time of his application for election in the design or in the construction of such works as are comprised within the profession of a civil engineer as defined by the charter, and shall furnish a satisfactory thesis or paper on a professional subject; or (*c*) he shall, whilst complying with either of the foregoing conditions as to training and occupation as set forth in the paragraphs (*a*) and (*b*), afford satisfactory proof to the council of his fitness for election without either examination or the submission of a thesis or paper.

4. Associates entitled to the privileges of corporate membership shall comprise every person who, not being a civil engineer by profession, was on the register as an associate on December 2, 1878.

5. Candidates for election into the class of associates not entitled to the privileges of corporate membership shall be persons who are not civil engineers by profession, but whose pursuits constitute branches of engineering, or who by their connection with science or the arts, or otherwise, are qualified to concur with civil engineers in the advancement of professional knowledge.

6. Honorary members shall be either distinguished individuals, who from their position are enabled to render assistance in the prosecution of public works, or persons eminent for science and experience in pursuits connected with the profession of a civil engineer, but who are not engaged in the practice of that profession in the United Kingdom or its dependencies.

7. Students shall be persons not under 18 years of age, who are, or have been, pupils of corporate members of the institution, who have complied with the regulations of Section IV. of these by-laws, and who have the object or intention of becoming engaged in the design or in the construction of such works as are comprised within the profession of a civil engineer as defined by the charter; and such persons may continue students until they attain the age of 26 years, but not longer.

8. The officers of the institution shall be a president, four vice-presidents, and other members of council to be elected or nominated under the by-laws, who shall constitute the council to direct and manage the concerns of the institution; also two auditors of accounts, a treasurer, and two secretaries. Such officers shall be elected or appointed annually in manner hereinafter directed.

9. Any member, associate member, associate, honorary member, or student having occasion to designate himself as belonging to the institution, shall state the class to which he belongs, according to the following abbreviated forms—viz., M. Inst. C.E., Assoc. M. Inst. C.E., Assoc. Inst. C.E., Hon. M. Inst. C.E., Stud. Inst. C.E.

SECTION III.—ELECTION, TRANSFER, AND EXPULSION OF MEMBERS, ASSOCIATE MEMBERS, ASSOCIATES, AND HONORARY MEMBERS.

1. Any person desirous of being elected a member, associate member, associate, or honorary member, must be proposed and recommended according to the Form A in the appendix, in which the name, usual residence, and qualifications of the candidate shall be distinctly specified. The proposal must be signed by at least six corporate members certifying a personal knowledge of the candidate, and a full conviction of his qualifications, and the candidate must sign the undertaking appended to the form.

2. The proposal so made, being delivered to the secretary, shall be submitted to the council, who shall consider the qualifications specified, and shall in the case of persons required by these by-laws to have passed examinations appointed or recognised by the council, or to have furnished theses or papers, satisfy themselves that the candidate has passed the necessary examination or examinations, or has furnished the necessary thesis or paper. The council shall determine the class for which the candidate is to be presented for ballot, and shall specify the same on the proposal. The chairman of the meeting of council which approves, or (after being satisfied as aforesaid) finally approves, the eligibility of a candidate, shall sign the proposal, which shall then be read at the next ordinary meeting of the institution, and be placed in some conspicuous situation until the candidate is balloted for, and six clear days shall elapse between the reading of the proposal and the ballot. The council shall cause to be held examinations for persons desirous of being elected associate members, and shall frame regulations for such examinations, defining the times at which they shall be held, the subjects which they shall comprise, and the fees to be paid or deposited by candidates in respect of such examinations; and they may from time to time add to or vary or rescind any of the aforesaid regulations as it may appear to them to be necessary. The examinations shall be directed by the council, who shall obtain such assistance as may be necessary from qualified persons to be appointed by them examiners in such subjects as the council may from time to time determine. The remuneration of such examiners shall be fixed by the council. The council may in their discretion permit persons who are not at the time candidates for election to present themselves for examination, and if they pass such examination the council may exempt them (wholly or partially) from further examination if they subsequently apply for election. After each examination held under the direction of the council, a report of the names of those who have passed shall be presented by the examiners to the council. The council shall have power to recognise such university degrees and collegiate or other certificates as after scrutiny they may deem to prove a sufficient standard of attainment in the subjects referred to, and may exempt such graduates or holders of such certificates from passing the aforesaid examinations appointed and directed by the council.

3. Any person whose proposal has been passed by the council shall be duly informed of it by a letter from the secretary.

4. Ballots shall take place at the first ordinary meeting of the institution in the month of December in each year, and at the first meeting in each ensuing month during the session, and at the last meeting but one in the session. Only corporate members have the right of voting.

5. Every candidate shall be declared to be elected unless there be at least one negative vote for every four affirmative votes.

6. In any election a second ballot shall be granted, at the same meeting, if it be demanded immediately by any three persons present having a right to vote.

7. In case of the non-election of any person balloted for, no notice shall be taken thereof on the minutes.

8. The proposal for transferring any person from the class of associate members to the class of members shall be according to Form C in the appendix. This form being subscribed to by at least 10 corporate members, and delivered to the secretary, shall be submitted to the council, who, subject to the conditions hereinbefore set forth, may, if they think fit, make the proposed transfer.

9. Any person duly elected a member, associate member, associate, or honorary member, or transferred from one class to another, shall be informed thereof without delay by a letter according to the Form D, enclosing a promise (Form E), which promise the person elected or transferred must sign and return to the secretary, and he must pay the admission fee and annual subscription for the current year (or the increase thereof in case of transfer) within two months after the date of his election or transfer, which otherwise shall become void; but the council may in particular cases extend the time.

10. Every individual elected, and having signed the Form F in the appendix, and the register of the institution, and having likewise made the proper payments, shall receive the diploma of his election. At the first ordinary meeting at which he is present, he shall, after having fulfilled the foregoing requirements, be introduced according to the ensuing form—viz., the president or chairman of the meeting, addressing him by name, shall say, "As president (or as chairman of this meeting) of the Institution of Civil Engineer, I introduce Mr. A. B. as a member, associate member, associate, or honorary member (as the case may be)."

11. The council shall have the right, by a majority of two-thirds of those present at a meeting of the council, to expel from the institution any member, associate member, or associate who may be convicted, by a competent tribunal, of felony, embezzlement, larceny, or misdemeanour, or other offence which, in the opinion of the council, renders him unfit to be a member; and in case the council shall be of opinion that the conduct of any member, associate member, or associate should become the subject of enquiry with a view of ascertaining whether there are grounds for his expulsion, or in case 20 or more corporate members shall think fit to draw up and sign a proposal for the expulsion of a member, associate member, or associate on any ground whatever, and shall deliver the same to the secretary to be laid before the council for consideration,

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the council shall make such enquiry as they deem adequate; and if they do not find sufficient reason for expulsion no entry of the enquiry shall be made in the minutes, but if the council by a majority of at least eleven-twelfths of those present at a meeting of the council specially summoned for the purpose, and at which at least 12 members of council are present, do find good reason for expulsion of the member, associate member, or associate, on the ground that he has been guilty of disgraceful conduct in any professional respect, they shall cause such person's name to be erased from the register, and thus expel him from the institution. The secretary shall give him notice according to Form G in the appendix, and the council shall report such erasure at the next annual general meeting.

SECTION IV.—ADMISSION AND PRIVILEGES OF STUDENTS.

1. Upon producing evidence of having passed such examination or examinations in the subjects of general education as may be appointed or recognised by the council, persons between the ages of 18 and 25 years may be admitted as students by the council on the recommendation (according to Form B in the appendix) of the corporate members under whom they are, or have been, pupils; and they may remain students of the institution, at and during the pleasure of the council, until they attain the age of 26 years, when they shall cease to be students. The council may cause to be held examinations for persons desirous of being admitted students, and may frame regulations for such examinations, defining the times at which they shall be held, the subjects which they shall comprise, and the fees to be paid or deposited by candidates in respect of such examinations; and the council may from time to time add to or vary or rescind such of the aforesaid regulations as may appear to them to be necessary, and shall have power to recognise in their discretion university degrees and collegiate or other certificates in lieu of examinations appointed under the provisions of this section.

2. Any person admitted as a student shall be informed thereof by letter (according to the Form F in the appendix) stating that the first year's subscription must be paid within two months, otherwise the admission will be void. When the first subscription shall have been paid he shall be entitled to attend the ordinary meetings, but not to vote at such meetings, and to have the use of the library (subject to such regulations as the council may from time to time prescribe), as well as to receive a copy of the *Minutes of Proceedings* relating to each session during which he shall continue to be a student.

3. Students of the institution are eligible to compete for the premiums or prizes arising out of the "Miller Fund," and any other funds devoted by the institution, or by any person or persons, for premiums or prizes for students.

4. The council may accord to students other privileges, but subject to such terms, regulations, and restrictions as they shall from time to time prescribe.

5. No student will be allowed to introduce a stranger into the rooms of the institution.

SECTION V.—CONTRIBUTIONS TO THE FUNDS.

1. Those members, associate members, associates, and students, whose place of business or whose residence is within 10 miles of the General Post Office, shall be considered residents, and those beyond such limits non-residents.

2. On change of place of business or of residence, so as to go beyond or come within those limits, before each annual contribution becomes due, the amount thereof shall vary accordingly.

3. Each resident member shall pay four guineas and each non-resident member three guineas per annum.

4. Each resident associate member and associate shall pay three guineas and each non-resident associate member and associate 2½ guineas per annum. The subscription for the current year paid by an associate member shall, on his transfer to membership, be taken as in part payment of his subscription as a member for that year.

5. Each resident student shall pay two guineas and each non-resident student 1½ guineas per annum. The subscription for the current year paid by a student shall, on his election to associate membership, be taken as in part payment of his subscription as an associate member for that year.

6. Every new member, associate member, and associate shall on admission to the institution pay a fee of 10 guineas; but no payment, other than the increased annual subscription, shall be due from an associate member on his transfer from membership.

7. Any member, associate member, or associate whose subscription is not in arrears may compound for future annual subscriptions by the payment of 60 guineas. All such compositions shall be invested, and the interest alone shall be appropriated to the current expenditure of the institution, except by special direction of the council on the report and recommendation of the Finance Committee.

8. All annual subscriptions are due on January 1 in each year for the year then commencing, and must be paid before April 1 of that year; any member, associate member, associate, or student, whose subscription is in arrear shall not be entitled to attend any meeting, or to receive the publications. The subscription of any member, associate member, or associate, elected at the ballot in December, shall become due on January 1 next ensuing; and the subscription of any student admitted in the month of November or December shall become due on January 1 next ensuing.

9. Every individual elected a member, associate member, or associate, and every student, shall be liable for the payment of his annual subscription, until he has signified to the secretary, in writing, his desire to resign, having previously paid all arrears, or until he has forfeited his right to remain in, or to be attached to, the institution.

10. Any person whose subscription is two years in arrear—that is to say, whose arrears and current subscription shall not have been paid on or before April 1, shall be reported to the council, who shall direct application to be made to him according to Form H, and in the event of its continuing one month in arrear after such application the council shall have the power, after suitable remonstrance, by letter, in the form so provided (Form I), of erasing the name of the defaulter from the register or lists of the institution.

11. In the case of any corporate member who has been long distinguished in his professional career, but who, from ill-health, advanced age, or other sufficient cause does not continue to carry on a lucrative practice, the council, if they find good reason for the remission of the annual subscription, may so remit it. Also they may remit any arrears which are due from such an individual, or may accept a collection of books, or drawings, or models, or such other contributions as, in their opinion, under the circumstances of the case, may entitle the person to be enrolled as a life subscriber, or to enable him to resume his former rank in the institution which may have been in abeyance from any particular cause. The council may, if they find good reason to to do so, reinstate, under such conditions as they may see fit, any member, associate member, or associate whose name has been removed from the register under the provisions of this section. These cases must be considered and reported upon to the council by a committee appointed by the council for the purpose.

CITY AND WEST-END RAILWAY.

The Select Committee of the House of Commons, of which Mr. Woodall is chairman, have again been occupied this week with the consideration of the City and West-end Railway Bill—a measure which provides for the construction of an underground railway, six miles in length, from Cannon-street to Hammersmith-broadway, to be worked by electricity.

Sir Benjamin Baker, engineer to the proposed line, cross-examined by **Mr. Horace Avory**, said he would undertake to keep the top of the tunnel of the proposed line not less than 30ft. below the surface in Piccadilly, 10ft. of this depth being London clay. On the City and South London there was only 2ft. of clay with watery subsoil above it, and that line worked well and without damage to surrounding property. With 30ft. of soil above the tunnel the effect of vibration would be *négligeable*. St. James's station was to be at the corner of Arlington-street and Piccadilly on the east side. The station in Piccadilly-circus was to be at Lemon Tree-yard, at the corner of the Haymarket and Piccadilly. The Baker-street and Waterloo line already had power over this site, but the two lines would work amicably, and thus a much better station would be made than if they had worked singly.

Sir Douglas Fox, engineer to the Liverpool Overhead Electric Railway, which at one end has half a mile of tunnel, gave evidence generally supporting that of Sir Benjamin Baker. In connection with the Liverpool overhead line he found that the vibration was inappreciable, and that the use of electricity had solved the question of ventilation. It was, he thought, self-evident that the route proposed was the most important in London that could be selected for an underground railway, being far superior to the Brompton and Piccadilly route, which seemed to be only a portion of a scheme. The line was likely to have a very large traffic, not only of itself, but because it connected with several other lines. As the line was to be bedded in the London clay its construction would be easy, and the estimates, according to his experience, were quite sufficient. As to inserting a vibration clause in the Bill, he thought it was quite right that the public should be protected against any real damage that might occur in carrying out work of this kind; but experience had shown that there was no risk of damage from vibration where the line was at this depth and in soil like the London clay. It was objectionable, therefore, to hamper the scheme with a clause which was found by experience to frighten financiers very much. It might very easily lead to many claims for compensation and be fatal to the Bill.

Mr. Galbraith, engineer to the Waterloo and City Railway, also gave evidence as to the practicability and advantage of the proposed line. With regard to the subsoil at Walbrook, which, it had been suggested, there would be difficulty in dealing with, he said that the soil there to a depth of 25ft. was of the usual character, while below that for a considerable depth was the London clay.

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TO CORRESPONDENTS.

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All communications intended for the Editor should be addressed C. H. W. Biggs, *139-140, Salisbury Court, Fleet Street, London, E.C Anonymous communications will not be noticed.*

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POWER TRANSMISSION.

The recent paper on the transmission of power to long distances by alternate currents of electricity, read by Mr. W. B. Esson before the Society of Arts, was followed by a most meagre discussion. This was a great pity considering the time and labour which must have been spent by the author in its preparation. Although the paper was confined to power transmission over long distances, and also to the alternate-current system, the allotted hour was too short for the subject. The author laid particular stress on the need of good mechanical design in the generators and motors for power transmission, and that it was preferable for this reason to bury the armature conductors in the iron core. The question of the regulation of generators for power transmission, and the increased drop due to a motor load, is given due prominence. We think, however, it is more satisfactory to speak of the self-inductive effects than armature reaction in this connection. In calculation, the self-induction of the armature and external circuit only need be considered, and the results can then be always foretold. The best frequency for all purposes is always more or less of a compromise, and we fully agree with Mr. Esson in his statement that low frequencies are best for power transmission. We cannot, however, go so far, as to say with him that "as far as power *per se* is concerned, the lower the better." With large generators a low frequency gives a more mechanical design, and also with a low frequency small motors with few poles run at comparatively low speed and have a good starting torque. But if we carry this matter to extremes, electrical trouble ensues. We believe the author will agree with us that with generators and motors the weight efficiency increases with an increased frequency, and are sure that he would not try to construct, say, a one thousand horse-power generator with a bi-polar field. The self-induction, or armature reaction trouble, becomes unduly felt if any such extreme measure is tried. The advantages and disadvantages detailed of a single-coil field over a magnet system with many coils were somewhat discounted by the author overlooking the inductor type of alternator. In this machine the magnetic leakage is not increased by the use of a single exciting coil, because there are no large polar surfaces exposed to leakage, as in the type manufactured under the author's direction.

The advantage of having the stationary part of the motor wound with the alternate-current circuit is pointed out, as in this way it can be wound for high pressures, say to five thousand volts, without danger to the attendant. Of course, with small motors, reducing transformers should be employed. The next points taken up by the author were those of cost of plant and line to transmit a given power over varying distances at varying voltages. These figures will be useful as a rough basis of calculation, and we regret that no discussion could be made on this part of the paper. It was due, of course, to the fact that those present had received no advance proofs of the paper, and that the tables of figures were not read

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by the author. The conclusion that the induction or non-synchronous motor is superior to the synchronous one for general purposes is quite correct, but there are special cases in which the synchronism of the latter type is alone sufficient to warrant its adoption. On the question of starting non-synchronous motors the author only refers to the use of resistances to reduce the current in the rotor at starting, and does not refer to the many ingenious methods of grouping the stator or rotor coils to give greater starting effort with a small current. These methods will be found described in our last volume. The Society of Arts is to be congratulated on the addition of this paper to their list of electrical contributions.

THE INSTITUTION OF CIVIL ENGINEERS.

The alteration of the constitution of the Institution of Civil Engineers affects every branch of engineering, and, in fact, every individual engineer in the universe, for the institution has always been looked upon as the parent institution as regards engineering to the English-speaking race. It has also been to a great extent the one great example to be followed by most of the engineering institutions in foreign countries. Hitherto its members have studiously held aloof so far as the examination craze is concerned, but at last they seem to have fallen into line, and to recognise that in some way or other examinations may be supplementary. The members—and by members we include all classes of members of the institution—have hitherto been admitted by selection. We are quite sure that under the fostering care of Mr. James Forrest the claims of candidates were thoroughly examined, and few ineligible men gained admission. It was and is an honour to belong to the institution, and no man ever heard a whisper that the society was prostituted for the sake of individuals. Its *Transactions* are among the most valuable issued by any society, and the abstracts which are published in the *Transactions* are excellent examples of what abstracts must be in order to be of any use. The institution, then, is the foremost of all institutions representing applied science. It has many offshoots representing special branches of applied science, while it includes within its membership representatives from all such bodies. Hence the step taken by the institution becomes more prominent than would any change in the constitution of a minor body. Retrogression is impossible. Examinations cannot be temporarily tried, but once introduced have come to stay. It is too late in the day to attempt any discussion as to the true value of an examinational selection, but one point has been usually overlooked. Select any two societies, or rather select one wherein entrance is obtained more easily by an examination franchise, and compare its papers and discussions with those of the institution. We venture to contend the latter are more useful, in that they tend to bring out points which can be used in practical work, whereas the former tend more to bring out points that will support or condemn theories. It is admittedly a want that both these purposes shall be served, and the difficult point is to apportion both classes of members so that in the representative body of applied science the tendency will not be to theoretic but to practical results. If the examination is to be used merely as an aid to those few individuals who ought to be members, but yet who cannot be nominated and elected under the old constitution, then by all means welcome the examination as an auxiliary; but if examination is gradually to supersede nomination or selection, then it will prove a great evil. One new departure we heartily appreciate, and that is the requirement of a thesis or paper upon a practical subject. This, if honestly contributed, would be a far more effective check than examination to ensure individual capacity. It shows also whether a man has any originality as against mere bookwork knowledge usually brought out by an examination. Altogether the new departure of the institution will be watched with great interest, and we trust its members will still continue to be men rather than bookworms.

THE TELEPHONE SERVICE.

Our leader of the 12th ultimo has taken effect, and we are glad to see that the Government have at last taken action in this matter. Thus we learn from the *Standard* of Wednesday last that the Treasury have decided that where any grievance is alleged as to the defective administration or apparatus of the service of any telephone company, a local enquiry shall be instituted and evidence taken. The enquiry will be conducted either by a lawyer or by an electrical expert. The action of the Treasury in the matter is accepted as evidence that this Department and not the Post Office possesses the control of the telephone companies.

REVIEWS.

The Application of Electricity to Railway Working. By W. E. LANGDON, M.I.E E., etc. (New edition.) London: E. and F. N. Spon.

Mr. Langdon's experience as engineer of the electrical department of the Midland Railway is of the best. His book fills a distinct gap in electrical literature, and that his work has been appreciated is proved by the demand for a new edition. The object of the work is set forth in the preface. It is "to illustrate and explain the manner in which it (electrical energy) may with advantage be applied to railway working." The method adopted in the previous edition is followed, though owing to the great progress made since the book was first issued much new matter has been added. The book is very largely descriptive, and hence it is hardly subject for criticism, though it may be subject to commendation. If, for example, the poles employed are almost universally of red Norway fir, that is a matter of fact, and the specification for such poles, their age, seasoning, branding and stamping, creosoting, etc., are all the outcome of long experience. Mr. Langdon summarises the results of that experience in an admirable manner. The same may be said of the remarks relating to pole-arms, brackets, insulators, bolts, stays; and all the various items that make up the complete line are fully discussed and the most recent practice described. We have recently had so much in our pages concerning railway signalling and working that our opinions upon the subject must be well known. In a large part the subject-matter of Mr.

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Langdon's book is outside the scope of our articles, though both refer more especially to what may be termed controversial matter. Mr. Langdon deals respectively with materials, surveying, construction, and batteries, in as many chapters, before he comes to block signalling, which, with the descriptions of the various systems, takes six chapters, bringing us to the application of electric light and power. The latter subject is not so comprehensively treated as are those directly connected with telegraphic work, but Mr. Langdon's conclusions are given without doubt in favour of electric lighting, though, as might be expected, little or nothing is said about the use of electrical energy for propulsion purposes. We are glad to see the emphatic commendation of arc lighting in goods yards and similar places thus: "In the loading and unloading of stock and in the marshalling of trains it is invaluable." We should have been glad if Mr. Langdon could have seen his way to discuss in detail the system of Mr. Sayers. We are not quite so sure as is Mr. Langdon as to the value of Mr. Trotter's experiments, nor do we give adhesion to the view that if there is plenty of light about the points—and certain points—there may be some considerable diversity at intermediate places. The area over which the light should be as good as possible is in our opinion larger than seems to be indicated. Train-lighting has its chapter, and deals pretty closely with the system adopted on the Midland. Then we have a short chapter on train intercommunication, and a far more complete discussion of administration than is to be found elsewhere. We have only briefly directed attention to a book full of interesting and valuable information of more than usually practical character, though this is only to be expected from the author's ripe experience.

FOR AND AGAINST MATHEMATICS, ETC.

BY W. PERREN MAYCOCK, M.I.E.E.

Most professors and many teachers will maintain that a good knowledge of mathematics is indispensable to the electrical engineering student, this opinion being probably very greatly influenced by the fact that they themselves have successfully overcome the inherent difficulties of mathematical study, and that they consequently do not quite understand why other people should stumble at those difficulties. To become a really good mathematician one must possess the power of abstract reasoning in a high degree, as well as a good kindred memory. Now some men can reason with and remember concrete or tangible things, while they find great difficulty in applying those faculties to abstract or non-tangible things. Hence there can be good experimental chemists, physicists, and, dare I say, electricians and engineers who are poor mathematicians.

Now a youth who at school or college has not devoted proper attention to mathematics, will often find difficulty in acquiring such knowledge when he enters the outer world, for the reasons that his brain is no longer in the fresh and unworried condition of boyhood, that he has much else to think of, and that his available time is short.

Variety is the charm of existence, and when you come to think of it, it is a very good thing that we of the electrical profession are not all expert jugglers with mathematical formulæ. If it were so, we should become so very learned, and so exceedingly incomprehensible to outsiders—*i.e.*, to the general public, that on the whole we should suffer through not being able to explain in plain everyday style the good works we wished to perform; for it is a fact that mathematicians are often quite incapable of expressing themselves in ordinary language. Even when writing what they intend to be an elementary exposition of a subject they—possibly unconsciously—use terms and phraseology to which they are doubtless used, but which certainly do not constitute plain English.

Here are two or three examples (the italics being my own) culled from a well-known work on "Dynamos, etc.," in which the undeniably eminent author's object has been to treat of the subject "*without the use of high mathematics*," the book being intended for "*the average engineering student and the average practical engineer.*" Be it high or low mathematics, I can vividly imagine the "average" student tearing his hair on reaching the following, which occurs very early in the book:

$$\int_{r_2}^{r_1} \frac{M\,m}{r^2}\,dr = -Mm\left(\frac{1}{r_1} - \frac{1}{r_2}\right).$$

Later on we arrive at the following interesting and lucid result:

$$F = -\frac{4\pi 3}{\Sigma \frac{l}{A}\frac{1}{\mu}}.$$

Perhaps these formulæ are unavoidable, in which case, in a book intended "*for average students*," could they not be supplemented by a little subsidiary explanation?

There is great need for a really good book on practical mathematics, in which the different branches shall be effectively combined, only modern methods treated, and that in a clear and concise manner. Who will write one? This reminds me of a certain technical school whose poor unfortunate students were referred to two bulky volumes on the integral and differential calculus respectively for their information on these subjects, volumes which would require years of close study to get through. All very well for the future professor of mathematics, but very disheartening for the electrical student.

Referring again to the book quoted above, the author takes the Mordey-Victoria machine as his first example of a dynamo, certainly not a simple construction to commence with. Another writer, on the first and second pages of his book, in speaking of ordinary alternating E.M.F., likens it to "*the sort of variation which takes place in the apparent distance of a satellite from its primary, as seen by an eye situated in the plane of revolution, and at an indefinitely great distance from the orbit. The form of the law is simply* $x = b \sin\left(\frac{\pi}{T}\frac{}{t-t'}\right)$." Quite so, but why drag in such an abstract analogy when much more obvious and practicable ones are at hand.

Certain writers still use the impossible German characters in formulæ connected with magnetic quantities, in place of the ordinary block capitals now generally accepted. Why this should be so is certainly remarkable, for one of the chief considerations in adopting a symbol should be the ease with which it can be written down. Many other examples might be quoted.

The cases in which really good theory and really good practice are combined in one and the same man are few and far between. Life is too short and knowledge too vast for an ordinary individual to thoroughly become both a theorist and practician. Both are necessary to progress, and on behalf of those who work in the fields of practice I would urge our best-known writers to strive to elucidate some of the many important phenomena and facts that are at present, like Jeames's birth, "wrop in a mistry."

THE TRANSMISSION OF POWER TO LONG DISTANCES BY ALTERNATING CURRENTS OF ELECTRICITY.*

BY W. B. ESSON, M.I.C.E., M.I.E.E., ETC.

(Continued from page 406.)

Now comes the question of the number of reversals of the current per second, regarding which there has been a good deal of discussion. British engineers are accustomed to talk of the number of complete cycles per second, meaning by cycle a current first in one direction and then in the other, as indicated by the complete wave *a* to *b* in the diagram, Fig. 1. Instead of repeating "complete cycles per second" every time, however, they use the word frequency, so that a "frequency of 50" means that the current is reversed 100 times per second, or that there are 50 complete cycles per second. In the working of synchronous motors the frequency question is of comparatively minor importance, but with regard to non-synchronous motors, which are now almost universally employed for power work, it is of the greatest importance. There is no particular frequency, the best under all circumstances, but it must be remarked at the outset that whatever the views held by lighting engineers, all who have had experience of power transmission, agree as to the desirability of a low frequency; so far as power *per se* is

* Paper read before the Society of Arts, March 24.

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concerned the lower the better. You are doubtless aware that in the States the first alternating-current plants were run at a very high frequency. The ordinary thing was from 125 to 132, a figure which was very suitable for scattered distribution and small transformers. With the development of alternating-current motors, however, the frequency for the standard designs of alternators has gone down to 60, while for machines which have to supply currents for power only the figure has been reduced to about 30. In the case of Niagara and some other large plants it is 25. In Europe the frequency for power transmission work ranges from 40 to 60, and the mean of these figures, 50, is about the lowest that can be adopted consistent with obtaining satisfactory results on the lighting circuits, which are in a greater or less degree generally combined with power transmission. At 50 the fluttering of arc lamps, when they are enclosed in opalescent globes, is inappreciable at a distance of a few yards.

It will be seen then that engineers have had to remodel all their designs for the purpose of power transmission, consequent on the high frequency permissible, nay advantageous, for lighting being altogether unsuitable for circuits running non-synchronous motors. Anything above 60 is to be viewed with

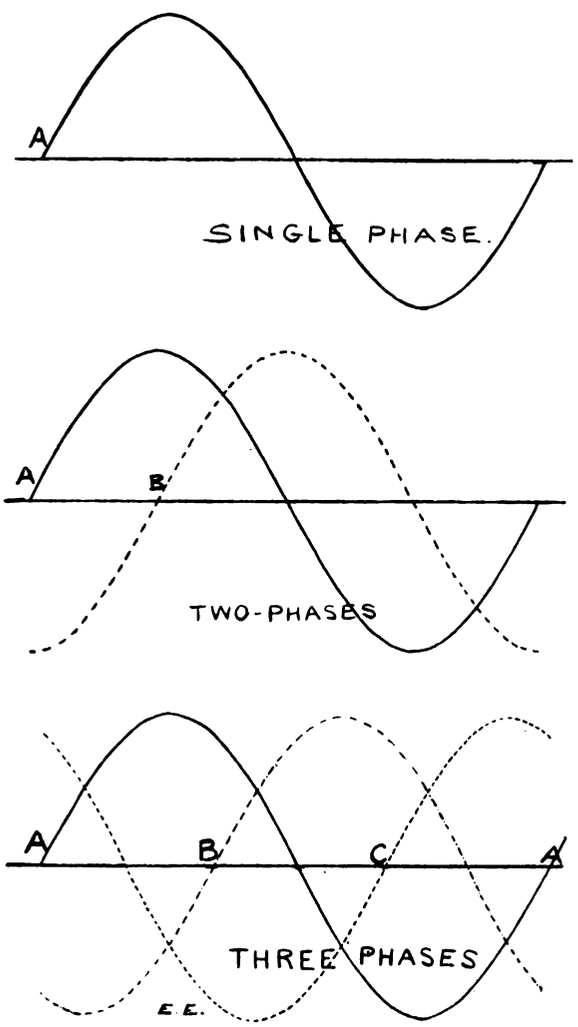

FIG. 1.

distrust, and we would go down to half this, or even below, if we could then, in a satisfactory manner, operate lighting circuits without introducing complications too costly to be justifiable. When we go above 60 we begin to get into trouble with generators, line, and motors all round. This is not the place to go into the many practical and theoretical considerations which have led to the universal adoption of the low frequency; suffice it to say that only the strongest reasons induced one engineer after another to alter his designs to suit power transmission work. Experienced men are all agreed as to advantages of low frequency, and it is a matter for congratulation that there is specified for the electric lighting works now in progress a frequency only about half of what was usual some time ago. As a consequence, the circuits are rendered much more suitable for the working of motors.

Another thing of some importance is the form of the E.M.F. curve of the generator. Shall it be flat-topped, or resemble the teeth of a saw, or be like any of the irregular figures shown by Dr. Fleming in his recent lectures on transformers, or shall it be a sine curve pure and simple? Well, the opinion universal among engineers having to do with power transmission, is that alternators giving a sine curve for the E.M.F.'s are in all respects the most suitable. It has been shown, as you probably know, that so far as hysteresis loss in transformers is concerned, the saw-tooth curve is best, but in transmission work there are many other things to be considered, and experience has shown what one might almost have arrived at by intuition—namely, that for smooth running a simple harmonic curve is best of all.

But to return to construction. The first polyphase generators consisted of a couple of ordinary alternators having their shafts rigidly coupled together so that the two currents produced by them were displaced by a quarter period. This was costly, inasmuch as two small machines are more expensive than one large one, and the next step was to combine the two machines in one, thus producing a two-phase generator proper. The most obvious way of doing this, so far as machines with rotating magnets were concerned, was to displace one-half of the fixed armature coils relatively to the other half, so that the currents of different phases were generated each by a separate half of the fixed portion of the machine, the magnets being common to both. The generators constructed by Messrs. Johnson and Phillips for the Sheba Mine plant were of this type. The armature consisted of a number of iron sectors, which were mounted in a cast-iron shell made in two halves.

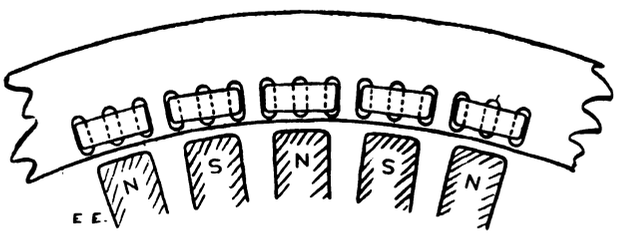

FIG. 2.—Single-Phase Hole-Wound Armature.

A machine-wound coil was fixed on each sector. The seven coils in the top half generates one current, the seven in the bottom half the other, with a phase difference between them of 90deg. Each current has a virtual difference of potentials of 3,300 volts, so that every coil is responsible for about 470 volts.

Generators of the above type, though capable of doing excellent work, are no better as regards armature reaction than are single-phase machines. Each semicircle of coils reacts separately on the magnet to weaken the field, and produce other effects which can well be dispensed with, while obviously it would be of advantage to usefully employ some of the space on the armature presently unoccupied by windings. As I have already said, the drop in pressure between no load and full load depends primarily on armature reaction; it is desirable, therefore, that any way of arranging the coils be adopted by which the reaction can be reduced. When we want to keep the reaction low in single-phase generators we make the number of convolutions on the armature coils as few as possible, the field as strong as possible, and the air-space between the armature core and magnet tips fairly large. In polyphase generators we can do all these things; and one thing more which greatly helps us—that is, mix the coils of the several phases. This latter constitutes an important point of difference between the machines

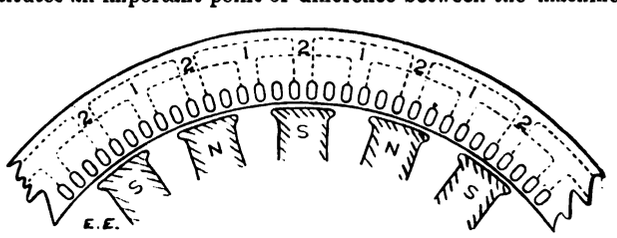

FIG. 3.—Two-Phase Hole-Wound Armature.

just described and those now constructed by the same firm. One form of armature with mixed coils consists of a number of laminated iron sectors mounted in a cast-iron shell as before, but in each sector are embedded two machine-wound coils displaced relatively to each other by a quarter phase. The sectors are built up independently by laying charcoal iron plates one on the top of the other until the necessary depth is obtained, the corners of each plate being bent out of the way to get it over the coils, and straightened back again when in position and before the next plate is put on. It will be seen that instead of there being semicircles of coils all of one phase reacting upon the magnets, what effect there may be now is due to the resultant of the two currents of different phases flowing in the intermixed coils. The result is that the reaction is greatly diminished; also that whereas the machine first described could only give for similar carcase dimensions, as a two-phaser, the same output it gave as a single-phaser, from the new machine, with the intermixed coils, there can be obtained, the carcase remaining the same, 25 per cent. more output.

Armatures with their coils wound through holes in the core plates have also the windings of the different phases intermixed. In such cases a micanite tube is first inserted into the hole and the wire is wound through it. Fig. 3 shows part of an arma-

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ture having a hole winding for two phases, while Fig. 4 shows part of an armature in which machine-wound coils are laid into slots punched on the interior surface of the core. It is to be observed that both in the case of the armature formed of sectors and the hole-wound armature the core surface presented to the field magnets is smooth; in the case of the armature with the coils laid in slots, however, the core surface is to some extent discontinuous.

Other things being equal, it is of advantage to have a construction such that the armature coils can be readily replaced by spares in case of an accident. In Johnson and Phillips's two-phase generators just described, each sector being independent, it can be replaced in a few minutes, and that without disturbing any of the adjacent sectors or making any other preliminary preparations, such as lifting the top half of the armature, racking the halves of the armature apart, or lifting the field magnet. In the machine with the armature coils wedged into slots the coils can be removed, but not without some trouble, and then either the halves of the armature must be racked open or the field magnet lifted. With the hole winding, independence of the coils cannot be readily secured,

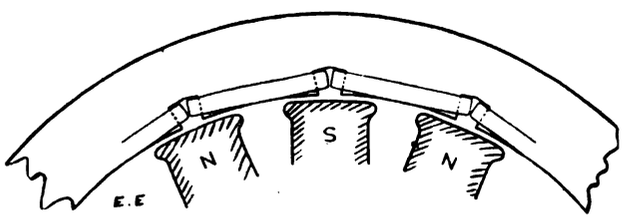

FIG. 4.—Slotted Armature

and in the case of a burn-out the machine has to be shut down while the repairs are effected.

Three-phase generators, in which the coils belonging to the different phases are intermixed, may have hole windings, but armatures for three phases can also be built up of movable sectors, each having one coil. When so constructed (Fig. 5), each third coil counted round the armature belongs to the same phase, and the coils are therefore coupled in three sets, so that if they are numbered 1, 2, 3; 1, 2, 3; 1, 2, 3, all round, all the 1's will be in one set, all the 2's in the other, and the 3's in the third. The armature reaction in a machine of this kind is greater than with intermixed coils, but it is certainly not so great as in the case of a single-phase, or of the two-phase machine, with the sectors in separate semicircles.

Having said so much regarding the armature, we may shortly consider the field. The magnet of the Sheba generators consists of a star-shaped steel casting in two halves, excited by a single coil wound on a central boss, from which project N poles on one side and S poles on the other. These polar projections are bent round and interlaced so as to form a circle of N and S poles, alternately running with a clearance of $\frac{1}{8}$in. or so between the tips and the armature core. This form of field magnet was employed originally by Mr. Brown for the well-known Frankfort-

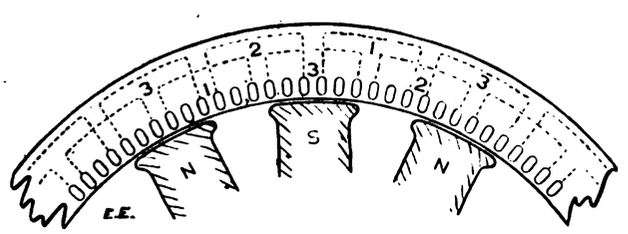

FIG. 5.—Three-Phase Hole-Wound Armature.

Lauffen transmission, and has the advantage of requiring a very small amount of copper for excitement as compared with other forms. It has, however, the disadvantage of a comparatively large stray field, with the exciting coil at some distance from its work, and the consequence is that when loaded on motors a large proportion of the induced field never enters the armature, a considerable drop of pressure with the load resulting. I have just said that to keep the armature reaction small, the field must be strong, and as this strength is wanted between the field poles and the armature, the importance of getting the magnetising force as close as possible to the magnet tips will be obvious. On this account the multiple-coil magnet has been more largely used for power work than the single-coil magnet, as the coils of the former can be brought close up to their work. If the single-coil magnet is employed, the designer must bear these points in mind; also he must keep the masses of iron in the poles as small as possible. The single-coil has not yet been used for generators with rotating armatures.

Whether the magnets require to be laminated depends upon the construction of the armature. With an armature core presenting a smooth surface to the magnet, the air-gap being uniform and things arranged so that the magnetic reluctance is for all positions of the magnet the same, lamination of the field is not very necessary. The armature built up of sectors as already described complies with these conditions as well as armatures having hole winding. But for armatures having open slots to receive the coils, lamination of the magnet is necessary; if not throughout, at least the tips must be laminated. In the best-known American machines the magnets are laminated throughout; they consist of sheet-iron stampings bolted together.

Generators are designed to give from 2,000 to 3,000 volts for small outputs, and from 3,000 to 5,000 volts for large sizes. In very large machines a pressure of 10,000 volts could no doubt be managed, but then it would be just a question as to whether it would not pay better to generate at low pressure and raise the voltage for the line by means of step-up transformers. At present the practice is not to exceed in the generators 5,000 to 6,000 volts, and the experiment of running at higher pressure for power work has yet to be made.

The monocyclic generator is peculiar to the "monocyclic" system, which deserves remark as constituting a means of preserving the simplicity of single-phase distribution for lighting while securing the advantages of a three-phase system as regards the starting of motors and to some extent their running. I regret that the time at my disposal does not permit me to describe this very interesting system. It has made, I understand, some headway in the States, though I do not know that there is much scope for it in this country, or that it will be employed for general transmission work to any great extent.

II.—THE LINE.

The line conductors may be laid under ground or carried overhead, but the latter plan is almost universally adopted. In the case of underground, the best practice is to use cables insulated with some fibrous material impregnated with a resinous or bituminous compound and lead sheathed. Over the sheathing it is yarned, then armoured by steel tapes, again yarned, and well compounded on the exterior. Needless to say, whether for the main transmission or for use only where overhead wires are undesirable, the conductors must be concentric or twisted together. Such a cable can be easily laid, and no skilled labour is required save in making the joints. It is simply put in a trench, which is filled in again when the laying is completed. The question of its being in the wet or dry enters very little into account provided it is not laid in a clay soil, which in time would prove detrimental to the lead covering. Before you on the table is a sample of concentric cable such as I describe, 20 miles of which were made for Messrs. Johnson and Phillips by Callender's Company. It has been laid down for the power plant at the Sheba Mine, and before shipment from London every length was tested after 24 hours' immersion in water, with an alternating pressure of 10,000 volts between the conductors, and 5,000 volts between the outer conductor and the lead covering. The inner strand consists of 19 wires ·057in. diameter, and has a cross-section of a twentieth of a square inch when stranded. The outer conductor has also 19 wires of ·057in. diameter, stranded on in two segments. The insulation between the inner and outer conductor is ·35in. thick, and between the outer and the lead ·23in. thick. The lead sheath is 1-10in. thick. On a bedding of jute above the lead are laid two steel tapes, and outside these is a finishing layer of jute yarn stranded on and dressed with hard compound. The outside diameter of the complete cable is 2·3in.; its conductivity resistance is ·88 ohm per mile for each conductor; its insulation resistance above 1,500 megohms per mile between inner and outer conductors, and 800 megohms between outer and lead. Its capacity is under one-half microfarad per mile.

But, as I have said, overhead conductors are in almost universal use. They are in any case much less costly than underground cables, they are more easily repaired in case of a breakdown, and are much better adapted for very high pressures. In putting them up the best telegraph practice is followed, though of necessity the scantlings are everywhere more substantial. The poles are spaced from 30 to 50 to the mile, and from 25ft. to 50ft. high as circumstances demand. They are generally of timber procurable in the district. For the Niagara-to-Buffalo transmission, for example, they are of white cedar, while for transmission lines in California they are of cedar or tamarack; but sometimes they are of the stronger and more durable material—iron—as, for instance, in the line now being erected by the Central Electric Works Company on the Rand.

The insulators are fixed on cross-arms of wood and iron in the usual way, but they must be of special form to secure the high insulation necessary. Oil insulators of the pattern originally introduced by Messrs. Johnson and Phillips have been largely used, and the lines of the historical Lauffen and Frankfort transmission were carried on these. One well-known form is on the table. The insulator has an internal and external bell projection, and the former dips into an annular trough of oil, the trough being movable on the bolt so that it can be readily lowered for the purpose of cleaning by merely taking out a pin. The insulation is practically perfect in this form of insulator, even where moisture abounds, as before the current could go to ground it would have to cross a surface of oil. It will be seen that the oil-trough is thoroughly protected from

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wet, and the insulator is particularly suited to climates where excess of moisture is present, and where, therefore, the additional care of the oil is well repaid by the extremely high insulation obtained. But for ordinary climates oil has been given up, and we rely upon insulators so designed that the current would have to leak over a long path before getting to ground. On the table is one of Johnson and Phillips's insulators for high-voltage transmission work (Fig. 6). It will be seen that it is made very deep, and that the sides of the grooves are perpendicular, so that there can be no lodgment of dirt or dust. An insulator of this form is quite suitable for a working pressure of 3,000 to 5,000 volts. An insulator supplied by the same firm for still higher pressures is here. It will be seen that the surface over which the current would have to pass to get to ground is very considerable; in the actual insulator it is 12in. from the binding wire to the bolt, of which over 9in. is on the underneath side. This insulator is made of the finest porcelain fired at a very high temperature; it will stand a pressure of 100,000 volts before puncture, and is perfectly suitable for a working pressure of 10,000 volts. The insulators used for the Niagara-Buffalo transmission are of somewhat similar shape, but in the latter there is a gutter round the bottom of the outside bell designed so as to drain away the water on each side clear of the cross-arm. The construction of the gutter is such that only at two points, both clear of the arm, can icicles form. For the Montmorency-Quebec transmission a somewhat similar insulator is used. It will be understood that on occasion special insulators have to be used, as when the line goes up steep inclines, thus bringing considerable strain on the supports. At times also it has been found advisable to insulate the line wires for a few feet, where bound to the insulators, by means of wrapping them with sheet rubber and compounded tape.

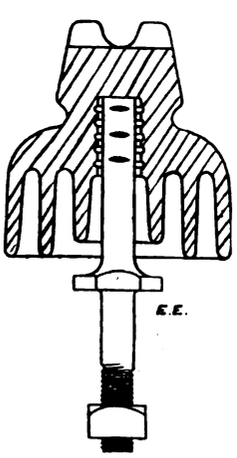

FIG. 6.—Triple-Petticoat Insulator.

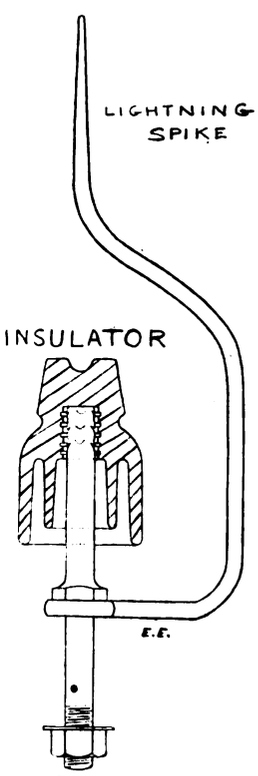

FIG. 7.

As regards the conductors, we shall see later how their size is to be determined, but whether they are laid underground or fixed overhead it is of the utmost importance that the generators, transformers, motors, etc., to which they are connected be efficiently guarded from lightning. It might, at first sight, be thought that there is no need to fix lightning guards to underground conductors, but the effects of induced discharges have to be guarded against just as carefully as have the effects of direct discharges. The kind of lightning guard in use for telegraph and telephone work is not adapted for power transmission. Generally the apparatus for the former consists of a simple spark gap, and as the E.M.F. at which the circuits are worked is comparatively low, such a device serves the purpose for which it is intended most satisfactorily. But when there is a pressure of over 2,000 volts and a reserve it may be of hundreds of horse-power available for maintaining across the gap an arc started by the lightning, it will be seen that in transmission work a somewhat different set of conditions comes into play. By the use of lightning guards, we endeavour to do two things—first, to conduct the direct or induced lightning charge as quickly as possible to ground, and thereby prevent damage to the apparatus and machinery; secondly, in the case of overhead lines to prevent the lightning from striking the conductors at all. In designing efficient guards to effect the first object the difficulties encountered were solely due to the fact that to maintain an arc across a gap requires much less pressure than is required to start it; in other words, the pressure required to make a spark pass between two points in a normal atmosphere is enormously greater than the pressure which will maintain a large current between the same points when the space is filled with carbon particles or metallic vapours. If across an ordinary spark gap between a high-pressure line and ground an arc were started by a lightning discharge, there would be nothing to prevent the generators from maintaining after the discharge had passed a large current across the gap, practically short-circuiting, and in all probability damaging themselves permanently before the fuses blow. Obviously, then, one of two courses has to be adopted. The first course is to provide a gap, which, though normally set to the amount which the lightning can jump, is automatically lengthened immediately the discharge has taken place to such dimensions that generators are unable to maintain an arc across it. Guards of this type have been devised by a great many inventors, the best known probably being the Thomson-Houston. In this the discharge takes place between two curved horns pointing upwards, and the arc when formed is repelled by an electromagnet until it goes out, the distance between the curved horns gradually becoming too great for the machine pressure to keep it going. Though this guard acts very well and generally breaks the arc promptly when formed, manifestly it would be much better to prevent an arc forming; and the second open to us is to use a metal alloy such that the starting of an arc in the gap becomes an impossibility. This is achieved in the Wurtz guard lying before you, an apparatus which recommends itself on the principle that "prevention is better than cure." It consists of a row of metal cylinders 1in. diameter by 3in. long, placed side by side parallel to each other, and each separated from its neighbour by a gap of 1-32in. The metal is an alloy of zinc and antimony, and when a discharge has passed there is nothing to mark the path it had taken save a small pit or burn. With the cylinders spaced as above, an arc cannot be maintained between them, the dense oxide vapour produced being non-conducting and unable to carry the current. This guard is always in a condition to protect the line, as the dimensions of the gaps are never altered, and so far as my experience goes its action appears to be all that can be desired.

All lightning guards depend as regards their action on the fact that a lightning discharge prefers to make its way to ground across a small air gap rather than through the coils of the apparatus, which are in parallel with the path to ground. It will be apparent that coils possessed of self-induction, having an influence quite negligible when considered with reference to the working frequency, may offer enormous opposition to the course of the highly oscillatory discharge of lightning. Seldom therefore does lightning damage the machinery when a proper guard is used, but it is nevertheless often advisable to introduce chokers for the purpose of supplementing the opposition which the coils of the generators would offer alone to the discharge. These chokers consist of coils offering practically no opposition to the normal current, but choking effectually any attempt to go through them on the part of the lightning. The combination of Wurtz gap guards and chokers has been adopted with success for several transmission plants. Whether the conductors be underground or overhead, efficient guards such as I have described must be employed to protect the apparatus at both the generator and motor ends of the line; at intermediate points they are not required.

The guards described provide a path to ground for direct or induced charges, but, as already stated, for overhead lines another kind of guard is employed by which we endeavour to prevent the lightning from striking the line at all. If once the lines are struck the guards already described will doubtless protect the apparatus; at the same time the precautionary measure of keeping, if possible, the lightning off the line is well worth taking. The well-known lightning spike (Fig. 7) used in telegraphy is the simplest of these guards. It consists of a pointed rod of wrought iron secured to the cross-arm by the insulator bolt and having its point projecting some inches above the line. One of these spikes is fixed at each insulator, care being taken to make a thoroughly good connection from them to ground. A better guard is a bare iron wire running the whole length of the line fastened on the top of the poles. This may be barbed fence wire, and it should be grounded every third or fourth pole. For the protection of the Niagara-Buffalo lines barbed wires are employed, grounded every 500ft. or so; for the Montmorency-Quebec lines strong galvanised iron wires are used run on the extreme ends of the top cross-arms, while the Tivoli-Rome lines have a single wire run on the top of the posts. These methods of guarding have proved very efficient, but, needless to say, the greatest care must be taken to ensure a good ground connection; failure in this respect may render the guards not only useless, but worse—an actual source of danger.

I now come to the size of conductor to be used, which depends on (*a*) the system to be used; (*b*) the working pressure; (*c*) the power to be transmitted; (*d*) the loss permissible in the line.

The total weight of copper required for transmission by two-phase currents employing four wires is, with the same loss in the line and same working pressure, exactly the same as required for single-phase transmission, though, in the former case, each wire has, of course, half the sectional area. This is on the supposition that the same type of motor is used, as it

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would not do, for comparison, to assume non-synchronous motors in one case and synchronous motors in the other. Call this weight 1. If for the two-phase transmission we use three wires instead of four, making the third, which replaces two, common to both circuits, this third wire need not be double the area of each of the other two, but only 1·4 times, and under these circumstances the weight of copper will be ·85 against the former 1. If three-phase transmission with three wires is used, the figure for the relative weight of copper depends entirely upon what is assumed as the standard of comparison with reference to the strain upon the insulation of the line and the apparatus connected to it. If we assume that there is between any two of the three wires the same difference of potentials that there is between each pair of wires comprising a circuit of the two-phase system, the weight of copper is represented by the figure ·75. So far the weights are :

1. Single-phase system, two wires	1·0
2. Two-phase system, four wires	1·0
3. Two-phase system, three wires	·85
4. Three-phase system, three wires	·75

It will be seen that on the three-phase system the same power can be transmitted by three wires as can be transmitted by four wires of the same size, working on two phases, it being assumed that the loss in the line is the same in both cases.

The second factor determining the size of conductors is the pressure to be adopted, this being one of the first things which has to be decided when a transmission scheme is being worked out. The pressure influences very materially the cost of line construction, as the weight of copper in the conductors is, for transmission, of the same power with the same loss in the line inversely as the square of the pressure. For economical reasons, therefore, it is desirable that a pressure be decided upon as high as the conditions render practicable, while for long lines high voltage is imperative.

We have seen that generators can be readily wound for pressures of from 2,000 to 5,000 volts ; 25-h.p. motors can be wound for 1,000 volts, 50-h.p. for 2,000, and 75-h.p. to 100-h.p. for 3,000 volts. Still larger motors may be wound for 5,000 volts, and it should be remembered that with the high-pressure part at rest, the exposed rotating part is subjected to no higher pressure than if the current entered the machine at only 100 volts. The high-pressure part can be completely protected so that it is impossible to touch it, consequently high pressure is attended with no extra danger to the man in charge of the motors. It will be seen then that in the case of transmitting power to a group of large motors, there is no need to use step-up and step-down transformers as an essential part of the scheme until the distance exceeds that at which a pressure of from 3,000 to 5,000 volts is economical. Transformers need only be used to step down the lighting circuits and for such motors as may be too small for winding for the line pressure.

In deciding upon the pressure, we have to consider the sizes of the motors we are going to use. Large motors may be worked at the line pressure just mentioned, but if the bulk of the energy is to be employed for motors of medium power it might pay to reduce the line pressure to a suitable figure for the bulk, putting more copper into the conductors, but saving the cost of transformers. If the motors rule so small, however, that the whole of the current has to be transformed, there is no use in working the line at less than 3,000 volts. It is desirable to illustrate these points by an example : Suppose we have to deliver 300 h.p. at some distant point made up—

Ten motors of	10	h.p.	= 100 h.p.
Four ,,	25	,,	= 100 ,,
Two ,,	50	,,	= 100 ,,
Total			300 ,,

Let us say that the limiting voltage for the winding of the motor is :

For the 10-h.p. motors = 300 volts.
,, 25-h.p. motors = 1,000 ,,
,, 50-h.p. motors = 2,000 ,,

We will leave 300 volts out of consideration as a pressure suitable for the lines. Taking transformers at 50s. per horse-power* all round we have as the expenditure on transformers for different line pressures—

Working at	For the 10-h.p. motors.	For the 25-h.p. motors.	For the 50-h.p. motors.	Total transformers.
1,000 volts	£250	—	—	£250
2,000 ,,	£250	£250	—	£500
5,000 ,,	£250	£250	£250	£750

This means that if we work at 5,000 volts we require transformers for all the motors. If we work at 2,000 volts we require them for the 25's and 10's, while if we work at 1,000 they are required for the 10's only. It thus appears that working at 1,000 volts we could expend on the line about £500 more, and working at 2,000 volts about £250 more than we could working at 5,000 volts, the total cost of the scheme coming out no higher. Taking copper at £65 per ton, and assuming for the time being that the other items making up the cost of the line are constant and independent of the size of the conductors, we can increase the weight of copper for 1,000 and 2,000 volts by about 7·7 tons and 3·85 tons respectively over that required for 5,000 volts, and without increasing the cost of the installation. Whether these additions to the weight will be sufficient to keep the loss in the line the same as before with the reduced pressure will obviously depend upon the distance to which the power is to be transmitted, and in the following table the effect of distance is made clear.

Cost of Line Wire to Transmit 300 h.p. to various Distances at various Pressures. Two phase System. Copper, £65 per ton. Power lost in line 10 per cent. = 30 h.p.

Volts.	One mile.	Two miles.	Five miles.	Ten miles.	Twenty miles.	Fifty miles.
1,000	£310	£1,240	£7,750	—	—	—
2,000	77·5	310	1 937	£7,750	—	—
3,000	34·4	137	861	3,444	£13,776	—
5,000	12·4	49·6	310	1,240	4,960	£31,000
10,000	—	—	77 5	310	1,240	7,750

Taking the figures for one mile, and adding to them the cost of transformers as already found, it will be seen that 1,000 volts gives for this distance the lowest cost. Doing the same with the two-mile figures we have almost a tie between 2,000 and 5,000 volts ; 1,000 is out of it ; 5,000 has slightly the advantage, though it has always the advantage beyond two miles. With the same sizes of motors suppose the power to be increased to 600 h.p., and what happens ? Here the cost of transformers and also the cost of the copper is doubled for the same percentage loss in the line, the result being that the increase from 2,000 to 5,000 should be made in both cases for the same distance from the generator. It is interesting to note from the table the distance at which it pays to step the pressure up to 10,000 volts. The step-up transformers would cost at 50s. per horse-power £750, and adding this to the cost of the line for 10,000 volts at a distance of 10 miles, it will be observed that the figure comes to £1,060, against £1,240 for 5,000 volts without stepping up. It therefore appears that when the distance approaches 10 miles step-up transformers must be resorted to.

(To be continued.)

* This allows for a power factor of ·75.

FORTHCOMING EVENTS.

The following are some of the announcements for the forthcoming week :

TO-DAY (FRIDAY).—Institution of Junior Engineers, at 8 p.m., at the Westminster Palace Hotel, Victoria-street ("Cycle Construction," by Mr. A. W. Marshall) —Royal Institution (Mr. C. T. Heycock on "Alloys and the Theory of Solution"), 9 p.m.—Also at Paris, meeting of the Ingenieurs Civils de France.

TO-MORROW (SATURDAY).—Royal Institution, 3 p.m. (Lord Rayleigh on "Electricity").—Chesterfield and Midland Engineers' meeting at Tamworth.

MONDAY, APRIL 5.—Society of Arts (Cantor lecture, "Alloys," by Prof. W. Chandler Roberts-Austen), at 4.30 p.m.—Society of Engineers (at the United Service Institution, Whitehall, Mr. M. Faraday on Rating), at 7.30 p.m.—London Chamber of Commerce (Botolph House, Eastcheap, annual meeting), at 2.30 p.m.

TUESDAY, APRIL 6.—Royal Institution (Prof. A. D. Waller, M.D., F.R.S., on "Animal Electricity," last lecture), at 3 p.m.—Institution of Civil Engineers (discussion upon the paper, "Electric Lifts and Cranes," by Mr. H. W. Ravenshaw, A.M.I.C.E.), and, time permitting, paper on "The Blackwall Tunnel," by Messrs. David Hay and Maurice Fitzmaurice ; also ballot for members.—Society of Arts (Mr. C. E. Fripp on Rhodesia), at 8 p.m.

WEDNESDAY, APRIL 7.—Society of Arts (Mr. Dunstan, on Dairy Produce and Milk Supply), 8 p.m.—Crystal Palace Lecture (Mr. Worby Beaumont on Railways), 8 p.m.—London Chamber of Commerce (North Borneo), at 2.30 p.m.—Institution of Naval Architects (annual meeting at the Society of Arts ; dinner at the Hotel Cecil), 7.15.—And at Sunderland, meeting of the North-East Coast Engineers ; also at Dundee, meeting of the Dundee Institute.

THURSDAY, APRIL 8.—British Aluminium Company's meeting (Westminster Palace Hotel), 12.30 p.m.—Royal Institution (Prof. W. Boyd Dawkins on the Relation of Geology to History, Lecture III., Roman Britain), 3 p.m.—Institution of Electrical Engineers at the Institution of Civil Engineers, 25, Great George-street, Westminster ("Recent Developments in Electric Traction Appliances," by Mr. H. A. Baylor).—London Chamber of Commerce monthly dinner (at the Trocadero).

FRIDAY, APRIL 9.—Royal Institution (Lord Rayleigh on "The Limits of Audition"), 9 p.m.—Institution of Civil Engineers students' meeting ("Poole Harbour," by Mr. Harold Berridge).

SATURDAY, APRIL 10.—Royal Institution (Lord Rayleigh on "Electricity and Electrical Vibrations"), 3 p.m.

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INSTITUTION OF ELECTRICAL ENGINEERS, Mar. 25

Sir HENRY MANCE (president) in the chair.

The ballot list was given in our last week's issue.

The **Secretary (Mr. Webb)** read a letter dated March 13 from Dr. von Stephan acknowledging his election as an honorary member of the Institution. The honour, he said, thus unexpectedly conferred upon him by an Institution whose roll included the names of so many scientists of world-wide reputation would not be other than highly gratifying to him. His interest in the advance in telegraphic science has always been great, and he regarded the improvement of communication as one means of establishing peace and goodwill between the nations of the earth. If he had succeeded ever so little in that, he would not have lived in vain. Dr. von Stephan also acknowledged the sympathy with him in his recent accident, and said he was now slowly mending.

The **Chairman** said the secretary would give some further information as to the increases in the premiums.

The **Secretary** said that the Council had resolved that for papers read before the Institution the premium should be increased from £10 to £20, the Paris electrical exhibition premium from £5 to £10, and the other £5 premium increased in the like manner. For original communications not read, but inserted in the *Journal*, the premiums would be £10 and £5, and for students' papers one premium of £10 and two of £5. The rule by which members of the Council were excluded from the premiums would be relaxed, but it would be arranged that no member of the Council who had contributed a paper during the session should be a member of any committee which made a recommendation with regard to the awarding of the premiums for that session.

The **Chairman** said he had been authorised by the Council to communicate to the members a fact which they all regretted. That was that their secretary (Mr. Webb) was about to retire from the service of the Institution. With the increase of their numbers the duties of the secretary had become more and more arduous. Mr. Webb was in his seventy-third year, and had reached a time of life when one might look forward to a well-earned rest. The Council had thought it fit that as he had been with them 20 years, when Mr. Webb left them he should be awarded a substantial and liberal pension. No one not actually behind the scenes could understand the great amount of work there was to be done by the secretary during their session. The Council felt that the man who should be Mr. Webb's successor should be as good a man as they could possibly afford. The qualifications would be advertised, but he might say that it was desired to obtain a man of liberal education, with some knowledge of French and German, and one who was in touch with the profession. It was proposed to give a salary of £400 a year. He had little more to say, as it was not for him at present to say anything as to Mr. Webb's services in the past. That was a matter to be reserved for a future occasion.

The Institution then resumed the discussion of Mr. Benest's paper on cable breakages off Cape Verde.

Mr. C. Bright, speaking from personal experience, congratulated Mr. Benest and Captain Thompson, of the "Dacia," on the skill with which they had carried out the first of the two repairing expeditions described in the paper. It was evident that in regions like those described in the paper a submarine cable was liable to become embedded, and its recovery was likely to be nearly as tedious a matter as Mr. Siemens had found with the cable in the Amazon. The cable close to the Senegal mouth gave no trouble, but that was laid upon the coast ledge that was described. Mr. Bright did not think the fact of the strain spoken of was necessarily conclusive evidence of the cable having been laid with abundant slack. In reference to the failure that occurred on the beach at the land end, Mr. Bright mentioned cases where white ants had produced failures by entering at the end of the cable in the hut and penetrating along beneath the armour. Some of the deep-sea sections of the South American cable were insulated with india-rubber, and it would be interesting to hear how they did, for different conclusions had been come to as to the effect of pressure on the insulation of rubber. There were periodic scares as to a failure in the supply of guttapercha, and considering what a long time it was since that cable was first talked about it might really come off before the Pacific cable was laid. The Silvertown Company had recently laid a deep-sea cable with indiarubber insulation off the coast of Cuba. His (Mr. Bright's) experience with indiarubber had been mainly on dry land or in swamps, and he would leave it to others to give information as to the behaviour of rubber in the deep sea. If Prof. Milne's conclusions as to submarine earthquakes and slips were adopted, the cause of many cable breaks would no longer be mysterious.

Mr. W. H. Preece complimented the author on his paper, and remarked on the manner in which the India Rubber and Gutta Percha Company made public, for the benefit of science and of the profession, the facts that were gathered in the course of their cable-repairing expeditions. They were much indebted to the company for that, and it could only be a subject of regret that no other firm of contractors in the country was willing to follow such an excellent example. In spite of expeditions like that of the "Challenger," and one or two others, little would be known of the deep sea except for the constant work of the cable companies. Mr. Preece doubted whether Mr. Benest had proved the existence of his submarine river, but considered that he had proved a submarine current. The fact that the temperature was 49·9, instead of about 35 F., showed that. There could hardly be any connection between the bad weather described and any great disturbance of the bottom. Mr. Preece then, in a parenthesis, protested against the expression "knots per hour." A knot was a speed of one nautical mile per hour and not a distance. If it was desired to abbreviate "nautical mile," the proper expression was "naut." Although it could be done when the bottom was known, he thought that there was great risk in laying a cable at a speed of seven knots and with only 9·9 slack when the bottom was not well known. Mr. Preece suggested that there had been off Cape Verde some volcanic upheaval. That would confirm what had been observed in the known volcanic region between the Straits Settlements and Australia. The consideration of this should make one think twice before laying a cable in unknown oceans which were believed to be in the regions of volcanic action. The Pacific Ocean was covered with volcanic remains. Every atoll and almost every coral reef had volcanic rock for a groundwork. Most of them were, of course, believed to have become extinct long ago, but it could not be counted on for a certainty throughout. The experience of Mr. Benest confirmed an old contention of his, that it was absurd to lay a submarine cable unless something was known of the bottom on which it was to rest.

Mr. March Webb said the gradients and contour lines on the charts gave no clue to the cause of the two breaks, and left them to theorise. In reference to the source of the water on the submarine outflow imagined by Mr. Benest, the railway from St. Louis to Dakar crossed a river which in the wet season discharged into the lagoons, but at other times the current was lost in the sand before reaching them. Though he made no point of it, the lagoons had no outlet. It seemed a fair conclusion that where there was a scouring-out action of the bottom, that neighbourhood was dangerous for cables. About two miles north of Arica, in Peru, there was a flow of fresh water under the surface through the lower sand which represented what in the foot hills was a stream of considerable magnitude.

Captain Wilson Barker suggested that if a cable happened to be dropped over a region similar to Bath, say, the action of hot springs charged with chemical matters might have to be considered. The natural phenomena off Cape Verde described in the paper were ascribable to the complex arrangement of currents there. Captain Barker said that he thought the doctor on board might give more interest than he usually did to the scientific information obtainable during a repair. The doctor had usually nothing to do while the engineer was very busy. Hurried work had led in some cases to the bottom being wrongly described. Soundings for instance, containing foraminiferæ had been reported as sand when there was really very little sand. In the same way coral had been reported when there was really none, but polyzoa and calcareous algæ. With a little care and the use of a pocket lens, if the observations were made at once, such mistakes could be avoided.

Mr. H. C. Donovan related a case of a West Indian cable repair in comparatively shallow water. Considering the cable had been down only four years, it was surprising how it was coated with vegetable growth. In deeper water, however, as they got to the break it was scoured, and presented signs of severe distress. The galvanised iron was scoured bright. That was between Martinique and Dominica, in 1,600 fathoms. There could be no question of any rivers there. He, however, knew of various cases of brackish water due to submarine outflows.

Captain A. Thompson said that when they heard of cable breaks they usually also heard of bad weather, but there could be no connection between weather and volcanic action. Mr. Preece had considered that the temperature showed a deep current, but he believed the temperature observed was the normal one for that particular depth. The surface currents which made an eddy about the locality of the breaks might determine a deposit of fine mud, which might have a slow motion of its own. That might account for the destruction of the cable.

Captain Goodsall disagreed with Mr. Benest's conclusion as to a submarine river outflow. Storms could have nothing to do with deep-water breaks, because the effect of the waves did not extend beyond 40 fathoms, and was very small beyond 11 fathoms. Captain Goodsall related a case in which a cable in the Indian Ocean was unworkable in bad weather because the copper had gone inside with the ends touching. The *débris* carried down the Senegal in the rainy season followed the course of the North African current. From an experience of 17 years he believed that the real cause of breaks was cable suspension.

At this point the **Chairman** suggested that all speeches should be kept as short as possible, and any that were written should be handed in.

Captain Lugar described a constantly recurring break on the cable from Paita in Peru to Santa Elena in Ecuador. The breaks occurred about March for years in succession, and coincided with the rainy period in the Cordilleras. Ultimately the course of the cable had to be changed.

Mr. R. K Gray acknowledged the complimentary way in which the India Rubber and Gutta Percha Company had been spoken of. He hoped that what information they were able to give would be of advantage to the Institution and to the profession. As director of one of the telegraph companies it had come to his knowledge that an indiarubber cable laid in 1875 was in very good condition. As to the speed of laying the cables, he was responsible to a certain extent for that. They thought it was perfectly easy, when they had a survey of the bottom, to lay at a high speed. They had paid out at more than nine knots, but Mr. Preece was correct in saying that you had to know the bottom When they were certain on that point the difference between five knots and 10 knots was really very little, because the angle at which the cable went over the stern would be very much the same. Cable breaks might be very expensive matters. He remembered the case of the Eastern and South African Company's cable, which broke eight times in as many years off the Rovuma River. Sir James Anderson

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thought those breaks were due to something at the bottom, like the welling up which he had seen in the Solway Firth. At the time he (Mr Gray) had objected that the height of the column of salt water was such that it would seem necessary to suppose a much greater head to produce the outbreak than the configuration of the land near the coast would allow. But they had heard the evidence as to the existence of submarine outflows, and it was curious to note that all these breaks had occurred about the month of March. The latitude in the case of the Rovuma, the Congo, and Arica was. not very different, and the seasonal effects might be presumed to be similar—*i.e.*, it was the season of inland rains. Mr. Gray also referred to the underground river courses in some limestone districts. When the line of the cable at the Rovuma River was changed, the periodic breaks stopped. There had been at one time something similar with the West African cable off the Congo, and similar trouble had been experienced by the Central and South American Company off Esmeralda Point. As to the question of deep ocean cables like the Pacific, which Mr. Preece had referred to, the circumstances were quite different, and the matter they were discussing had no bearing on it. The Bermuda cable, for instance, gave no trouble.

Captain Lugar said. if he remembered rightly, the Rovuma cable was laid in 1879, and broke in 1882, 1883, and 1884 in succession. When it came to be repaired again in 1885. Sir James Anderson suggested that it should be laid in shore. It was ultimately laid in 100 to 200 fathoms, and lasted 10 years.

Portion of a communication from **Prof. Milne** was read by the **Secretary** He could not be present at the meeting, as he was detained by illness. It would be interesting to ascertain the precise hour of the 1895 failure, as at 22 hours on March 5 of that year his instruments showed the usual indications of a distant earthquake.

Mr. Warren and **Mr. Rymer Jones** handed in written communications.

Mr. Parsone, in a written communication, referred to repeated breaks off Pescadores Point in Peru. He also referred to evidence of similar submarine outflows on the coast of South America.

The **Chairman** said that any additions to the discussion should be sent to the secretary, and called on Mr. Benest to reply.

Mr. Benest said that the reason of the somewhat unusual course they took in one of their repairs was that there was a land line between Yoff Bay and St. Louis. By using this in the way described they had got through within five days of arriving at the spot, whereas in the ordinary way the repair might have taken three weeks or longer. He wished to make it abundantly clear that there could be no question of suspension, but he considered it very possible that there may have been a subsidence of the bottom. Mr. Benest went into the question of the soundings with the aid of the wall charts, but was unable to complete his reply within the limits of the time; and

The **Chairman**, in suggesting that it should be communicated in writing, as he himself intended to do with his contribution to the debate, closed the discussion by remarking that a submarine outflow of fresh water in the Persian Gulf was known to have an origin from the hills some hundreds of miles inland. He himself was inclined to imagine something like a submarine landslip – something like what happened, for instance, at Naini Thal. The deep-waterflow might be the determining cause of such a slip.

PHYSICAL SOCIETY, March 26.

Mr. SHELFORD BIDWELL (president) in the chair.

At the invitation of Dr. S. P. Thompson, the meeting was held at the Technical College, Leonard street, Finsbury.

Mr. Rollo Appleyard read a paper on **"Liquid Coherers and Mobile Conductors,"** and showed the following experiments: (1) A glass tube, containing mercury and paraffin oil, is shaken up until the mercury divides into small spheroids. The resistance of the chain of spheroids under these conditions is several megohms. Coherence can be brought about by a direct current, a spark, or by a Hertz oscillator. The coherence is visible, the spheroids forming into large globules. At the same time the resistance falls to a fraction of an ohm. (2) An unstable emulsion is formed by shaking water and paraffin oil together in a glass tube, called by the author a "rain" tube. The oil may be coloured with alkanet root. By electrification the water suspended in the oil is suddenly precipitated in a shower through the oil, precisely as rain is precipitated in the air after thunder. (3) A mixture of paraffin oil and water is poured into a photographic dish, just covering the bottom, and a little mercury is poured in. Any two separate globules of mercury in the dish are then connected by wires to a battery of about 200 volts through a reversing key. A momentary tap of the key causes instantaneous deformation of the mercury, especially of the globule connected to the negative pole. If the current is kept on, the negative globule sends forth a long tentacle of mercury across the dish to the positive globule. The tentacle may break into spheroids. Intermediate globules send forth "fingers" towards the positive terminal globule, and by continued application of the current the "fingers" link intermediate globules, illustrating the nature of liquid coherence. By using the current reverser as a telegraphic transmitting key, the motions to right or left of the "finger" of any stray globule may be interpreted to form the letters of the Morse code. By a succession of taps of the key in one direction or the other a globule can be made to "caterpillar" along the dish

Prof. Ramsay said he had once attempted to facilitate churning by the application of eight or nine volts to some milk. He thought the cream came a little faster, but it turned sour very quickly.

Prof. FitzGerald thought that the effects observed in experiment (3) were the result of current, and not of electrostatic charges, and he would like to know the value of the actual current used. There was no doubt that the motions were due to variations in capillarity.

Mr. Shelford Bidwell asked how the mercury was formed into spheroids in the tube in experiment (1).

Mr. Appleyard, in replying to Prof. FitzGerald, said it was not easy to define the circuit, as the terminal globules were rather capricious; but he would try and measure the current in some particular case. The mercury-tube in experiment (1) was shaken in a horizontal plane; the operation took about 10 minutes. Equal volumes of mercury and oil was a good proportion. One-quarter of the length of the tube should be left as an air-space.

Prof. Dalby then exhibited some apparatus relating to degrees of freedom of bodies restrained at different numbers of points.

Dr. Thompson exhibited two kinematic models depending upon the principle that any simple harmonic motion may be considered as the resultant of two oppositely-directed motions. The first illustrates the synthesis of two opposite circular motions of equal period and amplitude to form a straight-line motion; the second shows the combination of two simple harmonic motions of equal period and amplitude in any difference of phase to form a circular motion. Dr. Thompson further exhibited a device for projecting by lantern the rotating magnet and copper disc of Arago. The curious rotations and lateral movements of iron filings in a revolving magnetic field were similarly projected on a screen. He also showed some experiments with a heat-indicating paint, made from a double iodide of copper and mercury, discovered 20 years ago by a German physicist. At ordinary temperatures the paint is red, but at 97deg. C. it turns black. If paper is covered with the substance and then warmed at a stove, the change is effected in a few seconds. Various designs can be wrought upon the back of the paper in dead black or gold, so that when warmed they appear in red and black on the front, according to their respective absorptive powers. Or local cooling by the hand will yield a silhouette. If the paper is allowed to cool, the silhouette vanishes, but it appears again when the paper is reheated. It has thus a kind of thermal "memory." A yellow double oxide of silver and mercury is even more sensitive It changes from yellow to dark red at 45deg. C. Lastly, Dr. Thompson exhibited a kinematic model of Hertz wave transmission. A row of lead bullets is suspended from strings so that the bullets hang clear of one another by about an inch in a right line. The strings are meshed, and herein the model differs from the well-known wave models used in acoustics. If the attempt is made to send an acoustic form of wave through the system, by giving an impulse to the first bullet in the plane of the other pendulums it fails immediately, owing to the slackening of parts of the meshes. Thus, only transverse vibrations can be transmitted. To illustrate the propagation of a Hertz wave, a heavy pendulum, oscillating in a plane at right angles to the line of bullets at one end, represents the Hertz "oscillator." A metal ring, mounted horizontally on a trifilar suspension, and properly "tuned," represents, at the distant end, the Hertz "resonator." Waves, formed by the transverse vibrations of successive bullets, are then propagated from end to end.

Prof. FitzGerald said the model was specially interesting, as illustrating the difference in velocities of propagation of a given wave and of the energy corresponding to it. The model did not accurately compare with ether, because in ether the rate at which the energy is propagated is the same as that of the wave. The difference of the two rates, for any medium, depended upon the "dispersion" of the medium. By slight alteration of the pendulum suspensions this dispersion might be made different at different parts of the model, and would then correspond to certain known cases of anomalous dispersion. Or, again, it might be made to illustrate the theory of Helmholtz with regard to the vibrations of the molecules of glass; according to which, the vibration of the molecules alters the vibrations of the waves, so that dispersion occurs, and the energy is not propagated at the same rate as the waves themselves. It was shown by Michaelson that it was possible to have a medium in which the energy is propagated in one direction and the wave in another. This was attained in a magnetic model by Ewing. The mesh apparatus indicated how a model could be made which should give out "harmonics" and "over-tones" very different from one another, where different wave-lengths would be propagated with different velocities, and the over-tones would correspond to the differences. Further, it indicated a mechanism for producing any desired spectrum, such, for instance, as that of hydrogen. A somewhat similar model had been designed by Glazebrook for illustrating the absorption bands of a medium when the rate of vibration was the same as the free period of the vibrations of each of the molecules, which is the theory of Helmholtz, but it was not such a simple model. The experiment of red paper changing to black was interesting as illustrating a red spectrum varying with temperature.

Mr. Shelford Bidwell proposed votes of thanks to all the exhibitors, and the society adjourned until April 9.

Glasgow.—Tenders are invited for supplying and fixing in the Olympia, New City-road, during the month of April, a 25-h.p gas-engine, together with 20 arc lamps, each of 2,000 c.p., and a quantity of small incandescent lights, together with all the necessary wire cable, switches, etc. Address tenders to E. H. Bostock, care of Lithgow and Son, printers, 76, West Howard-street, Glasgow.

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LEGAL INTELLIGENCE.

CLAIM FOR WAGES.

In the City of London Police Court on Tuesday, before Mr. Commissioner Kerr, the case of McCrudden *v* the Mazarron Electric Light Company, Limited, was heard. This was a claim by Mr. Hugh McCrudden, electrical engineer, 64, Sayer-street, New Kent-road, to recover the sum of £16 13s. 4d. for a month's salary in lieu of notice against the defendants, of Dashwood House, New Broad-street. Mr. Harry Dobb was counsel for the plaintiff, and Mr. Lambert Bond appeared for the defendants.

It appeared that the plaintiff had been in the defendants' service for some time. He was sent out to Barcelona by them to fit up certain electric lighting appliances. Upon his return to this country he was told that his services would not be further required. He asked for a month's notice or a month's wages in lieu thereof, but neither was forthcoming.

The defendants' case was that the plaintiff was not entitled to any notice. He gave them a month's notice to leave, but when his notice expired the defendants engaged the plaintiff to go to Spain again to do certain specific work, on the understanding that when he reached London upon his return he was to leave the defendants' service, and not to ask for any notice.

The plaintiff denied that, and the case was adjourned for trial before a jury.

A QUESTION OF CUSTOM.

In the Croydon County Court on Tuesday, March 23, an action of some interest to electrical engineering firms was heard before his Honour Judge Vernon Lushington, Q.C., who gave an important decision in reference to a certain contract. The plaintiffs were the Chloride Electrical Storage Syndicate, Limited, of Westminster, and the defendant was Mr. Henry Hurst, of Kalgoorlie Lodge, 36, South Norwood-hill, S.E.

The plaintiffs' claim was for £48. 16s., for storage batteries or accumulators supplied and fitted.

From the evidence given, it appeared that an installation of the electric light was carried out for the defendant by Mr. Mugford, a local electrician, and the plaintiffs were consulted as to providing the batteries or accumulators After Mr. F. Wingfield Crawter, A.I.C.E., their London agent, had been down and seen Mr. Mugford, an estimate was given and was accepted by the defendant. After the work had been done, it was found that there was insufficient power for supplying the necessary current for the length of time desired. The case for the plaintiffs was that they had properly executed all that was contracted for.

Mr. Crawter and **Mr. Mugford** both gave evidence, the latter saying that he told the former the output of the dynamo, the power of the engine, and the number of lights installed in the house. However, he did not tell him on what candle-power basis to form his estimate. So far as witness's experience went, when nothing was mentioned in a contract or estimate as to the candle-power of the lights for which the current was desired, it was understood that 16-c.p. lights were meant.

His **Honour**, after a long hearing, said the plaintiffs undoubtedly undertook to put down a battery of accumulators for the defendant capable of supplying the necessary current to "20 lamps for six hours." Did that mean 20 lamps of 8 c.p. or 16 c.p ? Nothing passed between the parties to indicate which was meant. Therefore his Honour looked for the custom of the profession, and accepted the evidence of Mr. Crawter.

Judgment was entered for the plaintiffs.

COMPANIES' MEETINGS AND REPORTS.

METROPOLITAN ELECTRIC SUPPLY COMPANY, LIMITED.

The tenth ordinary general meeting of this Company was held on Monday last at the Portman Rooms, Baker-street, W, Sir E. M. Shaw presiding.

The **Chairman**, in moving the adoption of the report, referred to changes which had been made on the Board since the last annual meeting, and owing to the death of the late chairman (Sir J. Pender), in whose place the directors had done him the honour to elect him. Owing to the largely increased duties and responsibilities which had recently fallen on Mr. J. Denison Pender in connection with the telegraph companies, that gentleman had felt compelled to resign his seat at the Board ; and to fill the vacancy thus caused they had elected Mr. James Pender, M P., thus securing the continuance of an honoured name They had also to record with regret the death of another of their original members, Admiral Sir George H. Richards ; and lastly, Mr. J. C. Parkinson had found it necessary to resign through other engagements. To fill these vacancies, Mr. W. Harrison Cripps and Mr. J. Birkbeck Lubbock, of Messrs. Robarts, Lubbock, and Co., had been appointed ; and Mr. Frank Bailey, their late chief engineer, had been elected to a seat on the Board as engineering director. With regard to the accounts, he would take the capital account first. The actual capital raised had been increased by £62,500 on account of new shares and £38,360 on account of 4½ per cent. debenture stock, making the total issue of that stock £220,000 out of the £250,000 which was authorised in 1895. The increase of share capital which was sanctioned at the special general meeting on June 23, 1896, to the extent of £500,000, was acted upon by the directors, who in the month of July offered for subscription 12,500 shares of £10 each at a premium of £2 per share ; the whole of this issue being at once applied for to nearly three times the amount required. This increase of capital had provided the necessary funds for the capital expenditure of the year, to which he then briefly referred. The total net expenditure, after allowing for amounts written down to depreciation, had amounted to £81,551. 10s. 11d , and of this the principal items had been due to the extension of business. He alluded to the items of mains, transformers, and meters, which together represented a total of £53,206. 8s. 9d. Looking at the extent of the areas served by this Company and the statutory requirements which were involved, it would be at once recognised that the expenditure on mains must continually increase ; and the amount shown this year, £27,786. 5s. 7d., against £18,026 in 1897, represented a very considerable advance in earning capacity for the future, although an immediate return from this outlay could not be expected. Transformers, £18,507, and meters, £6,913, also had to keep pace with the increase of customers, but produced a more prompt return upon the outlay. As the system of transformer sub-stations, which they were now commencing, was developed, the expenditure under this head would somewhat diminish. The item of buildings, £7,603, consisted to the extent of more than half of purchases of additional property for the extension of works and for the sub-stations already mentioned, the remainder being expenditure on the practical completion of the extensions at Sardinia-street undertaken in 1895 and to minor additions at the other works. Plant and machinery, £21 565. 1s. 8d., represented £12,475 on account of the new plant for the Sardinia-street extension, £4,500 for Manchester-square, £2,600 for additional boilers, etc., at Amberley-road, and £1,950 for Rathbone-place, the efficiency of each of these stations being thus materially strengthened. The credit item of £6,768 to accumulators meant that the whole of the charge hitherto appearing in the accounts under this heading had been written off to the depreciation account. This item, with a sum of £1,025 written off on account of transformers, made up the £7,793 which appeared to the debit of the depreciation account. The item of compensations, etc., £4,168, which consisted to the extent of £2 570 of the final expenses in connection with the Manchester-square vibration litigation, and to the extent of £1 598 of the cost of rebuilding the property known as the John o' Gaunt in Sardinia-street. The revenue income had grown during the year by the sum of £10,011, not so large an increase as in former years, but satisfactory, inasmuch as the increase in the demand had been encouraged by advantageous terms which had been given to their best customers, thus securing a more continuous demand, and thereby enabling a highly gratifying decrease in the cost of production. With a largely increased output the cost of production had, owing to the economies which had been found practicable, only gone up by the small sum of £82, and this with the price of coal per ton slightly in advance of 1895. The gross profit, before allowing for depreciation, was £46,191, against £39,154 in 1895. Of this they had again written off £12 000 to a depreciation account. This amount had been arrived at after a careful consideration of the whole position of the Company's assets and prospects, and the Board considered that they were making all the provision which could justly be looked for. Turning to the net revenue account, after taking advantage of various sources of additional profit, and allowing for the increase of interest on debenture stock and new shares, and also for the closing of the old preliminary expenses account, there remained a balance of £16,028, of which the directors proposed to appropriate £14,970 to making the dividend for the year up to 5 per cent. on the ordinary share capital, leaving £1,058 to be carried forward to the next account. Having regard to the conditions of the year's working, and to the fact that interest had had to be provided on a considerable amount of capital expenditure which could not be immediately productive, he thought that they would consider that the attainment and establishment of what they believed to be a sound 5 per cent. basis was a very satisfactory result.

Admiral Lord J. Hay seconded the motion.

Mr. Temple-Layton congratulated the directors on the very satisfactory report they had presented. He thought, however, that, as they were likely to require more capital, it would be an extremely good opportunity to raise the money at the present time, when the money market was depressed, and they were likely to obtain all they required at from 3 per cent. to 3½ per cent. interest. He was also of opinion that they ought to do away with the founders' shares, which were always likely to prove a source of trouble and litigation.

Mr. Young desired to know whether the reduction in the price of light to which the chairman had referred was made in the price per unit or by giving discounts to customers.

Mr Newton, after remarking that the Company was giving satisfaction all round, endorsed the remarks of Mr. Layton as to the desirability of doing away with the founders' shares. With regard to the proposed issue of further capital, he trusted that in future any additional capital would be issued at par. Certainly, he considered that it was the bounden duty of the directors to so issue it while they had the founders' shares remaining.

The **Chairman**, in replying, said that with regard to the founders' shares the Board was of opinion that it would be to the best interests of the Company to endeavour to redeem the founders' shares. The matter had been under their consideration for some time past, and they might rely upon it that every effort would be made to bring it to a satisfactory conclusion. As to the reduction in the price of the electric light, that had really been made on the price per unit, but in accordance with special circumstances. Mr. Newton had urged that any further capital should be issued at par while the founders' shares remained. He, personally, could

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not disagree with that opinion; but there were so many points to be dealt with in considering the subject that it was impossible to give a definite answer at the present time.

The motion for the adoption of the report and accounts was then put and adopted.

Mr. J. Pender, M.P., Sir E. Shaw, and Mr. J. B. Verity were re-elected directors, and the auditors, Messrs. Deloitte, Dever, Griffiths, and Co., were also re-elected.

DIRECT SPANISH TELEGRAPH COMPANY.

The forty-fifth ordinary general meeting of this Company was held on Tuesday at Winchester House.

The **Marquis of Tweeddale**, who presided, congratulated the shareholders upon the increase in the receipts as compared with those of the preceding year. That increase amounted to £4,564, and was due, it was true, to exceptional circumstances—that was to say, to the insurrection that had so long prevailed in Cuba. At the same time there was a slight increase in the ordinary traffic for the year. The increase in their receipts had enabled them to recommend the same dividend as last year—namely, 10 per cent. on the preference shares and 4 per cent. on the ordinary shares—to add the usual £5,000 to reserve fund, and also to repay to that fund the sum which was taken from it some time ago partly to maintain the 4 per cent. dividend and partly to defray the cost of repairs. The reserve fund now reached the sum of very little short of £40,000. He proposed the adoption of the report and accounts.

Mr. Edmund Etlinger seconded the motion, which was agreed to, as was also the following resolution: "That the dividend at the rate of 10 per cent. per annum (less income tax) on the preference shares, and a dividend at the rate of 4 per cent. per annum (free of income tax) on the ordinary shares, both for the half-year ended December 31, 1896, be and are hereby declared."

EASTBOURNE ELECTRIC LIGHT COMPANY.

The annual meeting of this Company took place last week at the Clifton Hotel. Mr. C. Boulton (the chairman) presided.

The **Chairman**, in moving the adoption of the report, which recommended a dividend of 7½ per cent., congratulated the shareholders on the prospects and progress of the Company. The Company was started in 1882, and in spite of many obstacles and the obloquy of jealous rivals they had continued for a period of 15 years. By the good service of their engineers and secretary they had overcome all difficulties, and now, as in the last two years, they offered the shareholders what he called a very fair percentage for their money. The dividend for the first 10 years of the working was very small. The dividend paid in 1892 was 3 per cent., in 1893 5 per cent., and in 1894 7½ per cent., and that was the dividend the directors offered this year. Many shares had been sold at premiums of £3. 10s and over, and those profits on shares had not been brought into account here, but had been carried to the reserve fund, by which means that reserve fund had been raised to £2,500. They had now over 12 miles of double cable and between three and four miles of single cable laid. When they considered that they had the greatest difficulty in obtaining permission to lay an inch of cable to begin with, he thought that was satisfactory.

Mr. Langham, in seconding, said during the year 764 new shares were disposed of at a profit of £1,938. That had been paid to the reserve fund. There were two reserve funds. One was the depreciation fund, and there was a separate reserve fund, which was intended to meet any unforeseen expenditure or for equalising the dividends, etc. At that moment they had a total reserve fund, including the depreciation fund, of over £5,000. At the end of the year the arc lights and incandescent lamps of 8 c.p. numbered 16,690, as against 14,754 at the end of 1895, being an increase on the year of 1,906 lamps. In January last the number of lamps had mounted up to 16,834.

The motion was carried. The auditors, Messrs. Hart Bros., Tibbetts, and Co. (London) were re-elected. Mr. Boulton was re-elected a director.

SHEFFIELD ELECTRIC LIGHT AND POWER COMPANY.

The sixth ordinary general meeting of the shareholders of this Company was held on Wednesday, when Alderman Franklin (chairman of the directors) presided.

The **Chairman**, in moving the adoption of the report, said it told a tale of remarkable progress in the electric light industry. It was only four years since the Company obtained their parliamentary powers. The first year the profits were £585, the next year £1,943, the third year £3,300, and last year they were £7,635. With that sum the directors proposed to pay interest on debentures, £1,125; to write off the balance of formation expenses, £445; transfer to depreciation fund, £1,000. That left a balance of £5,152, out of which they proposed a dividend of 7½ per cent., to place £1,000 to reserve, and carry forward £99. The price of electricity had been reduced from 6d. to 5d. per unit, and that would make a difference of £2,000 in their revenue. The £1,000 had been placed to reserve to meet contingencies. Last year the number of consumers increased by 63 per cent., and the electricity sold by about 60 per cent. The number of lamps wired last year was 42 665, as against 26,071 in 1895. Although the business done had only increased some 60 per cent., the profits have gone up 100 per cent. This had been achieved by the reduced cost per unit consequent on greater output and by more vigilant management. The Company had now laid 35 miles of mains, and more capital was required to further extend them and their plant. Last year the shareholders sanctioned the issuing of shares at 10s. premium. That realised £1,740, which it was proposed to add to depreciation account, bringing it up to £4,739, which would be useful in meeting the expenditure on overhead mains which had now been put underground. It was proposed to issue the remaining 1896 shares at £2 premium, and to increase the capital from £98,000 to £280,000, to be called up as required.

Alderman Gamble seconded the motion, and it was agreed to.

The 7½ per cent. dividend was declared, and authority was given to increase the capital as stated.

Messrs. J. Senior and Tasker were re-elected auditors.

OXFORD ELECTRIC COMPANY, LIMITED.

The sixth ordinary general meeting of the shareholders of this Company was held recently at Oxford. The chairman of the directors, Sir Henry C. Mance, C.I.E., presided.

The report, which was as follows, was taken as read: "The directors beg to submit their report and the accounts for the year ending December 31, 1896. The revenue account shows a gross profit of £3,368. 7s. 1d. After providing for the interest on the debenture issue there remains £1,818. 3s., and adding £360. 3s. brought forward from last year, the amount available for dividend is £2,178. 6s. The directors recommend payment of a dividend at the rate of 4½ per cent. per annum upon the ordinary capital, the shares issued in March, 1896, ranking in accordance with the terms of the prospectus for one-half (2¼ per cent.). This dividend will absorb £1,640. 18s. 6d., and £537. 7s. 6d. will be left to carry forward to next year's accounts. Since the last report 4,055 8-c.p. lamps (or their equivalent) have been added to the system. On December 31 the number of lamps connected equalled 19,058 8-c.p. lamps. The directors see no reason why the increase of business during 1897 should not be equally satisfactory. In the conviction that the ultimate demand for electric current in Oxford will be much greater than was originally supposed, the directors have considered it advisable to still further increase the size of the generators. A considerable addition has been made to the plant during the year, and this, with an additional boiler and transformer stations in suitable localities, will enable the Company to instal an additional 15,000 8-c.p. lamps. The plant where necessary has been renewed and the whole maintained in efficient order out of revenue. Notice has been given that the present debenture issue will be paid off during the year for the purpose of making an issue on terms more advantageous to the company. To provide for capital expenditure the directors propose to shortly issue 2,000 ordinary shares of £5 each, at a premium of 10s. per share, and to offer the shares in the first instance to the present shareholders. The directors who retire by rotation are Sir Henry C. Mance, C.I.E., and Mr. J. Irving Courtenay, M.A., who offer themselves for re-election. Mr. W. S. Carver, the auditor, offers himself for re-election."

The **Chairman**, in proposing the adoption of the accounts, said the amount received on account of current sold to private customers last year was £6,863, as compared with £5,194 received during the previous 12 months. In addition to this, there had been a considerable increase in the amount received under their public lighting contract. This had been caused by the additional number of arc lamps now in circuit. Lamps connected December 31, 1895, 15,003; lamps connected December 31, 1896, 19,058—increase, 4,045; 225 consumers connected 1895, 270 consumers connected 1896—increase 45; colleges connected, 1895, 15; colleges connected, 1896, 16 and four halls—increase, one college and four halls. Forty customers installed additional lamps during 1896. A new 500-h.p. engine (triple-expansion surface condensing) and dynamo of 260 kilowatt capacity had been added to the plant, which would enable them to connect to the mains 15,000 additional 8-c.p. lamps or their equivalent. Three new transformers had been obtained. The public lighting had been increased 16 additional lamps, bringing the total up to 32, the candle-power of each arc lamp having been increased from 1,200 candles to 2,000. He believed he might say that this extension of public lighting had given general satisfaction, so much so that it had been suggested that further extensions should be considered. The Board had felt justified in reducing the price of current from 8d. to 7d. per Board of Trade unit. This reduction took effect from December 25 last. Customers who paid within one month of the delivery of the account would be entitled to a discount of 2½ per cent. on the reduced price.

The report was adopted, and the directors and auditor re-elected.

BELL'S ASBESTOS COMPANY, LIMITED.

The ninth ordinary general meeting was held this week at the Cannon-street Hotel.

Mr. Henry Heywood presided, and, in moving the adoption of the report, said the business in their manufactured goods had increased in every direction, and, he might almost say, from every centre; and the extra profit had been earned, not at the expense of their customers, but in consequence of the larger trade done, in spite of their difficulties through competition.

Mr. A. J. Burnett seconded the motion.

In answer to questions, the **Chairman** stated that theirs was a trading and not a trust company. They had therefore not invested their reserve fund at 2 or 3 per cent., but had used it in their business. Had they not done so they must have borrowed from their bankers or have issued more share capital. It was true that some of their patents had expired, but they possessed others which were exceedingly valuable. They were subjected to severe competition, and they had more than once had to take action in

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order to obtain injunctions against infringements of their trade marks. In face of the competition they had to contend against he must decline to give any information respecting their turnover.

The motion was adopted.

MEVAGISSEY ELECTRIC LIGHTING COMPANY.

At the annual meeting, Messrs. Arthur Coode, J. E. Veale, Dr. C. M. Grier, Messrs. J. Kemble and J. K. Roberts (directors), Mr. F. Headley (consulting engineer), Mr. T. H. Cragoe (auditor), Mr. J. M. Coon (secretary), and a number of shareholders were present.

The **Chairman** moved the adoption of the balance-sheet, which showed a small balance to the Company's credit.

Dr. Grier seconded, and it was unanimously carried.

The retiring director, Dr. Grier, was elected, on the motion of **Mr. J. E. Veale**, seconded by **Mr. Matthias Dunn**.

Mr. Headley stated that increased facilities for producing revenue would be shortly provided, and a trial electric capstan fixed on Mr. Richard Barron's fishing lugger.

CONTRACTS FOR ELECTRICAL SUPPLIES

CONTRACTS OPEN.

Brussels.—Tenders will be received on April 7 at the Brussels Bourse for two lots of telegraphic instruments (specification No. 51), for the Belgian Government. Particulars at the Brussels Bourse.

Cardiff.—The Corporation are prepared to receive tenders for the manufacture and delivery and laying of high and low pressure compound concentric cable and sundry transformers. Further information is contained in an advertisement.

St. Pancras.—The Vestry require tenders for the wiring and other work in connection with the electric lighting of the Whitfield-street baths and wash-houses. Tenders to be in by the 27th inst. Fuller particulars are given in our advertisement columns.

Paris.—The French Posts and Telegraphs Department want tenders for the supply of packing cases for the telegraphic service for the next four years. Tenders are to be in on April 13, but preliminary application must be made at Paris, rue de Grenelle 103, before April 4.

Hamburg.—Tenders will be received on April 5 for installing the electric light in the Collection of Hamburg Antiquities in the Johanneum. Particulars for 1·50 marks (1s. 6d.) from the Secretary's Office, Finanz Deputation, at the Rathhaus, Hamburg. A local security will be required.

Luxemburg.—The Postal and Telegraphic Authorities of the Grand Duchy will receive tenders at Luxemburg on April 11 for 12 tubular telegraph posts, 1,500 insulators, about a ton of bronze wire, 40 tons of galvanised iron wire, 3,000 metres of copper wire, insulated with guttapercha, about 2cwt. of sal ammoniac, and 1cwt. of sulphate of copper, etc.

Edinburgh.—The Council require tenders for the supply of steam coal for the electric supply station from May 15, 1897, to May 15, 1898. Specification, forms of tender, and conditions of supply can be obtained at the Resident Electrical Engineer's Office, 5 Dewar-place. Sealed tenders to be lodged with Mr. Thomas Hunter, W.S., town clerk, City Chambers, by 10 a.m. on April 10.

Wakefield.—Tenders are required by the Corporation for the erection of an electric lighting sub-station in Westgate. Plans and specifications may be seen, copies of forms of tenders, bills of quantities, and any other information may be obtained, on application to Mr. R. Porter, city surveyor, Town Hall, Wakefield. Sealed tenders, endorsed "Tender for Sub Station," to be sent to the City Surveyor by 9 a.m. on April 5.

Bath.—The Corporation invite tenders for the extension of the buildings of the electric light works, situate at Dorchester-street. Plans and specifications and all information, together with copies of the quantities, at 1, Belmont, Bath Forms of tender may be obtained from Mr. F. H. Moger, clerk, 3 Wood-street, Bath, and tenders must be delivered to him, sealed, and endorsed "Tenders for Works at the Electric Light Station," by noon on April 12.

Edinburgh.—The Lord Provost and Magistrates and Council are prepared to receive tenders for the wiring of the City Observatory, Calton Hill. Specification, form of tender, and plans of the building can be obtained at the office of the Resident Electrical Engineer, 5, Dewar-place, Edinburgh, on deposit of £2. 2s., which deposit will be returned on receipt of a bona fide tender, unless same is late. Tenders must be sent to Mr. Thomas Hunter, W.S., town clerk, City Chambers, not later than 10 a.m. on April 9.

Brighton.—The Town Council require tenders for the supply and delivery of armoured lead-covered electric cables and jointing sundries at the Corporation electricity works. Specifications can be obtained on application at the office of Mr. Francis J. Tillstone, town clerk, at the Town Hall, Brighton. Sealed tenders, addressed to him, and marked "Tender for Electric Cables," must be left at his office before 10 o'clock in the forenoon on April 12. A fee of £1. 1s. will be charged for the specification, which will be refunded on the return of the same, accompanied by a bona fide tender, on or before the above-mentioned date.

Bristol.—The Electrical Committee of the Council are prepared to receive tenders for the supply, delivery, and erection of condensing plant, steam and exhaust piping, etc. Plans, specification, and form of tender may be obtained at the office of the Secretary on payment of £3. 3s., which will be returned on receipt of a bona fide tender. Any further information required may be obtained from Mr. H. Faraday Proctor, city electrical engineer. Tenders must be delivered not later than noon on April 7, 1897, addressed to Mr. Frank Wm. Prosser, secretary, Electricity Department, Temple-back, Bristol, and endorsed "Tender for Condensers."

West Ham.—The Town Council require tenders for the erection of electric lighting buildings at the Abbey Wharf, Stratford, London, E Plans may be seen, and specification, form of tender, and further particulars obtained, at the office of Mr. Lewis Angell, engineer to the Corporation, Town Hall, Stratford, E , on deposit of a £5 Bank of England note, which will be returned on the receipt of a bona fide tender. Tenders, endorsed "Tender for Buildings," to be sent to Mr. Fred. E. Hilleary, town clerk, Town Hall, West Ham, by 4 p.m. on April 13. The contractor will be required to enter into a bond, with two sureties, for the performance of contract, and no work will be ordered under the contract until such bond has been duly executed. The contractor whose tender is accepted, and with whom a contract is entered into, will be required to pay the whole of his workmen such rate of wages and observe such hours of labour as are recognised by the workmen's trades unions and in force at the time of signing the contract. In the event of any breach of such agreement the Council will enforce the penalty clause in its entirety.

Kingston-upon-Hull.—Tenders are required by the Electric Lighting Committee for the supply and erection of the following plant: Section A—Lancashire boilers; Section B—Babcock-Wilcox boiler; Section C—Green's economiser; Section D—Overhead travelling crane; Section E—High-speed engines; Section F—Condensers, pumps steam-pipes, etc.; Section G—Continuous-current dynamo (high and low tension), transformers switchboards, etc; Section H—Storage batteries; Section I—High and low tension mains, casings, junction-boxes, etc. Specification for the above (the whole bound up in one specification), with conditions of contract, may be obtained at the office of Mr. A. S. Barnard, borough electrical engineer, Dagger-lane, Hull, on payment of £2. 2s. for each copy. This sum will be refunded on the return of the specification, with a bona fide tender for one or more of the sections. Tenders, sealed and marked "Electric Lighting—Tender for New Works," must be delivered to the Chairman of the Electric Lighting Committee, Town Hall, Hull, by noon on April 8.

RESULTS OF TENDERS.

Leeds.—At a meeting of the Tramways Committee it was decided to accept the tender of Messrs. John Fowler and Co., Leeds, for the supplying and fixing of steam-piping to the generating station in connection with the electric cars. The same firm are also supplying the engines and other material. The committee resolved to order from Mr. Mills, of Birkenhead, 10 trailer cars, each to have accommodation for 46 passengers. Mr. Mills has already supplied 25 of the ordinary electric cars. Six of the cars will be supported on the "Brill" truck, which is largely used in the United States.

Paisley.—The Corporation at their meeting on March 29 accepted the following tenders in connection with the electricity works:

S. Z. de Ferranti, Limited, three steam alternators (two 200 kw. and one 100 kw.), main switchgear, three rectifiers and switchgear, and transformers	£10,603	10	0
Babcock and Wilcox, Limited, three steam boilers, Vicar's mechanical stokers, and Green's economiser	2,415	0	0
Callender's Cable and Construction Company, Limited, high and low tension and arc lighting mains	6,154	0	0

BUSINESS NOTES.

Gloucester.—There was an inspection here last Friday of the Behr electric car.

Croydon.—The old Theatre Royal is to be turned into a palace of varieties, and will be lighted throughout by electricity.

South London Electric Lighting Company.—Letters of allotment and regret have been posted. The subscription list closed on Tuesday night.

Electric Light at the Alhambra.—A new entrance has been provided at the Alhambra, and the extension has been fitted with the electric light by Messrs. F. W. Henton and Co.

Ashton.—Last Saturday the Ashton Society of Engineers had their fifth lecture on the subject of electric lighting. It was by Mr. Clirehugh, the consulting electrical engineer for the Corporation.

Glasgow.—At a meeting of the Glasgow and West of Scotland Engine-keepers' Association, a lecture on "Electrical Traction as applied to Tramways," was delivered by Mr. R. Wallis-Jones, M.I.E.E, London.

Direct United States Cable Company, Limited.—The Board have resolved upon the payment of an interim dividend of 2s. 6d. per share, being at the rate of 2½ per cent. per annum, for the quarter just ended.

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Birmingham.—The Estates Committee have recommended the City Council to provide at the Council House a passenger lift to be worked by electricity. The cost is estimated at £440.

Wimbledon.—The Board of Trade have decided to grant a provisional order to the Urban District Council, authorising them to supply electricity within their district, and to expend £32,000 for the purpose.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended March 28 amounted to £1,336, as compared with £1,133 in the corresponding week of the previous year, being an increase of £203.

Bristol Tramways and Carriage Company, Limited.—The traffic returns for the week ended March 26 were £2 207. 19s. 5d., compared with £2,025. 7s. 11d. for the corresponding period of last year, being an increase of £182. 11s. 6d.

Liverpool.—The Lord Mayor has affixed the Corporation seal to the purchase of the tramways of that city. The money paid will be over £500,000. The Corporation intend to substitute electric traction for horses, and to reduce the fares from next August.

Shoreditch.—The Finance Committee of the London County Council reported at the last meeting that the loan of £41,800 to the Vestry of Shoreditch for electric lighting works had been completed.

Indiarubber, Limited.—This Company has been registered, with a capital of £2,000, in £1 shares, to collect, get, purchase, or otherwise acquire, prepare, import, sell, and deal in indiarubber, caoutchoue, gum, elastic, guttapercha, etc.

Ealing.—At a District Council meeting, on the recommendation of the Electric Lighting Committee, it was agreed to spend £500 on a new condenser at the electric lighting works. The Surveyor stated that the number of private lamps now applied for was over 10,000.

Globe Telegraph and Trust Company, Limited.—The directors announce an interim dividend, payable on and after April 30, of 3s. per share on the preference shares, less income tax, and of 2s. 6d. per share on the ordinary shares (income tax already deducted).

City and South London Railway.—The returns for the week ended March 28 were £974, compared with £918 for the corresponding period of last year, being an increase of £56. The total receipts for the half-year 1897 were £13,792, compared with £12,656 last year, being an increase of £1,136.

The Revenue Returns.—An account of the total revenue of the United Kingdom has been published, from which we gather that for the three months ending March 31 the sum of £685,000 was paid into the Exchequer from the telegraph service, the total revenue under this head being £2,910,000.

Sheffield.—The most important piece of work in connection with the lighting arrangements of the town hall has now been completed. This latest addition is a very handsome electrolier, intended to illuminate the grand marble staircase, which is entered from the principal door in Pinstone-street.

Woking.—As the result of nearly two years' satisfactory working of the two "Hornsby" improved water-tube boilers of 123 h.p. each, with a working pressure of 160lb., at the Woking Electric Supply Company, Limited, Messrs. Hornsby have received a further order for a 123-h.p. boiler for the Woking station.

Brighton.—The Watch Committee of the Town Council have had under consideration an application from Mr. Henry Lindfield for permission to run an electric char-a-banc from Brighton to surrounding places of interest, and have replied to the effect that they will be willing to grant licenses for such vehicles after inspection and approval.

Eastern Extension, Australasia, and China Telegraph Company, Limited.—The directors have, subject to confirmation by the shareholders, declared a dividend for the quarter ended December 31 last of 2s. 6d. per share, together with a bonus of 4s. per share, or 2 per cent., making a total distribution of 7 per cent. for the year 1896.

Dover.—A start has been made with the contract for laying the rails and bed of the tramway, which has been undertaken by Mr. Briggs, of Blackburn, for £9,729. Work commenced last week in Strond-street, opposite the London, Chatham, and Dover Railway Station. St. Mary's Church has been installed with electric light, which gives great satisfaction.

Torquay.—Mr. J. C. Wharton, engineer of the proposed electric tram from Torquay to Paignton, gave a lecture on electricity last week. The Mayor presided, and said his being in the chair must not be construed into his being in favour of the tram scheme. That matter would not be decided for some time, and would first require very careful consideration.

Personal.—The Edison and Swan United Company inform us that they have appointed Mr. J. Lockwood as their district superintendent in Manchester, and that the business of the company will be carried on from the premises in Victoria street, previously occupied by the Manchester Edison-Swan Company, now amalgamated with this company.

Electric Railway Material.—A catalogue of electric railway material for overhead trolley lines is somewhat of a novelty, and most electrical engineers will find the one issued by Messrs. Laing, Wharton, and Down, Limited, New Bond-street, London, W., very interesting. The catalogue deals with the Medbery line material, of which full particulars, illustrations, and prices are given.

Willoughby (N.S.W.).—It has been decided to proceed with the construction of the proposed electric tram from the terminus of the present cable tram at the Lane Cove-road to Victoria-avenue. Some years ago, when the idea was first mooted, the cost of the extension was estimated at £25,000, but owing to the low cost of the electric system the estimate is now fixed at £17,000, being £9,450 for the track and £7,550 for the necessary power and equipment.

The Treasury and Telephone Grievances.—The Treasury have decided that, where any grievance is alleged as to the defective administration or apparatus of the service of any telephone company, a local enquiry shall be instituted and evidence taken. The enquiry will be conducted either by a lawyer or by an electrical expert. The action of the Treasury in the matter is accepted as evidence that this Department and not the Post Office possesses the control of the telephone companies.

The Crystal Palace.—The programme of the grand commemoration of the Diamond Jubilee of the Queen at the Crystal Palace, which consists of what is to be called the Imperial Victorian Exhibition, is a very interesting little book. It contains a history of the Crystal Palace from the time it was opened by the Queen in Hyde Park on May 1, 1851, up to the present day, besides giving in detail the whole of the arrangements for the forthcoming year, including the great triennial Handel Festival.

Evaporative Condensers, etc.—We have received a catalogue from Messrs. John Fraser and Son, Millwall Boiler Works, London, of their patent evaporative condenser, which depends for its action on the rapid evaporation of a thin film of water when passing over the surface of brass tubes. A fan passes a current of air past the tubes as the water runs down them, and produces a freezing action. Messrs. Fraser also send us a catalogue of their dry-back marine boiler, with patent air-heating apparatus and induced draught for land use.

Derry.—At a meeting of the Lighting Committee, the following notice of motion from Councillor Magee appeared on the agenda paper: "That electric lamps be erected for the lighting of Fountain-place, Victoria-street, Aubrey-street, Harding-street, Foyle-alley, and Mountjoy-street, in the positions marked on the street-lighting map." The Chairman explained that he had received from Councillor Magee a letter stating that the latter was indisposed and could not attend the meeting. The motion was postponed for a fortnight.

Conduit Traction in New York.—The Metropolitan Traction Company has confirmed the announcement of its decision to adopt electricity on several of its lines. Out of 165 miles of road it will have 43 operated electrically, and the method will be, as stated, that of the underground conduit. Mr. J. D. Crimmins, speaking for the company, says that the cost of running a car one mile, including everything but the fixed charges on the investment, is, with electricity, 9 to 9½ cents; with compressed air 12 to 14 cents, and with the cable about 18 cents.

Newport (Mon.).—The Corporation have decided to make considerable additions to their municipal electricity supply works and to the distributing mains, in order to keep pace with the demand for electrical energy for lighting and power purposes. The original works were only opened 18 months ago, being laid down by Mr. Robert Hammond, the gentleman who recently reported to the Middlesbrough Corporation, and who has been reappointed engineer at Newport to carry out the extensions, the capital outlay involved in which will amount to £30,000.

Lancaster.—At a meeting of the Town Council the report of the Electricity Committee was read, stating that on the 15th inst. they had further considered an application from Messrs. Yates and Jackson for a supply of electricity to the Park Hotel, and resolved that the supply asked for be granted and the engineer instructed to lay the necessary mains. It was resolved that a sub-committee, consisting of the Chairman, Aldermen Kitchen and Bell, and Councillor Heald, be appointed to consider the question of providing an additional boiler and other machinery at the electricity works.

Frome.—The hon. secretary and treasurer of the Frome Cottage Hospital, Mr. L. R. Tanner, has recently presented that institution with a complete set of Röntgen ray apparatus. It is proposed to charge a fee for the use of the apparatus in the case of paying patients, the money to assist in the maintenance of the apparatus, but hospital cases will be treated free of charge. At present the Rev. W. A. Duckworth has undertaken to charge the batteries from his dynamo at Orchardleigh House, but it is hoped shortly to be able to instal the electric light on the ground floor of the hospital.

Chiswick.—The Law and Parliamentary Committee at the District Council meeting, reported that at its last meeting a letter was read from Messrs. Finnis and Wylie transmitting a copy of a letter received from the solicitors to the Bourne and Grant Electricity Supply Company, Limited, asking if some modification of their alterations in the draft lease and agreement would be accepted by the Council. The committee recommended the Council not to assent to such a proposal. The Surveyor reported that in his opinion a form of dust destructor with only a low chimney shaft would probably be in use in a few years.

Electric Light Schemes.—The Board of Trade have decided to grant provisional orders to the Urban District Council of Farnworth, who are authorised to expend £7,300; the Garston Urban District Council, who are empowered to spend £20,000; the Urban District Council of Hoylake and West Kirby, who are authorised to spend £10,000; the Corporation of Wrexham and the Urban District Council of Wilmslow, who are empowered to expend £10,000 and £18,415 respectively on electric lighting purposes. These provisional orders will require confirmation by Parliament before they can become operative.

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Crewe.—At the Town Council meeting a discussion took place on the proposal to have an installation of electric light for the new isolation hospital. The medical officer calculated that if the hospital was lighted with electric light 40 beds could be provided, whereas if lighted with gas only 28 beds could be used. The Local Government Board wrote saying that with regard to a loan of £500 for electric lighting plant for the hospital, having regard to the fact that gas-pipes were already laid in the wards and buildings, the proposal appeared to involve unnecessary expense. The motion for electric lighting was defeated by 13 to 10.

Islington.—The Electric Lighting Committee of the Vestry have considered the desirability of revising the present scale of charges for the supply of electricity to private consumers, and propose to adopt the following scale on and after October 1 next—viz., for an average of one hour's consumption or under per day during the quarter of the maximum number of lamps alight at any one time, 7d. per unit; for an average of two hours per day, 7d. per unit for the first hour and 6d. per unit for the second hour; for an average of three hours per day or more, 7d. per unit for the first hour, 6d. per unit for the second hour, and 4d. per unit for the remainder. They ask the Vestry to approve this action.

Telegraphists and the Tweedmouth Committee.—A crowded meeting of telegraphists at Liverpool on Saturday night passed resolutions condemning the report of the Tweedmouth Committee and declaring that they could not consider any concession final until a salary of 28s. per week is reached after five years' service without technical examination, and an advance to £200 per annum by 2s. 6d. weekly increments, is obtained in the case of male telegraphists. It was demanded that the maximum for female telegraphists be 40s. per week, the weekly increments after five years' service to be 2s. A mass meeting of telegraph clerks was also held in Edinburgh on Saturday night, and similar resolutions were passed.

Havre.—The introduction in 1894 of electricity instead of horse power for the tramways has proved a great success. During the past year the lines were taken to the suburbs of Biéville and Sanvie, and works will shortly be commenced greatly extending the service within the town. In 1893, when horse traction was in use, the passengers numbered 5 099,166, and the receipts amounted to £29,334. In 1896 the number rose to 9,659,754, and the receipts to £46,102, increases of 4,560,588 passengers, or 89·42 per cent., and of £16,768 receipts, or 57·23 per cent. During the three years, 4¼ additional miles have been opened for traffic. The system in operation is that of the Thomson Houston Company with overhead wires.

Douglas.—In view of the offer made by the electric tramway company to light the town of Douglas with electricity on certain concessions being made, a deputation has left Douglas for several Continental towns to inspect the systems of electric lighting and traction, and gain object lessons before accepting or otherwise the offer. The deputation has letters of introduction to the British consuls at Hamburg, Rouen, and other Continental cities which will be visited. The tramway company do not bind the Corporation to accept their offer, but if accepted they promise to light up the front of the bay and the principal thoroughfares for the coming season with electric light, and will substitute electric traction for horse power on the margin of the bay.

Blackburn.—The Gas Committee of the Corporation have decided, on the application recently made by a deputation of consumers of electricity, for a reduction in the rate of charges. Hitherto the price has been 6d. per unit for the first two hours, and 3d. afterwards; the charges being based upon a daily average taken at stated periods from the consumers' meters. The committee decided to reduce the terms, and from July 1 next to charge 6d. per unit for the first hour, and 3d. per unit for the second and subsequent hours' consumption. Thus, many consumers whose average has not hitherto entitled them to a rebate will now earn concession. An allowance is also to be made on the current and subsequent quarters of 5 per cent. for early payments.

Brighton Electric Railway.—The work of repairing the damaged car of the Brighton and Rottingdean electric railway is going on apace, and it is hoped that the line will be ready for reopening shortly after Easter. The car is being provided with extra machinery and wheels, and it is anticipated that the journey between Brighton and Rottingdean will only take about 20 minutes. The new jetty at Paston-place, for which Messrs. Reed and Son have the contract, will be simply a landing-stage, as the new waiting-rooms and offices will adjoin the electric railway station on the beach. There will thus be no danger from future gales. Provision for protecting the car will be made at Greenaways, about half a mile on the Brighton side of Rottingdean.

The Proposed Electric Trams at Cardiff.—The special committee *re* tramways have expressed great satisfaction at the plans and details of the proposed electric trams, which were prepared Mr. Harpur, the borough engineer. The length of single lines within the borough as proposed would be about 12 miles, and those shown outside about 10 miles. The extent of the present tram lines is 8·73 miles. In answer to the committee, Mr. Appelbee (electrical engineer) said there would be no difficulty in supplying the current from the present generation station, but if they went in for the whole scheme it would be cheaper to construct a generating station on the eastern side of the town. It seems to be the general opinion of the committee that the trams would pay.

Lewisham.—On the recommendation of the Works and General Purposes Committee, the District Board of Works have decided to request that an application which had been made to the Board of Trade on behalf of the Blackheath and Greenwich District Electric Lighting Company, to dispense with the consent of the Board of Works to the granting of an order to empower them to supply electricity in a part of the district, be not acceded to. The committee objected to the promoters, although including the principal thoroughfares in the centre of Lewisham in the area in which they seek to obtain power to supply electricity, not including them in the list of streets in which they propose to lay down distributing mains within two years after the commencement of the order.

Arc Lamp Carbon Adjuster.—We have received from Messrs. Rosling and Appleby a sketch of an arc lamp carbon adjuster devised by Mr. A. H. Gibbings, of Bradford. It consists of a hinged clamp with concentric cylindrical surfaces to take the two ends of the arc lamp carbons. These carbons are put into the holders loosely, and the clamp is applied to the two ends which are to be brought into line. The carbon-holders are then tightened up. The clamp is said by the makers to give perfect alignment, but we do not gather quite why this should be so. The carbons certainly cannot be bent by tightening up the holders, and where much correction is needed would be likely to be broken. A practical test for a few weeks would, however, show the value of the device, which perhaps we have judged rather hardly.

London.—At the meeting of the Court of Common Council Mr. Hitching asked the chairman of the Commission of Sewers (Mr. H. George Smallman) if he would make an application to the City of London Electric Lighting Company for a reduction of the cost of the electric current, the charge to the citizens being now 8d. per unit. Mr. Smallman advised the hon. member to write a letter to the Commission of Sewers—individually he could not make such a representation to a public company. Mr. Deputy Dowling asked whether the charge of 8d. per unit was made only for the first two hours' use of the current, and after that period it was reduced to 4d. per unit. Mr. Smallman asked for notice of the question. Mr. Deputy Sayer stated that under the contract for certain lamps the charge per unit worked out at about 3d.

St. George's (East), London.—The Finance Committee of the Vestry have reported on the letter from the Board of Trade with reference to the objection of the promoters of the St. George's (East) electric lighting provisional order to the insertion in the order of a clause similar to Clause 60 in the Camberwell order, and recommended that the Board of Trade be informed with reference to the statement of the agents of the promoters with regard to the Vestry having consented to the grant of the provisional order, that the Vestry in giving consent to the application for a provisional order did not consider or intend that such consent involved approval of the terms of the order, which at that time had not been published, and were still of opinion that the clause referred to should be inserted in the order. This the Vestry agreed to.

Catalogues.—Messrs. Drake and Gorham, of 66, Victoria-street, have sent us their last list of electric lighting plant and accessories. It is a strongly-bound, well-turned-out book, the special feature being that "every single article required to complete a town electric light installation is catalogued therein." (Messrs. Drake and Gorham naturally think that since the invention of the Jandus no other arc lamp is "required.") Beyond the list itself, a considerable amount of information is given concerning the initial outlay in the case of country houses, and also working costs; and we are pleased to see that the subject of a private plant driven by a gas or petroleum engine is by no means neglected, for in that direction there are more opportunities of business than is generally understood.—We have also received a second short price-list from Messrs. New and Mayne, and hope to deal with it next week.

Kingston-on-Thames.—The Lighting Committee recommended at the Town Council meeting that the amount of the insurance of the electric works be increased from £8,000 to £10,000; that the offer of Messrs. Siemens for a 200-kw. steam alternator and extension of the switchboard, the firm taking back the day-load alternator, be accepted, subject to the Local Government Board authorising the borrowing of the necessary capital; that the upper Board be requested to authorise the borrowing of the further capital for 40 years; that an offer be made to lay a cable and erect lamps in Lingfield-avenue upon the Artisans' Land Company agreeing to wire the houses, to pay £2. 10s. for the erection of each lamp, and to pay £3. 12s. per annum for lighting the same with electricity until the road is taken over; that the wages of the senior engine driver be increased from 35s. to 36s. per week. The report was adopted.

Eastbourne.—The *Eastbourne Gazette* says: "Mr. George Boulton made such a spirited speech at the electric light company's meeting on Monday that we may almost anticipate a renewed 'battle of the lights.' It would be an excellent thing if an amicable arrangement could be made for the acquisition of the concern by the Town Council. The municipal electric lighting undertaking of Brighton has proved very profitable. The returns for the past 12 months indicate a profit of £14,680, which with the balance from the last account is brought up to £15 830. Of this sum, £4,519 is absorbed by interest charges and £4,311 by sinking funds, £5,000 is carried to the next account, and £2,000 goes to the relief of the district rate; £22,056 of the income was derived from private users, while the charges for public lighting brought in £5,956. Eastbourne ratepayers have lost a good deal through want of foresight and excess of caution."

British Aluminium Company, Limited.—The report of the directors of the British Aluminium Company, Limited, with accounts to December 31 last, to be presented at the general meeting to be held in London on 8th inst., states that a profit of £5,744 has been made, which, with £1,123 carried forward from last year, amounts to £6,868, out of which the directors recom-

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mend the payment of 7 per cent. on the preference shares up to January 1, 1896. Since last year's report a factory at Greenock has been built and equipped for the purpose of making electrolytic carbons, the factories have been completed, and great progress has been made with the additional engineering works for the storage of the water at Foyers. In order to supply the growing demand, the directors have decided to increase the plant of the different factories, and the necessary orders to carry out this work have already been given. The directors have entered into agreements to lease water power to the Acetylene Illuminating Company, Limited.

Kingstown.—A public meeting has been held in favour of the acceleration of the speed of the electric tramcars between Haddington-road and Dalkey. There was a large attendance, and the proceedings were of rather a lively character. Mr. MacNab, T.C. (Blackrock), amidst continued interruption, proposed: "That this meeting of the people of Kingstown desires to place on record its sense of the great waste of time and serious inconvenience caused to the public of this district by the present totally inadequate rate of speed imposed on the running of the electric trams, and that it requests the Board of Trade to permit of the cars proceeding at the rate of 12 miles an hour, a rate which, it is quite satisfied, is entirely compatible with the public safety save when passing through the streets of Kingstown, Blackrock, and Dalkey, where it considers a rate of six miles an hour would be fair and reasonable." This resolution was eventually declared carried, there being a strong chorus of dissenting voices. The meeting broke up without further disturbance.

Belfast.—At the meeting of the Electric Committee there was a large attendance of members to examine the plans for the proposed station on the Laganbank-road, which had been prepared by the engineer. It was resolved to enquire from Prof. Kennedy if he would be prepared to advise the committee as to those plans and the specifications relating thereto, and report to the committee. The accountant submitted a statement of account of the year's working, showing the net profit on the undertaking to have been £1,553. 0s. 6d., without allowing for interest and sinking fund, neither of which has to be provided on the capital, which takes the form of a grant from the gas department up to £50,000 or depreciation. A meeting has been held to consider the inauguration of a direct tramcar service from York-street to Antrim-road. A resolution was carried to the effect that a deputation, consisting of the chairman and the other members of the Corporation present, together with a number of ratepayers, should wait upon Mr. Nance and ask him to take steps for having a tram service established from Antrim-road to York-road terminus.

The Bury Trams.—At the half-yearly meeting of the Bury, Rochdale, and Oldham Tramway Company, the Chairman made an interesting statement with regard to the proposal to convert to electricity. He said that under the Tramways Act, 1870, the local authorities would in 1902 and 1903 have the option of purchasing several sections of the company's tramways, but it had been urged upon the directors from several quarters that electric traction should be introduced at any rate on one or two sections, at once. They had, under these circumstances, felt justified in intimating to the Corporations of Bury and Rochdale, and to the authorities in Wardle and Littleborough, that if they desired the electric system substituted for steam, the company would be prepared to introduce it if suitable and reasonable arrangements could be made. The Corporation of Bury had decided that electric traction was desirable, and they hoped to hear further from them before long. The District Council of Wardle had accepted the proposals of the company, and the other authorities had the matter under their consideration. The directors proposed to adopt the overhead system.

Kingston-upon-Hull.—The Corporation have published a notice that the Board of Trade, by virtue of the powers conferred upon them under the provisions of the Kingston-upon-Hull Electric Lighting Order, 1890, have approved of the following description of supply to be adopted by the undertakers for the supply of energy under the said order—namely, "The system is a continuous-current supply at constant pressure with accumulators. The current is generated in part at low pressure, and in part at high pressure. The high-pressure current is transformed to low-pressure at converting stations erected above ground, which are in the sole occupation of the undertakers. The low-pressure mains consist in part of bare copper strips carried on insulators in cement conduits, which contain no unfixed conducting material; in part of continuously insulated cables drawn into iron pipes or bitumen concrete casings; and in part of steel-armoured, lead-covered, continuously insulated cables laid in the ground without further protection. The high-pressure mains consist of continuously insulated concentric cables, lead-covered, and drawn into stoneware casings."

Glasgow and the Telephone.—A deputation from the Telephone Committee of the Glasgow Town Council has waited upon the Postmaster-General (the Duke of Norfolk) and pressed upon him that the General Post Office should decide definitely as early as possible whether it would or would not comply with the request of the City Corporation for a telephone license, which had now been four years under the consideration of the Department. The deputation, which was accompanied by Sir Charles Cameron, M.P., Mr. Alexander Cross, M.P., and Mr. Provand, M.P., urged that, as a matter of high municipal policy, it was inexpedient that a private company like the National Telephone Company should have the right to interfere with the streets in order to lay the improved underground service that was needed, that the Corporation could supply an efficient service at half the price now charged by the company, and that if a license were granted to the Corporation it would probably yield a greater revenue to the General Post Office than was now derived from the city. The Postmaster-General promised to consider the matter carefully, and to give an answer as soon as possible.

Aberdeen.—It is proposed to introduce, in connection with the electric lighting undertaking, a new principle in the system of rebates. The question has been raised in a report prepared by Mr. P. M Cran, Mr. Alexander Smith, and Mr. Blackman, for the consideration of the committee. These gentlemen submit that the system of giving a discount to large consumers on a sliding scale, in proportion to the number of units used, does not meet the special needs of the case. The aim, they hold, should be to give discounts to profitable consumers, in contra-distinction to large consumers, because it is possible for a large consumer to be a source of absolute loss to the undertaking, as much capital expenditure being required to supply, for instance, three units as it does to produce 200 units. The charge for electricity during the past year has been 5d. per unit, of which approximately 3d. was needed to cover capital charges, which are running on just the same whether much or little electricity is supplied, and 2d. for the actual cost of producing and supplying the electricity. They recommend the Council to adopt the Brighton system of charging, and to fix the charge for the first hour's consumption at 6d. per unit; to supply all further units at 3d.; to abolish a special tariff for motors and public lighting, and to supply all at one uniform rate.

Exeter.—It was decided at the City Council meeting to allow the National Telephone Company to lay their wires in the city underground. The Electric Lighting Committee recommended that with a view to lighting the principal streets of the city by electricity, it be recommended to the Council that notice be given to the gas company to determine the existing contract for public lighting at Michaelmas. In moving the adoption of the report, Mr. Domville said the recommendation was made because it was intended to carry out a series of experiments in the streets and open spaces in order to determine whether arc or incandescent lighting was the better for the public convenience. It was not intended that the contract with the gas company should be terminated, but there was no reason why the Council, while the experiments were being carried out, should pay for both gas and electricity. The recommendation was not made in a spirit of antagonism. Mr. Wreford seconded. Mr. J. W. Williams, seeing that the light failed on Sunday week, thought it was hardly workable as yet, and moved that the recommendation be postponed for six months. Mr. Dunn thought that the gas company, if they took the Council at their word, might put them in a very awkward position. The Town Clerk replied that the gas company would hardly do that to a customer paying them nearly £4,000 a year. The recommendation was adopted.

Dudley and Wolverhampton Tramways Company.—At the third ordinary general meeting of this Company, the Chairman (Mr. John Fell) said: "Some months ago we attempted to take advantage of the universal opinion with regard to electricity. We know very well if tramways are run by that that their cost is very greatly reduced; in fact, I should not hesitate to say that the cost by running with electricity would represent, practically speaking, 2d. per mile as against the present engine expenses, and that reduction, of course, in itself, would pay for a considerable amount of increased capitalisation and then show a substantial profit. We entered into negotiations with one or two gentlemen, and one agreed on behalf of his company to purchase the line, but some hitch has occurred, and the negotiations have not proceeded so satisfactorily during the past month as we had hoped they would up till that time. The position is that the local authorities have, I believe, made the conditions of increased powers so onerous that for the moment there has been an abandonment of the Bill. The directors have still the hope that they may carry through their programme, but the matter is at present in the hands of the solicitors, and in order not to say something which might be considered unkind to local authorities or the gentlemen who may take up this line, I propose to say no more except that your directors will do their very utmost to secure the interest of the share holders."

Birmingham, Wolverhampton, and District Electric Tramways.—Mr. Emile Garcke, the secretary of the British Electric Traction Company, Limited, has addressed a letter to the various local authorities concerned in the projected electric tramways, in the course of which he states: "Some of the corporations were prepared to give their consent to our Bill, but in the case of others the consent was made conditional upon our entering into agreements for the purchase of electrical current, and also in regard to other matters as to which it has proved impossible to agree to such terms as are compatible with the commercial success of the scheme. As we have not therefore been able to comply with Standing Orders, there has been no alternative but to withdraw the Bill. We very much regret that we have been compelled to take this course, recognising as we do the disappointment which it will cause to the inhabitants of the various districts who are desirous of obtaining the greater facilities of communication we are prepared to provide. Having regard, however, to the considerable time and attention we have already devoted to this scheme, it is not our intention to abandon its main features, and we propose to resume negotiations with the various authorities and companies with a view to carrying out a scheme of consolidating and extending various tramway undertakings in the district, and of adapting the same for electrical working; and we believe that by the course we now intend to take we shall be able to make better progress with the business.'

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Treeton.—Lieutenant-Colonel Albert C. Smith, R.E., an inspector of the Local Government Board, has held an enquiry relative to an application by the Parish Council for sanction to borrow £600 for the purposes of electric lighting. The proceedings were under the Local Government Act, 1894, and the Lighting and Watching Act, 1833. Mr. Trevor Edwards, solicitor to the West Riding County Council, regretted that the Local Government Board had not fallen in with a suggestion that their enquiry and that of the County Council should be held at the same time. Mr. Fiske stated that the assessable value of the parish was £12,000. The population, as ascertained by a census taken for School Board purposes about six months ago, was 2,000. Mr. Keep explained the nature of the application. This matter of electric lighting had been considered for over 12 months, and estimates had been obtained in regard to other systems. The Parish Council had given a unanimous vote in favour of an electric installation, and the villagers who had been canvassed did not oppose. Acting upon these facts, the Parish Council had obtained tenders, and had practically decided upon the necessary details of construction. Roughly speaking, there would be an annual outlay of £150—the actual amount was £148. This would be provided as under: Duke of Norfolk, who was practically the landlord of Treeton, £25; Rother Vale Collieries, £25; cottage owners, representing 242 houses, £52; Treeton parish assessment, £46, or 1d. in the pound. The £148 was made up as follows: repayment of loan and interest, £30; maintenance, £28; stores, £10; attendance—*i.e.*, wages—£50; power, which the colliery company undertook to supply for the term of the loan, £30. The tender for the work was £593, and the loan asked for was £600. There were six tenders, and that of Messrs. John Dewhurst and Son, of Sheffield, had been accepted. Answering Mr. Edwards, Mr. Keep furnished the various objects of the scheme, and the Inspector promised to report in due course. It was understood that this was the first application of the kind made by a parish council.

Cork.—A special meeting of the Corporation has been held "To consider and approve, or otherwise, of an application of the Cork Electric Tramways Company, Limited, intended to be made to the Lord Lieutenant in Council, under the Tramways (Ireland) Acts, 1880 and 1895, to authorise the construction, working, and maintenance of tramways in the city of Cork, to be worked by horse power, electrical or other mechanical power, with all necessary works connected therewith, as shown and delineated on deposited plans. Tramway No. 1A (a double line), in the city of Cork, commencing by a junction with the company's authorised tramway No. 1 at the northern end of St. Patrick's Bridge, passing thence in a westerly direction along Camden-place, Camden Quay, Pope's Quay, Farren's Quay, Newsom's Quay, North-mall, to its termination at a point in Wise's Quay at its junction with Sunday's Well-road. Tramway No. 1D (a double line, except two chains in length over North Gate Bridge and Kyrl's Quay), in the city of Cork, commencing by a junction with the company's authorised tramway No. 1 at the northern end of the Grand-parade, passing thence in a north-westerly direction through Daunt's-square, Cornmarket-street, Kyrl's Quay, over Northgate Bridge, to its termination by a junction with the above-described tramway No. 1, at a point in Newsom's Quay, opposite to the north-west end of said bridge. Tramway No. 2C (a double line), in the city of Cork, commencing by a junction with the company's authorised tramway No. 2, in Albert Quay, at its junction with Victoria-road, and passing thence, in an easterly direction, along Victoria Quay, to its termination at a point in Victoria Quay opposite the gates of the Marina. Tramway No. 5A (a double line), in the city of Cork, commencing by a junction with the company's above described tramway No. 1C, on Camden Quay, opposite the south-eastern end of Pine-street, to its termination by a junction with the company's authorised tramway No. 5, at the north-western end of Pine-street, at its junction with Leitrim street." Mr. Maurice Healy, M.P., appeared before the Council on behalf of the supporters. He was supported by Mr. Wm. Murphy, ex-M.P.; Mr Baylor, of the Thomson-Houston Electric Company, and Mr. Wakeham, ditto. Mr. Walter Honan, solicitor, watched the proceedings on the part of the Harbour Board, and with him was Mr. Price, the engineer of that body. Mr. Hanrahan, solicitor, attended on behalf of the gas company. The discussion chiefly related to the width of the streets, and how they would affected by the tram lines. Eventually all the extensions were approved.

Bray.—On Monday the Commissioners sat in the town hall as Grand Jurors of the township, for the purpose of enquiring into the proposed scheme for the construction of electric tramways in the township. Mr. E. Liller, traffic expert, was examined to show that the tramways were required, and, if constructed, would be a success. He stated that tramways would not pay in a place like Bray if crippled with a heavy wayleave, as rent, in the start. He thought that a share of the profits after a certain point had been reached would be a fairer arrangement as between both parties. Mr. Emile Garcke stated that his company—the British Electric Traction Company—carried out such undertakings as the one under consideration in England and elsewhere. His company had a right to issue £600,000 capital, of which only £200,000 had been raised, and £400,000 was available for subscription. His company took an interest in the proposed scheme, and were prepared, provided the Grand Jury passed it, to find the necessary capital to build and equip the line. If such conditions as a 5ft. 3in. gauge or heavy wayleave rents, which would make the paying capacity of the lines doubtful, were imposed, his company would prefer to lose the money already advanced to the local company than to risk more. His company was prepared to sink between £30,000 and £50,000 in Bray and take all risks if they got fair terms, but if their estimate of £32,000 for construction was largely increased by the imposition of impossible conditions they could not go any further in the matter, and the whole scheme, so far as they were concerned, would fall to the ground. Mr. J. H Ryan, C.E., explained the engineering details of the scheme. On the motion of Mr. Langton, seconded by Sir Rowland Fanning, a resolution was unanimously adopted approving of the scheme on the following, amongst other, conditions: that a sum of £2,500 be deposited to cover any damages occasioned during the construction of the works; that the undertakers or company pay a wayleave rent of not less than £5 per mile and 10 per cent. of all profits earned after paying ordinary shareholders 6 per cent. per annum; that the undertakers pay to the Commissioners annually the costs incurred by them in maintaining the paved portion of the roadway along which the tramlines may be laid; that, in the event of the trolley-wire system being adopted, the method of bonding the rails shall be subject to the approval of the Commissioners; and that the Commissioners shall be at liberty to purchase the undertaking at any time after the lapse of two years from the date of the agreement between the parties, the lease granted to the company being for a period of 42 years.

Cardiff.—At a meeting of the Electrical Committee of the Corporation the electrical engineer's report of January 19, with reference to extensions of plant, was considered. Mr. Appelbee reported that the plant now working and that on order was not sufficient to keep pace with the orders. They were not in a position to take on any orders of importance, and in consequence of this a number of private firms were putting in plant on their own account. Councillor Brain considered that working with insufficient plant was only tinkering with the business, and thought that the works should be doubled at once. In his private business, if he found that his orders exceeded his supply, he would not hesitate about laying in new plant. He did not consider that the policy of the Corporation of just laying in enough plant to keep things going was enough. Mr. Evans thought that the Corporation were following out the best policy. It was useless for them to lay in a quantity of machinery which might never be wanted, and would, perhaps, not suit their purpose in a few years' time. Mr. Hallett agreed with Mr. Evans, and said that they were laying in the best machinery possible. Improvements were being effected so quickly in electrical machinery that machines up-to-date when built were supplanted by better machinery in a couple of years. He considered that purchasing as they wanted it was the best method of keeping up with the times. Mr. Appelbee said that the present plant was sufficient for 13,850 lights. They had 14,000 lamps on now, but for practical purposes they could take on another 3,000, making a total of 17,000, when the whole of the plant now on order was put up. Their orders, however, exceeded this number. They had no spare plant, and so, if anything went wrong, consumers supplied by that portion of the plant would have to go without light until repairs could be effected. The manufacturers of electrical machinery were so full up with orders that if they ordered machinery now they would probably not get it for 12 or 18 months. He thought that, under these circumstances, it would be advisable to order two more machines, each to supply 8,000 lamps, and the necessary boilers and engines to work them—about 1,000 h.p. It would also be necessary to erect further buildings at the works for the accommodation of this machinery. This, he thought, would be sufficient to meet the demands for two or three years. Mr. Evans proposed that Mr. Harpur prepare plans and estimates for the buildings, and Mr. Appelbee prepare specifications and estimates of the machinery required. Alderman Sanders called the attention of the committee to the fact that Mr. Appelbee's report had been in since January 19 and that nothing had been done up till now, and said that if they went on in that manner the orders for the new machinery would not be given until Christmas. The motion proposed by Mr. Evans was seconded by Mr. Brain and carried, and it was decided that the necessary estimates, etc., should be prepared and considered at as early a date as possible.

PROVISIONAL PATENTS, 1897.

MARCH 22.

7366. Electric culinary appliances. Georges Edmond Dutertre, 8, Rue des Princes, Brussels.

7368. Improvements in and relating to an improved method of printing by means of electricity. Arthur Albert Collins, 13, Alexandra-villas, Brighton.

7373. Improvements in apparatus for controlling the action of electric motors at a distance. William Oliver Smith and George Keith Buller Elphinstone, 101, St. Martin's-lane, London.

7381. Improvements in electric glow lamps. Paul Scharf, 28, Southampton-buildings, Chancery-lane, London.

7398. Improvements in terminal clamps for electric wires. Alfred Edward Wrotteeley, 322, High Holborn, London.

7405. Improvements in prepaid or coin-freed electric meters. Charles William Scott Crawley and Alfred Soames, 70, Palace-chambers, Westminster, London.

7415. A new or improved electric advertising sign. William Robert Newbold Gard, *Invention* Office, Mitre-court, Fleet-street, London.

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7412. An improved telephone switchboard indicator or annunciator. Newman Henry Holland, 45, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents, etc., Act 1883, Section 103, September 2, 1896, being date of application in Canada.) (Complete specification.)

7420. Improvements in electrical resistances. Augustus John Marquand, 1, Queen Victoria-street, London.

7421. Improvements in or connected with the electric lighting of buildings or other areas particularly applicable to fire-brigade stations, asylums, hospitals, hotels, ships, and like institutions. Reginald Francis Kirk Stubbs, 7, Southampton-buildings, Chancery-lane, London.

MARCH 23.

7462. Improvements in the permanent way and wheels for electric cars. Robert Cooke Sayer, 11, Clyde-road, Redland, Bristol. (Complete specification.)

7474. Improvements in telegraphically-operated signals. Joseph Newby Newsom, Oddfellows' Building, St. Louis, Missouri, U.S.A. (Complete specification.)

7487. Improvements in or relating to automatic speed governors for electrically-propelled vehicles. Armistead Keith Baylor, 70, Chancery-lane, London.

7497. Improvements in regulable transformers and in regulating alternating-current dynamo-electric machines. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (General Electric Company, United States.) (Complete specification.)

7545. Improvements in the manufacture of filaments suitable for electric lamps. John Hadden Douglas-Willan and Frank Eustace Welkins Bowen, 24, Southampton-buildings, Chancery-lane, London.

MARCH 24.

7645. Improved means for preventing installations for electrical transmission of energy, in particular electrical railways, from causing disturbances in telephonic circuits. Siemens Bros. and Co., Limited, 28, Southampton-buildings, Chancery-lane, London. (Siemens and Halske, Germany.)

7646. Improvements in electrical motor-generators. Siemens Bros. and Co., Limited, and Henry Cook Leake, 28, Southampton-buildings, Chancery-lane, London.

7671. Improved means of applying the heat of the electric arc for welding, soldering, and other purposes. Richard Bruno Roxby, 53, Chancery-lane, London. (Albert Hirsch, Germany.)

MARCH 25.

7772. Improvements in alternating-current motors. Walter Langdon-Davies, 16, Red Lion-street, Clerkenwell, London.

7774. Improvements in selective signal apparatus for party telephone lines. John Edward Kingsbury, 24, Southampton-buildings, Chancery-lane, London. (The Western Electric Company, United States.) (Complete specification.)

7775. Improvements in or relating to electrodes for secondary batteries. William Joseph Starkey Barber-Starkey, 322, High Holborn, London.

MARCH 26.

7823. Improvements in electric switches. Edward Woodrowe Cowan and Alfred Still, Broadheath Engineering Works, Broadheath, Cheshire.

7824. An improved method of controlling alternating-current electric circuits. Edward Woodrowe Cowan and Alfred Still, Broadheath Engineering Works, Broadheath, Cheshire.

7868. Improvements in electrical clocks and similar instruments. Frank Hope-Jones and George Bennett Bowell, 6, Lord-street, Liverpool.

7870. Improvements in or relating to dynamos or electric motors and in apparatus for driving fans by electricity. John Walter Gibbs, 6, Lord-street, Liverpool.

7877. Improved apparatus for controlling and registering the time of working of electric lamps. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Société Anonyme des Horloges Electriques Cauderay, Switzerland.)

MARCH 27.

7950. Improvements in wheels or pulleys for receiving and transmitting motive power by cords, bands, chains, or connecting rods, which improvements are applicable to velocipedes, motorcars, electric generators, and various classes of high-speed machinery. Frederick Hurd, 23, Southampton-buildings, Chancery-lane, London.

7955. Improvements in the electric propulsion of vehicles and apparatus therefor. Siemens Bros. and Co., Limited, 28, Southampton-buildings, Chancery-lane, London. (Siemens and Halske, Germany.)

7958. Improvements in and connected with electric batteries. Ernst August Jahncke, 78, Fleet-street, London.

7982. Improvements in or connected with electrically-operated gas-burners. Carl Axel Georg Braunerhjelm, Norfolk House, Victoria-embankment, London.

SPECIFICATIONS PUBLISHED.

1892.

13395.* Electric signalling apparatus. Mercier. (Amended.)

1896.

4174. Method of fixing caps to incandescent electric lamps and joining the leading-in wires of such lamps to contact plates. Sinclair.

6477. Cord grip for electric light fittings. Donovan.

6890 System of distribution of electrical currents Berditschewsky.

7255. Secondary batteries Lake. (Julien.)

7649 Electric cables or conductors. Edmunds.

8216. Electric motors and dynamos. Gray.

8410. Electro-deposition of metals, particularly applicable to the deposition of wires. Graham.

9258. Combined astatic and dead-beat galvanometers, especially for use on board ship. Clark.

9565. Electric melting apparatus. Schindler.

18785. Telephonic apparatus Schwarze.

24594. Electrical resistance devices. Cummings.

25884. Means for storing up the electricity generated by the application of the brakes to the wheels of motorcars or locomotives. Thomas, Toops, Hulen, Hendrick, Hendrick, and Hendrick.

29883. Electrical ignition apparatus for petroleum and other lamps and candles. Kaiser.

1897.

251. Secondary batteries and process of forming same. Harris and Holland.

293. Commutator connections for dynamo-electric machines and motors. Siemens Bros. and Co, Limited, and Grotefeld.

1434. Means for operating the electric road switches on electric railways. McLaughlin.

1435. Electric railways on the sectional conductor system. McLaughlin.

1535. Electric precipitation of gold and silver from cyanide solutions. James.

1591. Incandescent electric lamps. Gover and Moffat.

2105. Electric meters. The British Thomson-Houston Company, Limited. (Fish.)

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	9¼-9¾
Brush Company, Ordinary	3	¾ 1
—— Non. Cum., 6 per cent. Pref.	2	1¼-1½
—— 4½ per cent. Debenture Stock	100	104-109
—— 4½ per cent. 2nd Debenture Stock	100	95 98
Callender's Cable Company, Debentures	100	106-111
Central London Railway, Ordinary	10	9½-10
——	6	5½-6
Charing Cross and Strand	5	10½-11½
Chelsea Electricity Company	5	9 9½
—— 4½ per cent. Debentures	100	112-115
City of London, Ordinary	10	19½-20½
—— 6 per cent. Cumulative Pref.	10	16½-17½
—— 5 per cent. Debenture Stock	100	132-136
City and South London Railway, Consolidated Ordinary	100	59 61
—— 4 per cent. Debenture Stock	100	139-141
—— 5 per cent. Pref. Shares	10	15½-16
County of London and Brush Provincial Co., Ordinary	10	11½-12
—— 6 per cent. Cum. Pref.	10	14½-15
—— 4½ per cent. 2nd Debenture Stock	10	14½-14¾
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	1¾-2¼
—— 5 per cent. Debentures	—	96 98
Edison and Swan United Ordinary	3	1¾-2¼
—— 5 per cent. Debentures	5	3-4
—— 4½ per cent. Debentures	100	105-110
Electric Construction, Limited	2	1½-1¾
—— 7 per cent. Cumulative Pref.	2	2¾ 3¼
Elmore's Copper Depositing	1	⅞-1⅛
Elmore's Wire Company	2	⅞ ⅞
W. T. Henley's Telegraph Works, Ordinary	10	19½ 20½
—— 7 per cent. Preference	10	18½-19½
—— 4½ per cent. Debentures	100	107-112
House-to-House Company, Ordinary	5	7½-7¾
—— 7 per cent. Preference	5	9-9½
India Rubber and Gutta Percha Works	10	20½-21½
—— 4½ per cent. Debentures	100	104-107 x.d.
Kensington and Knightsbridge Ordinary	5	11½-12
—— 6 per cent. Pref.	5	8-8½
London Electric Supply	5	1½-1¾
Metropolitan Electric Supply	10	15½-16½
—— 4½ per cent. First Mortgage Debenture Stock	100	120-124
National Telephone, Ordinary	5	6¾ 7⅛
—— 6 per cent. Cum. First Pref.	10	16-18
—— 6 per cent. Cum. Second Pref.	10	16-18
—— 5 per cent. Non. Cum. Third Pref.	5	6-6½
—— 3½ per cent. Deb. Stock	100	102-105
Notting Hill Company	10	12-13
Oriental, Limited, £1 shares	1	1½-2
—— £5 Shares	5	8½-9
—— £4½ shares	4½	7½-8
Oriental Telephone and Electric Company	1	⅜-½
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	103-105
St. James's and Pall Mall, Ordinary	5	14-15
—— 7 per cent. Pref.	5	9½-10½
Telegraph Construction and Maintenance	12	35-38
—— 5 per cent. Bonds	100	103-106
Waterloo and City Railway, Ordinary	8	10¾-11¼
Westminster Electric Supply, Ordinary	5	13-14
Yorkshire House-to-House	5	8½-9

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NOTES.

The Institution Secretaryship.—The approaching vacancy of the secretaryship of the Institution of Electrical Engineers is now advertised.

The Athenæum.—Prof. Armstrong, of the Central Technical Institute, has been elected by the Athenæum Club under the rule for the annual election of a limited number of persons eminent in science, or art, or literature.

The Italian Electrical Engineers.—It is stated in *L'Elettricità* that at the last session of the Italian Association of Electrical Engineers at Turin, Mr. R. Pinna was elected president of the Turin section of the association in the place of the late Prof. Galileo Ferraris.

Biological Action of Rontgen Rays.—Prof. Stefana Capranica has presented to the Reale Accademia dei Lincei the results of his experiments on the alleged germicidal action of Röntgen radiations on the infected body. The experiments were made on mice and rats, and the results appear to be entirely negative.

New Book.—We have received from the W. J. Johnstone Company, New York, Mr. R. C. Duncan's translation of Prof. Gerard's book on "Electricity and Magnetism." This book, in its original French form and in the German translation, is well known on the Continent, and we hope to deal adequately with Mr. Duncan's English version directly.

The British in Canada.—For this year's meeting of the British Association at Toronto, the president of the Mathematics and Physics Section will be Prof. A. R. Forsyth, F.R.S ; Chemistry, Prof. W. Ramsay, F.R.S.; and Mechanical Science, Mr. G. F. Deacon. The two evening discourses will be delivered by Prof. Roberts-Austen, C.B., F.R.S., and by Prof. John Milne, F.R.S.

Speed Indicator.—An electric speed indicator which is designed specially for warships is described in the *Revue Industrielle*. The principle is that a tiny magneto, driven off the main shaft, gives a current which varies with the speed. A galvanometer introduced anywhere in the circuit, therefore, if properly graduated, gives the number of revolutions per minute, and the direction "ahead" or "astern."

Whistling Arcs.—Mr. Forée Bain has described in the *Western Electrician* the curious behaviour of some of the lamps on an arc lighting installation at West Chicago. Those lamps which happened to have the longest arcs whistled like "a deviline whistle"; also the telephones were affected. Mr. Bain says the effect is due to electrostatic induction, and after a quantity of trials it was eliminated by placing all the outside sheaths of the cables in metallic connection.

New Observatory.—At the last meeting of the British Astronomical Association, at University College, Mr. E. W. Maunder stated that a short time ago the Royal Botanical Society approached the Royal Astronomical Society, and made them an offer of a site for the erection of an observatory. As it did not seem within the purpose of that society to entertain the proposal, it was passed on to the British Astronomical Association, and the council of the association had decided to accept the offer.

London Chamber of Commerce.—The fifteenth annual general meeting of the London Chamber was held on Friday at Botolph House, Eastcheap, Mr. W. H. Willans, the chairman of the council, presiding, in the absence, through illness, of Sir Albert K. Rollit, the president. The Chairman said that the amount of business transacted by the Chamber in the past year had been considerably above the average. Three hundred and thirty new subscribers had joined the Chamber, and the total receipts had been £10,528, the largest sum dealt with by them in any one year since the formation of the Chamber.

Telephones in Chicago.—Some time ago the action of the Chicago Telephone Company in endeavouring to enforce the adoption of coin-in-the-slot instruments was noted in these columns. The company took that action because it was understood to have become a custom for the telephone in a "store" to be practically at the command of the public without payment. The city council, however, does not intend to let the thing go through just as the company wishes, and, according to the *Western Electrician*, the council seems prepared to treat a refusal of the company to install the ordinary instrument as a breach of the conditions under which its "franchise" was granted.

St. Elmo's Fire.—A report has been issued from the Bamberg Observatory on the phenomenon of St. Elmo's fire witnessed there on the 19th ultimo before and during a storm of that date. The points where the "fire" manifested itself were the turrets of the parish church and of the Michelsberg Church. From 7.30 p.m. till 11 p.m. on the 19th these pinnacles glowed with flashes following each other in rapid succession and regular intervals. A gilded angel, which serves as a weather cock, on the parish church was illuminated with especial brilliance. Next evening the phenomenon was repeated before the moon rose. "From this gloom the golden angel loomed forth, now a brilliant flame, now a pale phosphorescence."

The Telephone to France.—The preliminary arrangements are completed for laying across the English Channel two additional telephone cables. The first will be laid shortly by the English cable ship "Monarch," the second being laid by the French Government. The cables will leave the English side of the Channel about three miles to the west of Dover. When the additional cables are duly installed it is stated that facilities for international telephoning will be given to the large commercial centres in both England and France, instead of confining them to London and Paris only as at present. When the two new cables are laid there will be in all about 34 wires across the English Channel between St. Margaret's, Dover, on the east, and Beachy Head on the west.

Power from the Nile.—Prof. Forbes has been to Egypt, and is coming back again at once. After inspecting the country and cataracts at Wady Halfa, he expresses a highly favourable opinion about utilising the power of the cataracts for generating current, and considers the general circumstances of Egypt exceptionally well adapted for its use as motive power. Coal is dear in Upper Egypt owing to the expenses of transport from Alexandria; and the cataract power would be available all the year round for working the railway, cotton ginning mills, sugar factories, and irrigation machines. Prof. Forbes will return to Egypt in September to make a complete survey and present the Government with a scheme for getting some good from the cataracts, which have been a consistent nuisance ever since history began to record things.

Below the Infra-Red.—Messrs. H. Rubens and E. F. Nichols have been endeavouring to fill the gap between the lowest known "heat rays" and the shortest "electric" waves. Instead of using a grating or selective absorption for obtaining infra-red rays, the authors filtered them out by three successive reflections from surfaces of fluorspar or rock salt, the source being a layer of the same substance on hot platinum foil. The fluorite reflections gave waves of about 30 times the length of the extreme red light waves, or, reckoning by octaves, midway between the shortest

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ultra-violet waves and the shortest electrical waves (6mm.) hitherto observed. Reflections from rock salt gave waves of about double the length. It would be interesting in many ways to ascertain the refractive index of water for such waves, if indeed it did not turn out simply opaque to them.

Tramcar Fire.—The Paris correspondent of the *Daily Telegraph* says that last Sunday afternoon there was a lively panic among the people in a tramcar running on the line from the Madeleine to Courbevoie. "This vehicle was propelled by electricity, and when he got to the Parc Monceau the driver, perceiving that his machine was on fire, jumped out, and turning off the current, prevented a probable accident. As soon, however, as they ascertained the cause of the halt the passengers sprang from their seats and bolted out of the vehicle, round which they gathered, forming the centre of a crowd which soon increased to upwards of 500 persons. The utmost excitement prevailed, and it was not until the fire had been extinguished that tranquility was restored. The driver attributed the mishap to the rupture of one of the wires." Really there seems no excuse for the electrical car to try to produce a feeble imitation of what can be done in the way of fireworks by the petroleum or gas car.

Technical Education Congress.—During the week before the Jubilee celebration the fourth meeting of the congress in connection with the International de l'Enseignement Technique, a society intimately associated with the work of technical education throughout France, will be held at the rooms of the Society of Arts. The Duke of Devonshire will be the president, and Sir John Gorst the vice-president. The former meetings have been in France. The congress will be opened at 11 o'clock on June 15 by an address from the president and from the president of the last congress, Mr. Léo Saignat. The meetings will be held on Tuesday, Wednesday, Thursday, and Friday from 11 to 1, and from 3 to 5. The expenses have been guaranteed by the Drapers', Fishmongers', Goldsmiths', Merchant Taylors', and Clothworkers' Companies, and consequently the subscription to the congress (for others than delegates of foreign Governments, members of the Society of Arts, or liverymen of the companies subscribing) will be fixed at 5s. This will entitle subscribers to a copy of the report of the *Proceedings*.

Surface Tension.—In connection with the "rain tube" which Mr. Appleyard showed at the Physical Society, it may be mentioned that the influence of a charge of electricity upon the surface tension of water (in air) has been recently quantitatively investigated by Messrs. E. L. Nichols and J. A. Clark at Cornell. The tension is to be obtained from the size of the drops from a special water-dropping apparatus, and elaborate corrections were necessary for temperature, a special form of electrometer was used. The results are published in the current number of the *Physical Review*. From the experiments the conclusions drawn are that the surface tension of water is decreased by giving it a static charge of electricity, and the decrease is independent of the nature of the charge. It is believed that other liquids are affected in a similar way. Cognate also to the subject is a favourite experiment of Mr. Wimshurst's, which is simply the holding of an electrified stick of sealing-wax (glass will do, but not so well) near the jet of a toy fountain. The effect on the drops is plainly marked.

The Paris Academy of Sciences.—Mr. H. Wilde, president of the Manchester Literary and Philosophical Society, has written to the Académie des Sciences announcing the gift of £5,500 to be set apart for an annual prize of 4,000fr. The Paris correspondent of the *Times* is supposed to be equal to anything, but, though undismayed by emperors, he evidently fears the chemist, for he telegraphs the long letter *verbatim*, with the following remark: "I send you the original letter, without undertaking, considering its special and technical character, to translate it." After this one expects something terribly technical. But there is nothing particular except a long sermon on the impropriety of raising Mendeleieff's law to the position of a dogma, with some compliments to French chemists in general and Mr. Berthelot in particular. In the last lines it is stated that the annual premium is to go to the author of a discovery or work in astronomy, physics, chemistry, mineralogy, geology, or mechanics which in the judgment of the academy shall be of the highest merit. The award is to be international, and may be retrospective. It is stated that the gift has given great satisfaction at the academy and in Paris generally.

The Civil Engineers.—The annual dinner of the members of the Institution of Civil Engineers was held last week at the hall of the Merchant Taylors' Company, Threadneedle-street, with the president, Mr. J. Wolfe Barry, C.B., in the chair. Among the company present were the Duke of Teck, the Lord Chancellor, Lord Stalbridge, the Speaker (Mr. Gully), Sir Benjamin Baker, Sir G. Stokes, Field-Marshal Sir Lintorn Simmons, Sir Douglas Galton, Sir Andrew Noble, Sir Guildford Molesworth, Sir W. Anderson, Sir Douglas Fox, Sir H. Mance, Mr. W. H. Preece, Mr. A. R. Binnie, Dr. Frankland, Major-General Sim (master of the Merchant Taylors' Company), Captain Abney, Prof. Unwin, Mr. Hawksley, Mr. Galbraith, and so forth. At the ordinary meeting last Tuesday, April 6, Mr. J. Wolfe Barry in the chair, the paper read was on "The Blackwall Tunnel," by Mr. David Hay and Mr. Maurice Fitzmaurice. It was announced that 13 associate members had been transferred to the class of members—viz., Messrs. John Beckett Baker, Joseph Phillips Bedson, George Dundas Churchward, George Elmsley Coke, James Fraser, William Hayden Gates, Nathaniel Grew, William Silver Hall, Samuel Hanna, George Francis Horbury, Francis William MacLean, Sir Charles Herbert Theophilus Metcalfe, Bart., and Thomas Harold Rawson.

The Competition of the Foreigner.—The following remarks of the consul at Monte Video have such a familiar sound that it comes almost as a surprise to find that it is not a British, but a United States consul, that speaks, and the inculpated merchants belong to the other side of the Atlantic: "It will be necessary," says the consul, "to exhibit in Monte Video the goods which we desire to introduce and sell—the same as our European competitors are doing—instead of expecting people to go to the United States for them, or to ask for samples to be sent from here to the United States of what is wanted. Unless our people at home are ready to spend money in trying to get new trade here they will hardly be able to get any." The United States consul at Monte Video (it is he who tells the old tale with only the name changed) further asserts that South American traders are, as a rule, too well satisfied with the present state of their business relations with Europe to go to the trouble and expense of experimenting with goods from the United States unless traders from the Northern Republic are prepared to place such goods before them in a practical fashion. It might be concluded that the ways of the English race are much the same whether domiciled in Britain or America. But perhaps it is safer to go no further than that a little discount may be allowed on consular reports.

The London Telephone Service.—In the House of Commons last Friday, on the motion to go into Committee

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of Supply on the Civil Service Estimates, Mr. Bartley called attention to the telephone system of London, which he said was sadly deficient and costly. Sir James Ferguson said that, though a director of the National Telephone Company, he had himself, when Postmaster-General, devised a system by which the revenue of the Post Office would not be injured by the telephone service. In the last three years the complaints had been reduced by 80 per cent., and he hoped a popular system would soon be in use. An alarming contribution to the debate on the subject was made by another member, Mr. E. Lawrence, who informed the House that a new system of telegraphy by rays without wires had been invented within the last six months that would revolutionise the present system. (The picture of all business London signalling to each other by electric waves is a delightful one, and doubtless the County Council going to Parliament for an Act to prohibit iron structures or anything that would stop them.) After this, Mr. Hanbury appears to have said the present system was not too good, but the Government had resolved not to buy out the existing rights of the National Telephone Company in London. The complaints that reached the Post Office were now very few indeed, and that fact was a tribute to the National Telephone Company. (It might mean that people have found complaining to be useless.) Since 1893 the service had been much improved, and the cost reduced. The subject then dropped.

Rontgen Ray-burn.—The *Lancet* has discovered (or thinks it has) a case of Röntgen radiations affecting the bones as well as the under-skin, or, to describe it in the accurate and beautiful language of the medical man, a case of radiographic dermatitis with ostitis. It is an American case, and comes from a paper published by Mr. T. C. Gilchrist in the February number of the *Bulletin* of Johns Hopkins Hospital, Baltimore. There was "marked thickening of the first and second phalanges, and tenderness over the metacarpals." Moreover, a "radiograph taken of the hand showed, as compared with one of the normal left hand, thickening of the bones of the phalanges and metacarpals themselves, with some irregularity of outline suggesting strongly the progress of a slow osteal or periosteal inflammation. These bones were also less diaphanous than those of the left hand." There is some speculation rather wide of the mark as to the physical cause of the lesion. Speaking on the general subject, the *Lancet* says: "A sufficient number of cases of Röntgen dermatitis have now been recorded to enable us to form a fairly clear idea of the pathology, if not the etiology, of this peculiar lesion. It is clear that in it we must recognise a form of slowly destructive, recoverable, but not very tractable inflammation of the skin in all its layers. In most cases it appears that this is all." This would almost describe the common chilblain. One very curious thing is the way in which many of the people who are constantly handling the Crookes tube declare that they have not only felt no ill effects, but after trying their best to give themselves Röntgen skinburn have utterly failed. It seems a nasty, uncomfortable sort of thing when you do get it.

Resonance and its Remedy.—Mr. K. B. Miller has been reading a paper on the practical aspects of electrical resonance before the Chicago Electrical Association, in which, after going into the elements of the matter and pointing out that under the proper conditions of correspondence quite an insignificant variation of E.M.F. may result in an immense strain on the insulation of the circuit, he passes on to consider the general problem of counteracting self-induction by introduced capacity and *vice versâ*. After some elementary instances of the (proposed) utilisation of resonance, the conclusion arrived at is that to those who have attempted to obtain a delicate adjustment of the capacity and the coefficient of self-induction of a circuit to any desired frequency, the difficulties of the method appear especially great. But though its application has not yet met with striking success, no one can deny the beauty of the conception and the nicety with which known physical laws have been utilised in one effort to bring the telephonic art to a higher degree of perfection. "None of the methods described has come into general use. The construction of condensers is at present far from perfect. They are expensive, liable to frequent breakdowns, especially when subjected to high E.M.F.'s, and are very susceptible to moisture and changes in temperature. Moreover, their use is accompanied by a considerable loss due to dielectric hysteresis, although this loss is not as great as that of magnetic hysteresis in iron. It seems, however, that a phenomenon so beautiful must find more general use in engineering works. It affords another tool to the inventor, the engineer, and the scientist with which to better existing methods, or to accomplish some end hitherto unattainable."

The Chemical Society.—The annual dinner of the Chemical Society was held at the Criterion Restaurant, Piccadilly-circus, last week, Mr. A. G. Vernon Harcourt, the retiring president, occupying the chair. The company included Lord Lister (president of the Royal Society), Prof. Dewar (president-elect of the Chemical Society), Mr. Christie (the Astronomer Royal), Sir John Evans, Dr. Gladstone, Dr. Hicks (president of the Geological Society), Prof. M. Foster, Major-General Sir J. Donnelly, Mr. Shelford Bidwell (president of the Physical Society), Mr. W. Hills (president of the Pharmaceutical Society), Dr. Stevenson (president of the Institute of Chemistry), Dr. B. Dyer (president of the Society of Public Analysts), Dr. H. Müller, Prof. Rücker, Dr. W. J. Russell, Prof. Emerson Reynolds, Mr. Fletcher Moulton, Q.C., Dr. Armstrong, Prof. Roberts-Austen, Dr. Messel (chairman of the London section of the Society of Chemical Industry), Prof. Thorpe, Prof. J. M. Thomson, Prof. Meldola, Prof. Dunstan, Prof. Clowes, Prof. Pritchard, Prof. G. C. Foster, Prof. Warington, Prof. Sprengel, Prof. Huntington, Prof. Herkomer, R.A., Prof. Tilden, etc. Lord Lister proposed "Prosperity to the Chemical Society," and caused great laughter by remarking that when the society was started it was said that a scientific man of the period expressed great doubt whether chemistry was a subject which could sufficiently occupy the attention of a society. The society's rooms at Burlington House were now becoming insufficient for their purpose. The President responded, and Sir John Evans, in his reply for "The Learned and Scientific Societies," proposed by Mr. W. Crookes, expressed satisfaction at the fact that the Royal Society welcomed to its ranks each year a certain number of chemists.

Society of Engineers.—At a meeting of the Society of Engineers held at the Royal United Service Institution, Whitehall, last Monday evening, Mr. G. Maxwell Lawford, president, in the chair, a paper was read by Mr. P. Michael Faraday, on "The Rating of Engineering Undertakings," in which the author pointed out the importance to engineers of a knowledge of the method in which the works under their control were assessed for the purpose of parochial rating. When rating an undertaking extending through many parishes, the assessment in any one parish must be fixed in accordance with the rental value of the property in that parish, and not by ascertaining the rental value of the whole concern and then dividing it among the various parishes claiming a share according to the size. The obvious advantage which an incoming tenant would have in the case of a water company, as compared with a

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gas company, owing to the fact that the former has statutory rights to collect its rates in advance, was pointed out, and the bearing which this point had upon the tenant's capital was shown to be very considerable. An explanation was given of the term "dead mains," it being pointed out that in certain parishes mains passed from one end to the other without in any way supplying occupiers in that parish, in contradistinction to "live mains," which were used for the immediate supply of the occupiers, and the importance of the division between these two classes being accurately made, owing to the fact that they are assessed upon different principles, was fully pointed out. In conclusion, the author maintained that it was a fallacy that the gasholders and retorts of a gas company were tenants' tools, and therefore not ratable. Though not specifically dealt with, the principles that would apply to an electric supply company's works would of course be somewhat similar.

The Royal Institution.—The discourse at Albemarle-street last Friday was by Mr. C. T. Heycock, F.R.S., on the subject of "Metallic Alloys and the Theory of Solution." Mr. G. Matthey was in the chair, and amongst those present were Lord Rayleigh, Sir Frederick Bramwell, Sir Douglas Galton, Dr. Frankland, Prof. Dewar, Mr. Crookes, Prof. Roberts-Austen, and Prof. Armstrong. Among the exhibits afterwards was a Callender and Griffith Wheatstone bridge for high-temperature work. Messrs. Griffin and Son exhibited a Röntgen ray apparatus, driven, as such an apparatus should be, by a Wimshurst instead of a coil. This (Friday) evening Lord Rayleigh gives a "discourse" on the limits of audition. It may be reasonably anticipated that he will have something to say as to the extreme smallness of the amplitude of most wave motions compared to what we are accustomed to picture to ourselves. It should be of interest beyond the limits of air vibrations. Lord Rayleigh has another lecture to deliver of his course on electrical vibrations to-morrow (Saturday)—and after that the holidays. The following will be the lecture arrangements after Easter: Dr. Tempest Anderson will give four lectures on "Volcanoes" (the Tyndall lectures); Dr. Ernest H. Starling, three lectures on "The Heart and its Work"; the Rev. Canon Ainger, four lectures on "Some Leaders in the Poetic Revival of 1760-1820—Cowper, Burns, Wordsworth, Scott"; Prof. Dewar, three lectures on "Liquid Air as an Agent of Research"; the Rev. J. P. Mahaffy, three lectures on "The Greek Theatre according to Recent Discoveries"; and Mr. J. A. Fuller Maitland, four lectures on "Music in England during the Reign of Queen Victoria" (with musical illustrations). The Friday evening meetings will be resumed on April 30, when a discourse will be given by Prof. J. J. Thomson on "Cathode Rays." The succeeding discourses will probably be given by "Anthony Hope," Prof. Harold Dixon, Lord Kelvin, Prof. H. Moissan, Mr. W. H. Preece, and Mr. William Crookes.

Units Again.—It is a curious taste, but some people are never tired of playing with new systems of units. Prof. Leonhard Weber, writing in the *Elektrotechnische Zeitschrift*, points out that in photometry there are six different quantities to be dealt with—viz., intensity of light, flux of light, quantity of light, illumination, brightness, and time-integral of illumination. Taking a candle as the unit of intensity, he shows how all these quantities can be expressed in terms of the centimetre, candle, and second. So it may be presumed that we are to have the C.C.S. system as a companion to the C.G.S. A scientific contemporary of very high standing, commenting on this, objects to the light of a candle. "In order to obtain a perfectly absolute system of units, quantity of light should be measured in terms of the energy radiated, and the unit of intensity would then be that of a source from which the amount of energy radiating per unit solid angle per second was one erg. This would reduce all photometric quantities to the C.G.S. system of units." Unfortunately, however, some people will consider that a unit of light should measure light, not radiant energy. The underlying assumption that the two are proportional right through the spectrum seems decidedly naïve. Really it was thought that the Geneva Electrical Congress had settled the photometric units business, at any rate for a year or two. Meanwhile, in France efforts are being made to secure the adhesion of scientific societies to the division of the hours of the day into 100 parts, each to be again subdivided into 100 parts. To obtain an opinion upon the proposed decimal division of time, the Société Française de Physique has sent out a circular to its members, and has appointed a committee to consider the replies received, and to advise therefrom as to the action the society should take. One of the incidental effects of the disestablishment of the second would be, of course, to smash up all our electrical units. As a compromise one might suggest the invention of the "mega-second," and its employment, say, in the physical astronomy of the fixed stars. Astronomers are a people who use one scale for angles measured in one direction and another 15 times greater for an angle in another direction, and are obviously much in need of missionary effort on the part of the systematisers. Anyhow it would do no harm, and be an outlet for the surplus energy of the latter.

Alloys.—Prof. Roberts-Austen has been delivering at the Society of Arts four Cantor lectures on "Alloys." The lectures being given in the afternoon instead of the evening, the audience has not been as great as it should have been. Last week, getting to the alloys of iron and carbon, the lecturer, by way of doing something unusual, manufactured diamonds. That is to say, there is every reason to presume he did, because, as a matter of fact, the dissolving away of the iron in acid, which is the only way of freeing the tiny carbon crystals from their solidified solvent, is not the sort of thing to be done in a few minutes at a Cantor lecture. The method of manufacture was that of Mr. Moissan. In the experiment, as performed by Prof. Roberts-Austen, the highly carburised iron was placed in a little pocket in a lump of refractory material, so supported over a vessel of water that it could be instantly inverted. On to the iron an electric arc was caused to play, and the iron melted down to a little pool. The crucible was then turned over suddenly, and the iron formed in the water a small nugget, which showed a grey, rather crystalline, fracture on being broken. The subject of alloys was also treated from a totally different point of view by Mr. C. T. Heycock at the last week's "discourse" at the Royal Institution. The main novelty exhibited was a method of turning the difficulty that the solutions of metal in metal being opaque (and generally red hot) there is no means of seeing or separating a precipitate. Compared with a heavy metal like gold, a light metal, such as sodium, has considerable transparency to the Röntgen radiations. Mr. Heycock said gold was very readily dissolved by metallic sodium, and if a solution of gold in sodium was allowed to solidify slowly then sections cut from the solid alloy would appear perfectly uniform to the eye. If, however, the sections were placed on a photographic plate and exposed to the Röntgen rays, on developing the plate a picture was obtained showing the actual structure of the solid alloy, the sodium being transparent to these rays while the gold was opaque. By means of lantern slides sections were exhibited cut from sodium-gold alloys containing different percentages of gold. These sections showed that crystalline

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plates of sodium traversed the mass both horizontally and vertically, and that the gold, as the solution solidified, had become concentrated between the crystalline plates of sodium. The analogy between the solidification of an alloy and the solidification of an aqueous solution was thus established. It would have been interesting to have been told the result of the process on the purple aluminium and gold alloy. But probably this would have shown no structure at all.

Lord Rayleigh's Lecture.—At the Royal Institution last Saturday afternoon, in the fifth lecture of his course on "Electricity and Electrical Vibrations," Lord Rayleigh went on with currents of high frequency, and devoted some time to the way in which that frequency may be ascertained. In many cases *à priori* calculation was available, in other cases direct observation by a revolving mirror. This, in spite of great difficulties, had, in combination with a photographic plate, even been applied to the investigation of frequencies up to one million a second. After showing a small mirror of polished steel suspended between the poles of an electromagnet excited by an alternating current and rotating in step with the alternations, and remarking that the principle had now become familiar on a large scale in the synchronous motor, Lord Rayleigh went on to explain how an absolutely steady rotation might be obtained by means of an intermittent current produced by the make and break from a tuning-fork. On account of difficulties with mercury contacts only weak currents could be employed, and therefore only light apparatus could be driven; but the method might be modified so that the bulk of the motive power was obtained from some other source, the electric current being used to put, as it were, the finishing touch to the steadiness of rotation. After a digression on steam-engine governing, the remainder of the lecture was occupied with a number of experiments illustrating the behaviour of high-frequency currents towards resistances of various kinds. With a Wheatstone bridge arrangement, in which roughly-coiled wires took the place of the resistances and a spark-gap that of the galvanometer, it was shown what a very small difference of symmetery was sufficient to produce a spark. Another striking experiment was one which Lord Rayleigh said was first shown by Mr. Campbell Swinton, in which the filament in a small glow lamp incandesced, because to the very high-frequency current that path of considerable resistance was easier than the longer one round a foot or so of brass wire. Another experiment showed the influence of ultra-violet light on the resistance of air. Sparks passed freely at a particular spark-gap so long as the light of another spark was allowed to fall on it through a quartz lens, but they ceased when the ultra-violet light was cut off by means of the interposition of a piece of glass. Prof. J. J. Thomson's experiment was also exhibited with the electrodeless discharge, obtained in an exhausted globe placed inside a coil carrying the high-frequency current. This discharge was commended to investigators into the passage of electricity through gases, as it was free from special anode and cathode effects, since it began and ended nowhere in particular. Early in his lecture Lord Rayleigh also referred to the use of very high-frequency oscillations to determine the specific inductive capacity of such a substance as water, and mentioned the anomalous value obtained as compared with the refraction for light. So far as apparatus were concerned, most of the experiments which had been shown might have been made much earlier in the century instead of being the result of quite recent discoveries. Ten or fifteen years ago, said Lord Rayleigh, there was an impression that the old high-tension electricity was worked out, and that the future lay with what might be called 100-volt electricity. From a commercial point of view that might be in a measure true, but from the scientific one it was quite a mistake. One could not help admiring the way in which the engineers had grappled with the problems of electrical distribution, and the results were enjoyed in the laboratory as well as elsewhere; but from the point of pure science little had been acquired for their work except a better knowledge of the magnetisation properties and laws of iron.

Animal Electricity.—At the Royal Institution last Tuesday Dr. Waller completed this year's course of lectures on "Animal Electricity." If the eminent lecturer confessed his inability to properly summarise in the course of an hour's lecture the exact position in which his investigations had left him in reference to the origin and explanation of the phenomena he had been demonstrating, much more is it impossible to do so within the compass of a note. Briefly, however, it may be said that Dr. Waller is led to find the explanation of the electrical effects obtainable from the living tissues as analogous to polarisation results, using that term in a widely extended sense so that it covers almost any chemical changes produced by the passage of a current and correlates these to explain the production of current by the different changes brought about in the natural processes of activity or nutrition. The argument is cumulative, and rests on the precisely similar effects obtained by dosing nerve or muscle with products analogous to those which might be presumed to be produced by electrolysis or developed chemically in the tissue when the latter is forced into exaggerated action by the electrical stimulus of an alternating current. Without assuming a more detailed knowledge of some of the most debatable points of physiology than may fairly be expected of electrical engineers, it would be little use to go further into the matter at present. Dr. Waller's task is yet far from complete, and he has practically to repeat much of his work with cold-blooded vertebrates on the more troublesome tissues of the mammalia, and, presumably, to check the results so far as possible on invertebrates. Already he has come on results which show that it is by no means safe to experiment with the familiar and easy frog and then generalise. The course of lectures will be published shortly, and then the mass of detail, which it would have been beyond our scope to do more than indicate, will be available for the biologist to criticise. There are those who have been ungrateful enough to complain because the permeability of iron is not greater than it is compared with air, and only the other day one of the greatest of English physicists spoke half humorously of the ideal state that would be brought about in alternating-current transformer design if only we had a substance of practically infinite conductivity. But our work is plain sailing compared with that of the investigator of physiological electricity. Our insulators do insulate, our conductors conduct, and our cores magnetise, and one can, on the whole, keep things in their places. The material that the animal electrician has to deal with is a mere sponge of semi-conductors, never free from local chemical action, and composed of material of which it can only be said that some of it is less unstable than the rest. It is small wonder, therefore, that clear-cut conclusions are not immediately obtainable. And at the end of it there is the remarkable fact that, built up of this stuff that, as material for a circuit, any engineer would treat with scorn, gymnotus, malapterurus, and their other wet and slimy friends get up and maintain a difference of potential which will give a greater shock than is at all pleasant. As a mere matter of physical construction it ought to be interesting.

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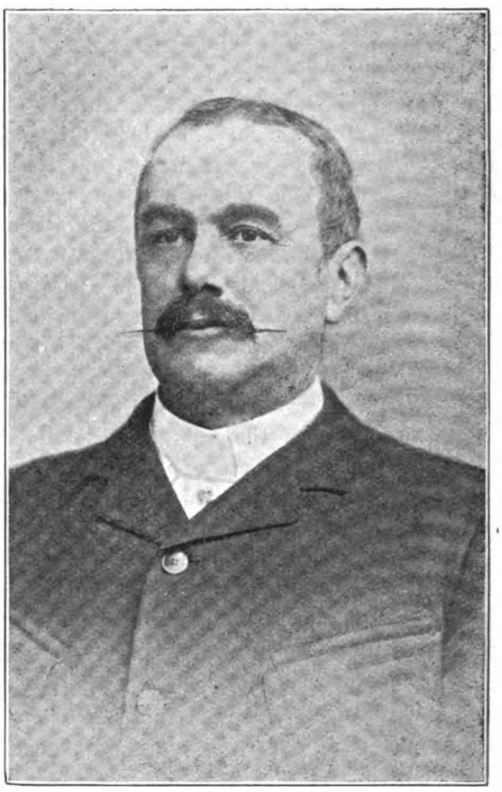
HARROGATE ELECTRICITY WORKS.

The completion of the Harrogate electric light station adds yet another to the steadily increasing list of electricity supply undertakings which owe their existence to municipal enterprise. Harrogate may be aptly termed the "Spa of the North"—in fact, it is to the North of England what Cheltenham is to the South-West. Far famed, like Cheltenham, for the medicinal virtues of its mineral waters, and being situated in an extremely favoured spot of Yorkshire as regards surroundings, besides possessing a particularly exhilarating atmosphere, the town attracts an abundance of visitors. The permanent residents, moreover, are mainly of the wealthy class—manufacturers, merchants, etc., from Leeds and other large commercial centres within easy reach. So, although the town is very scattered, and also comparatively small, judged by the population standard—containing, as it does, only about 17,000 inhabitants—yet it is, on the other hand, very wealthy in proportion to the number of inhabitants, and therefore presents an excellent field for electricity supply. It cannot be denied but that the Corporation have been rather dilatory in providing the supply: this is all the more to be wondered at considering the magnificent progress which the town has made in other respects—progress, too, which has added wonderfully to the attractiveness and healthiness of the place. Harrogate owes a great deal of its prosperity to the energy and efficiency of its public servants. A visitor cannot but be struck with the model-like cleanliness of the town. The roads and sidewalks alike might well be the envy of a town less favoured in this respect. Nor does the cable-laying for the electric light seem to have been detrimental to the even excellence of the pavements. Perhaps this is to be accounted for by the fact that all necessary trenching has been executed by the Corporation's staff, under the supervision of Mr. Samuel Stead, the borough engineer. But however this may be, certain it is that the pavements

J. H. WILSON, ESQ., MAYOR OF HARROGATE.



COLONEL THWAITES, CHAIRMAN OF THE ELECTRICITY COMMITTEE.

MR. SAMUEL STEAD, BOROUGH SURVEYOR OF HARROGATE.

MR GEO. WILKINSON, M I E E., CONSULTING ENGINEER.

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present few traces of their recent disturbance, and everywhere give evidence of careful preservation. This reflects great credit on the Corporation's engineering staff.

The history of the electric light undertaking just completed extends over several years. The Corporation obtained their provisional order in 1891, but the matter was then left in abeyance until advances made by Mr. Campbell Swinton, on behalf of Messrs. Parsons, Limited, of Newcastle-on-Tyne, again brought the question to the front. The proposals of Messrs. Parsons, Limited, to take over the provisional order and to undertake the carrying out of an electric supply scheme were submitted to Mr. George Wilkinson, consulting engineer, of Westminster. Mr. Wilkinson in his report strongly urged the Corporation to undertake the supply themselves rather than go to the expense of buying out an established company later on. This advice was taken, and the services of Mr. Wilkinson were further retained to prepare an electric lighting scheme in conjunction with a refuse destructor, the idea being to utilise ashpit refuse to generate steam. A report on a combined refuse destructor and electric generating plant was duly submitted by Mr. Wilkinson, with the result that it was adopted in its entirety, and tenders were obtained for carrying out the work. On further consideration, however, it was decided to postpone the erection of a refuse destructor and only to embark upon the electric lighting portion of the scheme. A lapse of about nine months intervened after this decision, then the Corporation once more amended their proposals, deciding to increase the expenditure originally contemplated by putting down plant of greater capacity. Fresh plans and specifications were drawn up by Mr. Wilkinson: these were adopted, and sanction to borrow £25,000 obtained. No further delay was indulged in. On the contrary, the work was put in hand and rapidly carried to completion, the total cost closely approximating to the estimated cost—viz., £25,000. Although it is early to discuss the probable output of the station after one or two years' working, the indications of a large demand for current for lighting and other purposes are very encouraging. The station may, in fact, be said to be starting under exceedingly healthy conditions as to load. An equivalent of about 8,000 8-c.p. lamps is already connected up to the mains, while many others are being wired. The Corporation are monopolising of the above total an equivalent of 2,000 8-c.p. lamps. Of these a large proportion is absorbed by the new baths, which are

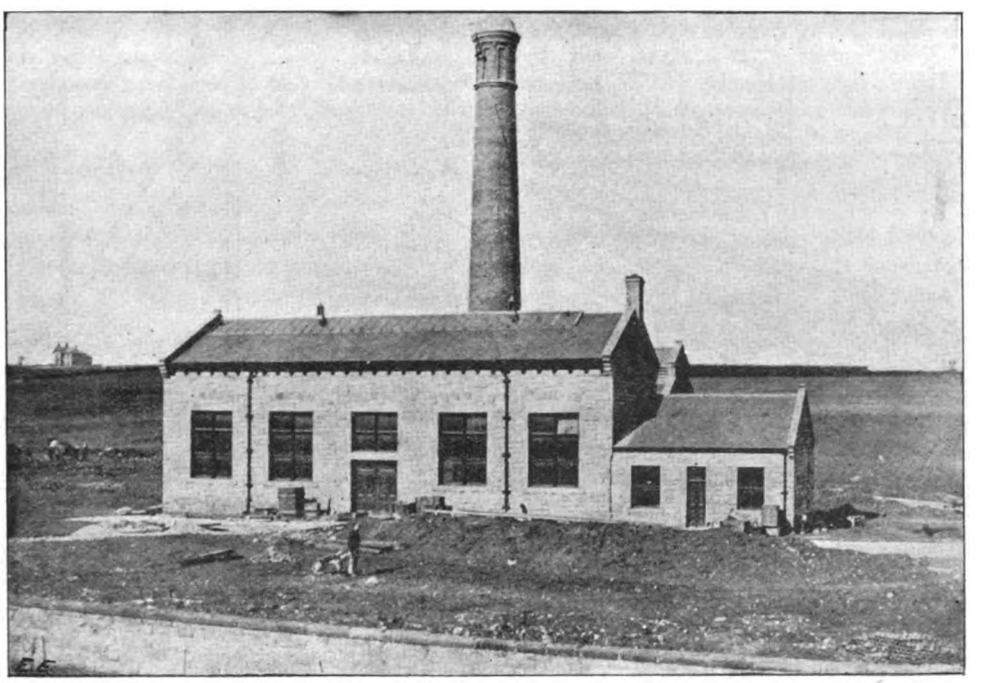

FIG. 1.—General View of the Electric Light Station at Harrogate.

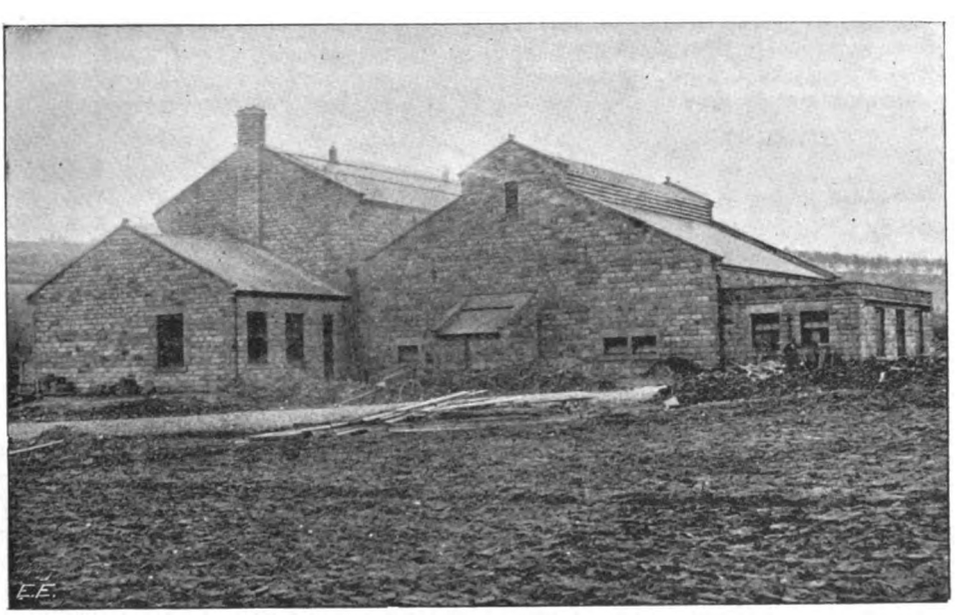

FIG. 2.—End Elevation of the Buildings.

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being erected by the Corporation at a cost of between £120,000 and £130,000. It may also be mentioned that the Corporation are utilising the electric current for power purposes wherever possible, and besides erecting fire-alarms and installing motors in the Corporation yard premises for chaff-cutting and other purposes, electric motors are also being installed for pumping sewage. For the latter purpose a motor of 16 h.p., capable of delivering 100,000 gallons daily to a height of 75ft., is being installed. Should this prove satisfactory it is intended to install two other electric motors of similar power by which means the sewage of the town will be elevated to the high lands of the sewage farm, which cannot be reached by means of gravitation. No street-lighting has been adopted at present, but Mr.

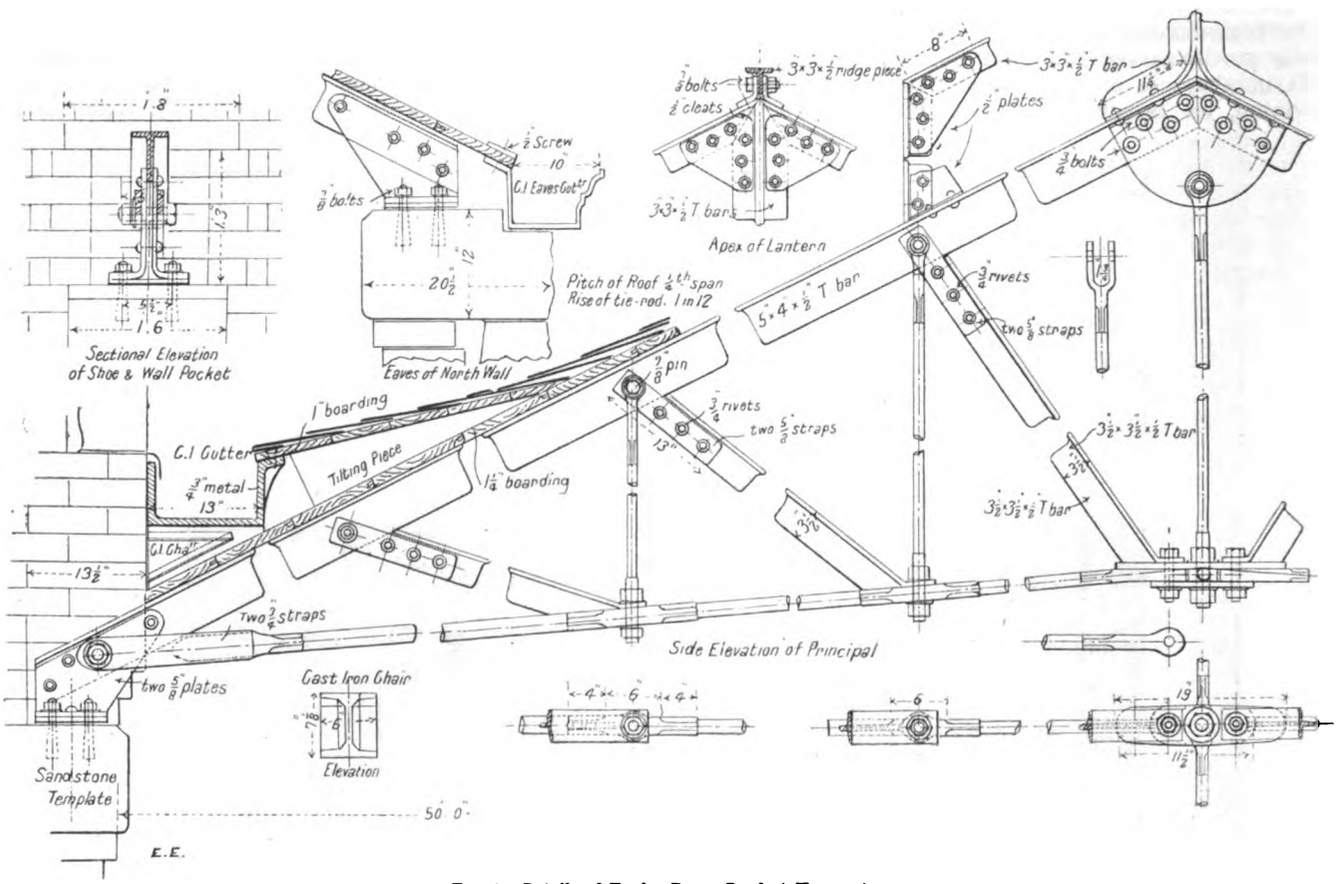

FIG. 3.—Details of Engine-Room Roof at Harrogate.

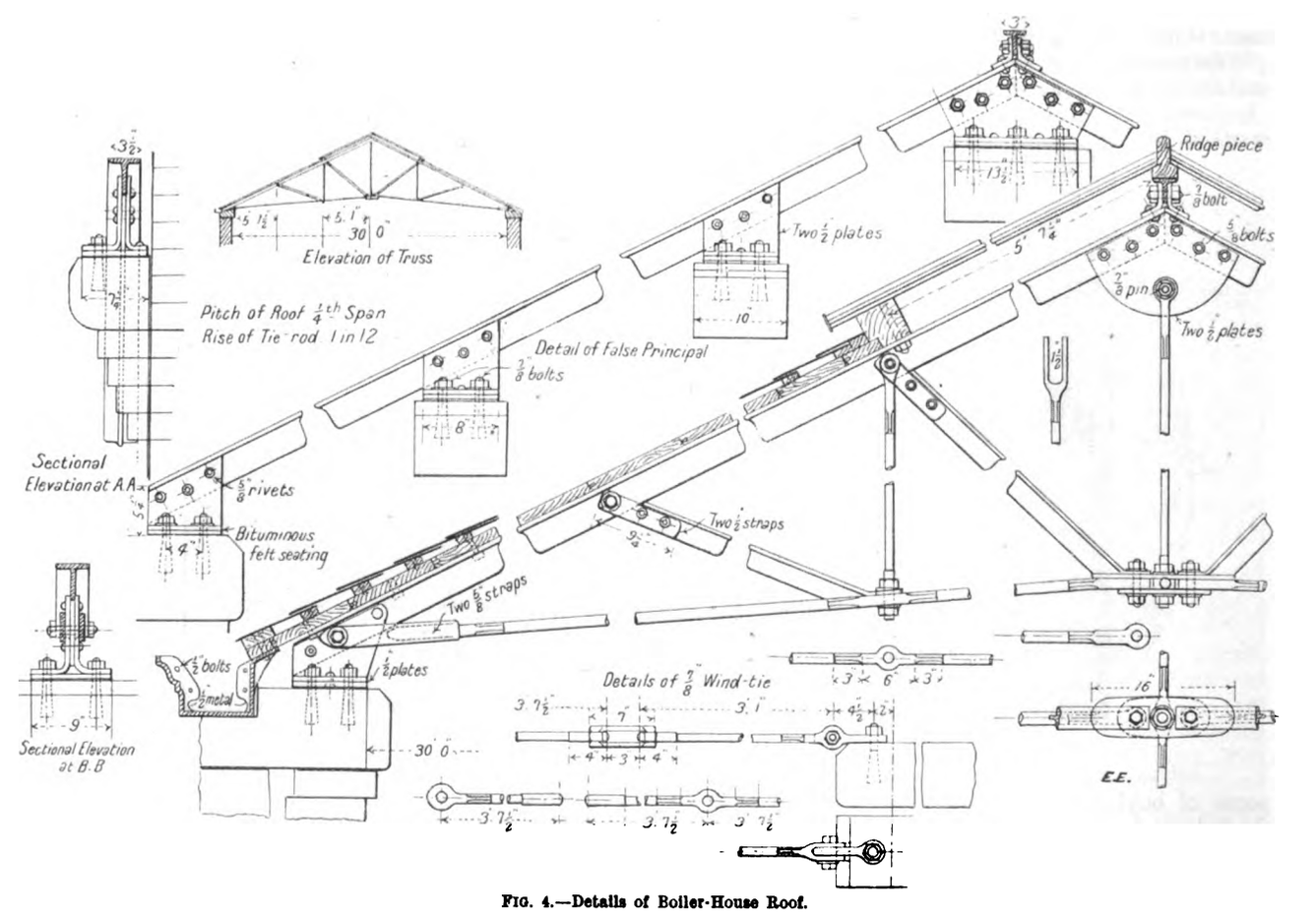

FIG. 4.—Details of Boiler-House Roof.

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Wilkinson is preparing a scheme which will be the subject of a Local Government Board enquiry. Special powers to run cables outside the limits of the borough have already been obtained.

It will be remembered that we gave a detailed description of a new system of house wiring, called the "Cosmo" system, in a recent issue of the *Electrical Engineer*. This system, which was invented by Mr. George Wilkinson, is meeting with great favour at Harrogate. The electric light works and offices, Victoria Baths, municipal offices, new public lavatories, Queen's Hotel, and numerous other buildings are being wired throughout on this system, which has simplicity and neatness to commend it. The price to be charged per unit to consumers is 6d. for lighting and power.

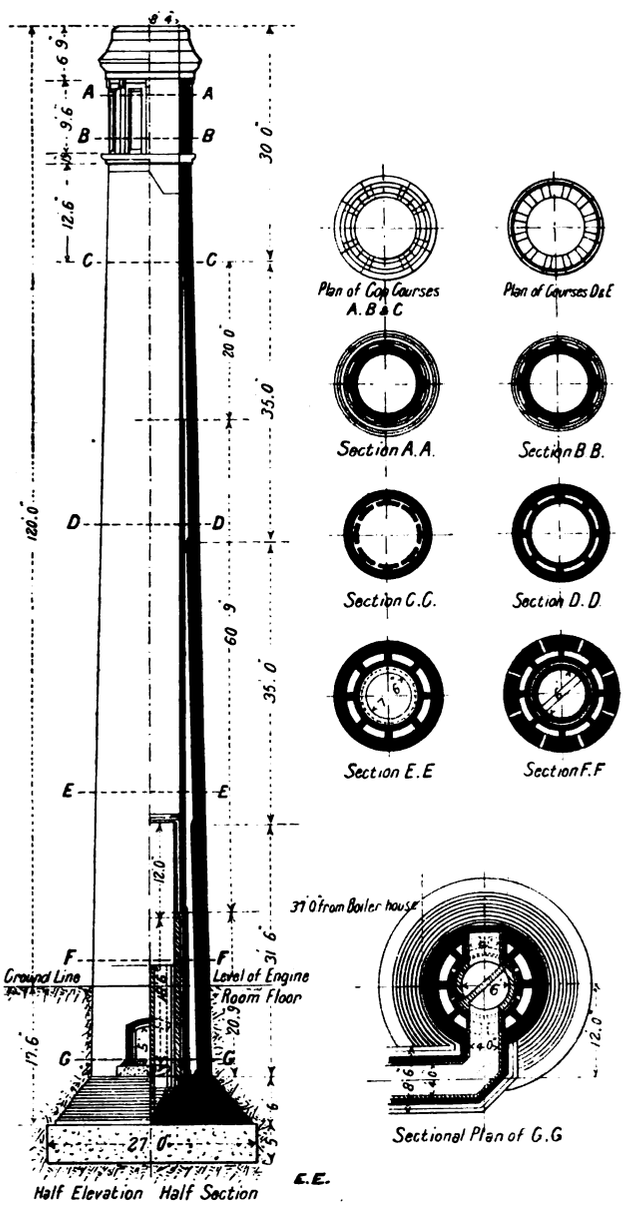

FIG. 5.—Details of the Harrogate Chimney Shaft.

The system of supply adopted may be briefly described as a high-pressure system, with a low-pressure network for the compact portion of the town, while the scattered character of the surrounding properties has necessitated a supplementary high-pressure network with transformers in the houses, transforming down from 2,000 volts to a 100-volt supply. The borough has an area, by-the-bye, of 1,287 acres, but we will deal with the system of distribution more fully below, as it presents many interesting and well-thought-out features.

In selecting the site of the generating station, the position which Harrogate holds as a health resort, and the consequent undesirability of erecting any building of the nature of a factory within the precincts of the town that might cause inconvenience or discomfort to visitors, had, of course, to be taken into consideration. In consequence of these weighty considerations, the station has been erected on the irrigation farm, which lies a little to the north of the borough. The site is adjacent to the Oak Beck, which will provide a supply of water for condensing purposes. In order to secure a sufficient quantity of water for this purpose, a dam and penstock have been constructed across the beck, and walls built for some distance along the sides. This source of water supply, however, is not considered suitable for use in the boilers, and a supplementary supply of water has been provided for the exclusive use of the boilers by constructing a brick reservoir on the side near the boiler-house. A pipe conveys to this reservoir an ample supply of pure water from a spring on the hillside above the station. With regard to coal supply, the site is not so conveniently situated, since the coal has to be carted some little distance. Breeze, however, can be delivered from the gasworks (which belong to a company, by the way) at a rate of 5s. per ton, while slack can be delivered at from 9s. to 9s. 6d. per ton. We will now proceed with a detailed description of the various sections of the scheme.

Buildings.

The buildings of the station are situated with a southern aspect, and are very plain in character, as will be seen from the photographs (Figs. 1 and 2). Their facing is of local stone throughout, backed with brickwork. The buildings comprise engine-room, boiler-house, coal-store, workshop. general store, superintendent's office, and testing-room. Owing to the subsoil being of a very gravelly nature and the site being in such close proximity to the Oak Beck, some little difficulty was experienced with water, and it was considered advisable to take precautions against any possible flooding by encasing all the lower portions of the boiler seatings, pits, and economiser with Val de Travers asphalte. This has proved effectual, as no inconvenience was caused by the very severe floods during the winter. The influx of water during the excavation work for the chimney shaft was very great, and caused much inconvenience and expense, the bottom of the excavation being about 14ft. below the level of the beck. The lower portion of the chimney and the main flue have also been enclosed in asphalte. The engine-room and also the boiler-house are so arranged that they can be extended without interfering at all with the working of the station; they are 75ft. 9in. and 55ft. in length respectively, while the width of the engine-room is 30ft. and that of the boiler-house 40ft. Both are covered in with steel roof principals finished with close boarding and slated. A skylight runs the entire length of both rooms, and in the boiler-house this skylight forms a raised lantern, the sides being filled in with louvres for ventilation. The glazing and louvres are constructed on Messrs. Helliwell's patent systems. Details of the engine-room roof are shown in Fig. 3, while Fig. 4 shows details of the boiler-house roof. The engine-room, it may be remarked, in addition to the skylight above mentioned, is provided with five large windows. The boiler-house is furnished with three large coal-bunkers, which are filled from the outside through tips. In practice it is proposed to lock these bunkers and weigh out a supply of coal to each stoker, an inducement being offered to the men to economise, in the shape of extra pay in proportion to the amount of coal saved. The walls of the engine-room are lined with selected red bricks, with a dado 5ft. 6in. high of salt-glazed bricks. The longitudinal girders for the overhead traveller, which runs the full length of the room, are supported upon brick piers forming a part of and stiffening the walls. The floor is paved with wood-block flooring laid upon concrete, but that of the boiler-house is of concrete only. Quite clear of the buildings stands the chimney shaft. It is 120ft. in height from the ground level, and is constructed entirely of one class of bricks. As will be gathered from the details shown in Fig. 5, the shaft is circular in section, the concrete foundation also being circular. Two layers of steel rails are embedded in the concrete foundation. The chimney stands on a very hard bed of shale, which affords a firm foundation, and no settlement has occurred since the shaft was completed.

A general idea of the exterior appearance of the station buildings will be obtained from Figs. 1 and 2. Fig. 2 shows the end elevation of the engine and boiler houses—

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the latter to the rear—while Fig. 1 is the front elevation of the engine-room, showing the chimney shaft in rear and a portion of one of the bank walls enclosing the Oak Beck in the foreground. These buildings have been erected according to plans prepared by Mr. Samuel Stead, the borough surveyor at Harrogate.

Steam Generating Plant.

Two boilers have at present been installed, but provision has been made for a third. They are of the Lancashire type, and were supplied by Messrs. Holdsworth and Sons, of Croft Boiler Works, Bradford. The dimensions of each boiler are: length, 30ft.; diameter of shell, 8ft.; and of furnace tubes, 3ft. 3in. They are designed for a working pressure of 140lb. per square inch, and were subjected to an hydraulic pressure equal to 240lb. per square inch before delivery. The plates used in their construction are $\frac{3}{4}$in., $\frac{1}{2}$in., and $\frac{11}{16}$in. thick for the shells, furnaces, and ends respectively. Fig. 6 shows a longitudinal section of one of these boilers, and Fig. 7 an end elevation. The fittings on the boilers were made by Messrs. Fletcher Bros., of Ashton-under-Lyne, and include for each boiler a dead-weight safety-valve, blow-off cock, "Divel" valve, and a "divergent" slide-valve. This dead-weight safety valve, an external view of which is shown in Fig. 8, has the weight enclosed in a circular casing, and the seatings are so arranged that they reclose practically on the opening point. The "Divel," or high-steam and low-water safety-valve (Fig. 9), is of special design. Hitherto, when steam has escaped from these valves, it has been impossible to tell whether it was issuing for high steam or low water. In the "Divel," however, there is an arrangement for dividing the flow. The high-pressure steam issues from one branch, as in the old types; but should the water get low in the boiler, the steam issues through a side orifice, showing at a glance the cause of blowing-off. The blow-off cocks and water-gauges are also of improved patterns.

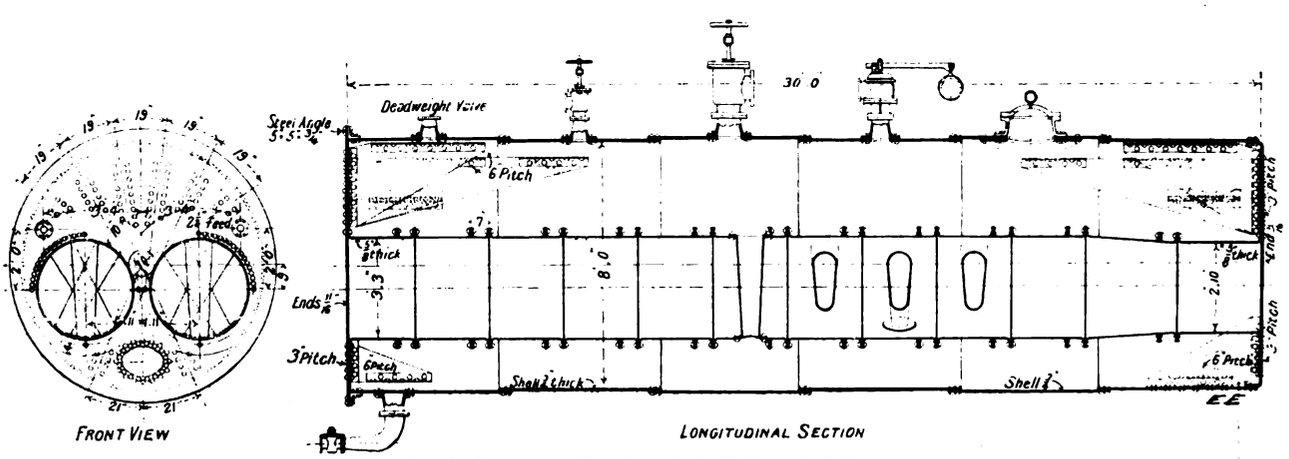

FIG. 6.—Section and Elevation of the Holdsworth Boiler.

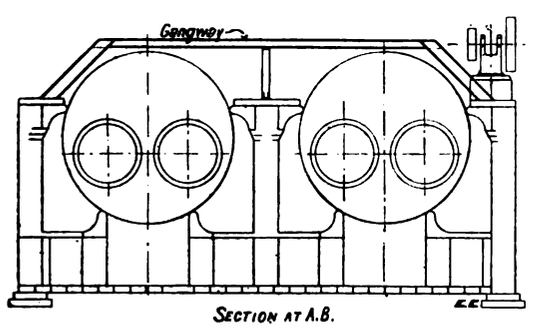

FIG. 7.—Sectional Elevation of Two Boilers in their Seatings.

The latter are automatic in both top and bottom arms, closing automatically should the glass break. It may also be mentioned that Messrs. Fletcher Bros. supplied the stop-valves on the steam-ring. These are of their patent "Divergent" type, in which the discs are drawn up and lowered by means of a flat cotter, and pushed against the faces by a taper plug working from the centre.

Mechanical stokers have been supplied and fitted to the boilers by Messrs. Ed. Bennis and Co., Limited, Lancashire Stoker Works, Bolton. There are two of these stokers to each boiler. Their appearance fixed is shown in Figs. 10 and 11. The action of this type of stoker is as follows: the fuel is fed into a hopper holding about 3cwt. Under this hopper is placed a cast-iron feeding box, in the interior of which a pusher plate is situated. A certain quantity of fuel falls in front of this plate, and is pushed by it over a ledge formed by the bottom of the box, the weight of the fuel so pushed being regulated by means of a cam on the driving shaft. The fuel then falls on to a flat plate, from which it is projected by a shovel, which being propelled forward strikes the fuel and scatters it over the fire. A patent pneumatic gear actuates these stokers, which in turn is driven off a shaft, running the length of the boiler-house, coupled to a small engine placed on the top of one of the boiler flues.

The economiser at this station has been supplied by Messrs. E. Green and Son, Limited, of Exchange-street, Manchester. It is one of their standard type, and consists of 192 tubes, each $4\frac{9}{16}$in. diameter and 9ft. long. These tubes are arranged in two groups in 24 rows of eight to allow free expansion and contraction. All parts subjected to internal pressure are made from strengthened sets of

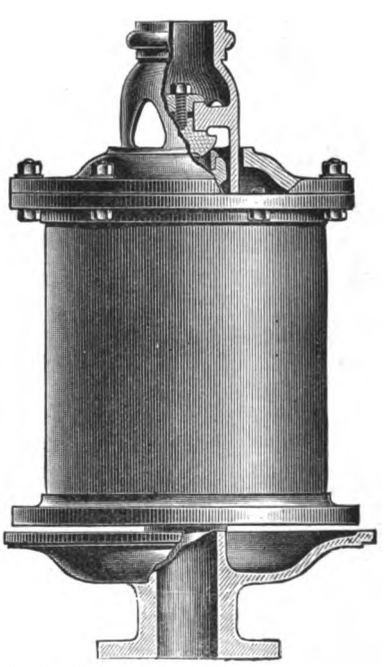

FIG. 8.—Fletcher's Dead-Weight Safety Valve.

patterns, and the top boxes are fitted with Green's high-pressure internal lid. Deflectors are provided at the back of the tubes to facilitate inspection or cleaning operations inside the chamber. The hydraulic test pressure was 350lb. per square inch. The scrapers are worked by the small engine, which also works the mechanical stokers and small auxiliary pump, the latter in connection with the priming tank mentioned elsewhere.

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Steam and Exhaust Pipes.

The contract for the above was sublet by Messrs. Ferranti to Messrs. J. and H. McLaren, who also supplied the main engines, as described below. A good idea of the arrangement of the pipe services to the engines, condensers, etc., will be obtained on reference to Fig. 12, which also shows the positions of the plant. With regard to the steam-pipes supplying steam to the feed-pumps and stoker engine, to be described hereafter. These pumps exhaust into the condensers of each or all of the engines, or into the atmosphere if desired. The large engines, it may be noted, are also provided with a valve on their exhaust-pipes for allowing the steam to exhaust into the air when required. The circulating water for the condensers is conveyed from the beck to a

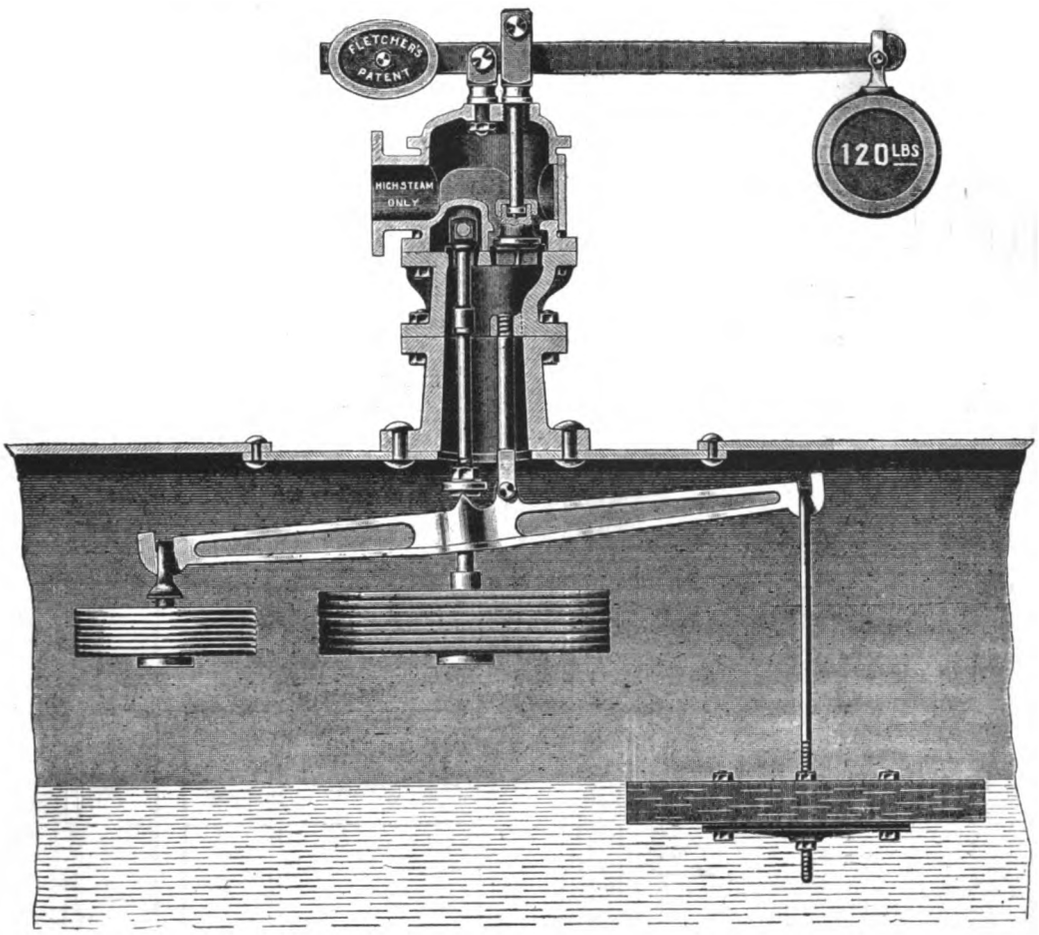
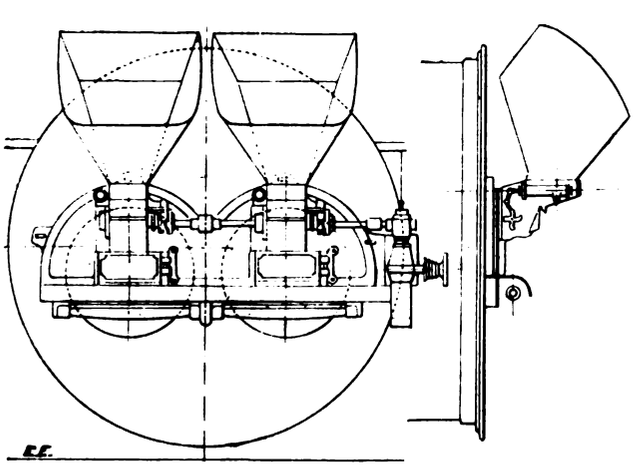


FIG. 9.—View of Fletcher's Patent "Divel" Safety Valve.

it may be mentioned that they are all of mild steel, electrically welded (flanges welded on), and have been subjected to a test of 500lb. pressure per square inch. The usual ring main, it will be seen, is carried over the boilers. It is of 7in. bore, and fitted with electrically-welded branches to the engines. These branch pipes pierce the engine-room wall, as shown, and those to the large engines



FIGS. 10 AND 11.—Views of Boiler Front, fitted with Bennis Stokers.

are 4in. diameter, while that to the day-load engine is 2½in. diameter. Water-separators are attached to these branches, and they are drained by Geipel's steam-traps, similar traps also being used for collecting condensed water from the cylinder jackets. There is another ring main of 1½in. steam-pipes running across the front of the boilers. This is for sump, shown in plan (Fig. 12), situated immediately in front of the engine-room, whence it is drawn through large cast-iron pipes to the condensers. These pipes are laid in trenches through the engine-room, and are covered by neat cast-iron covers. The discharge goes back into the same beck whence it is drawn. The condensed water from each engine is forced through cast-iron pipes, which are laid in the same trenches. It goes to the hot-well, which is situated in the corner of the boiler-house. Before entering the hot-well, however, the water is passed through a McDougall's oil-separator. Two boiler-feed pumps, each capable of delivering 2,000 gallons of water at 150deg. F. per hour against a boiler pressure of 125lb. per square inch, draw out of this hot-well, and are provided with an arrangement of pipes to deliver through the Green's economiser, or, as an alternative, direct to the boilers. The pumps are of the two-throw type, with 4in. diameter ram by 6in. stroke, and were made by Messrs. Hanson, Carter, and Co., of Bradford. A main has also been led from these pumps to deliver water from the feed-tank into the engine or boiler house in case of fire. The boiler blow-off pipes are of cast iron. They are carried in a trench in the boiler-house floor, and for safety do not go into one main, but each boiler, and the economiser also, has a separate pipe leading to a sump outside the boiler-house wall.

Provision is also made for priming the various centrifugal pumps in connection with the condensers, and for taking away all water from the steam-traps and drain cocks. The priming tank and pump in connection therewith are situated in the boiler-house. As will be gathered from the above remarks, the arrangement of pipes has been most carefully thought out in order to make the most use of the heat generated at the boilers, and therefore to obtain maximum efficiency.

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Engines.

These, with the exception of a special day-load plant mentioned hereafter, have been supplied by Messrs. J. and H. McLaren, of the Midland Engine Works, Hunslet, Leeds, who are sub-contractors to Messrs. S. Z. de Ferranti, Limited. The main engines, two in number (Figs. 13 and 14), are of the inverted compound surface-condensing enclosed type, having their respective flywheel alternators coupled direct to the crankshafts between the cylinders. They are each designed to develop 225 i.h.p., either with the condensers at work or without. The high and low pressure cylinders are respectively 14½in. and 25¼in. diameter by 18in. stroke, and their speed is 150 revolutions per minute. Both cylinders are steam-jacketed, and are fitted with relief valves at each end. The cylinders are supported on cast-iron columns which enclose the connecting rods, etc. These columns are fitted with doors, which provide easy access to the crank-pin and cross-head. Special care has been taken with the lubricating arrangements. Oil-pumps, situated in the bed-plate, pump oil under pressure to the different parts of the engine, and a thorough system of oil collectors and splash guards has been provided to stop any possibility of oil getting on to the alternators. The slide-valves are of the trip pattern, and are balanced, while the high-pressure valve is connected directly to McLaren's patent automatic expansion governor. With this governor the speed of the engine can be controlled, it is claimed, to within 2 per cent. up or down, notwithstanding any variation of load. And by means of a simple speeding gear the speed can be altered while the engine is running from 5 per cent. to 10 per cent. above or below the normal, which is a necessity when alternators are being run in parallel. The low-pressure valve is provided with a hand adjustment for regulating the cut-off

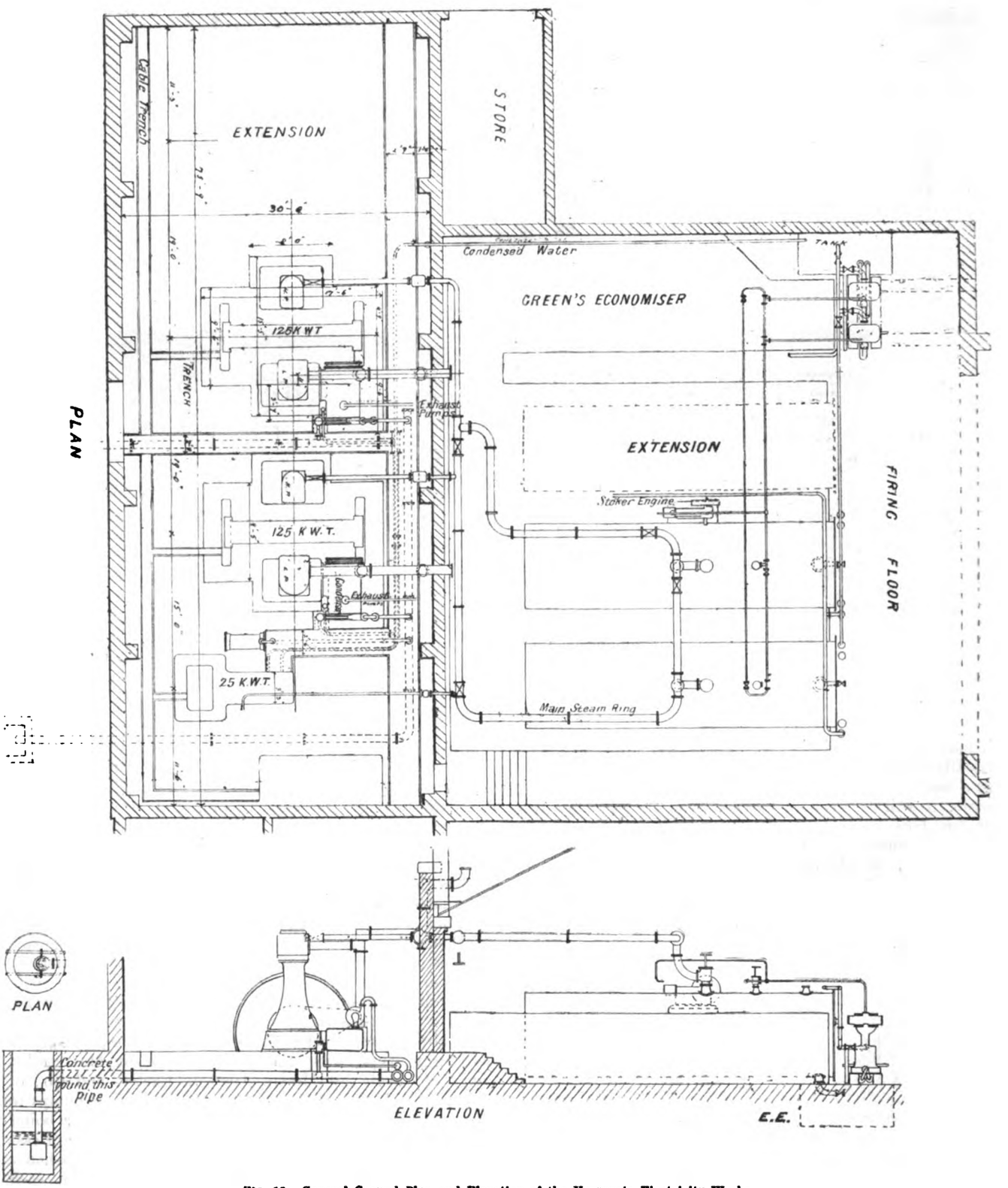

FIG. 12.—General Ground Plan and Elevation of the Harrogate Electricity Works.

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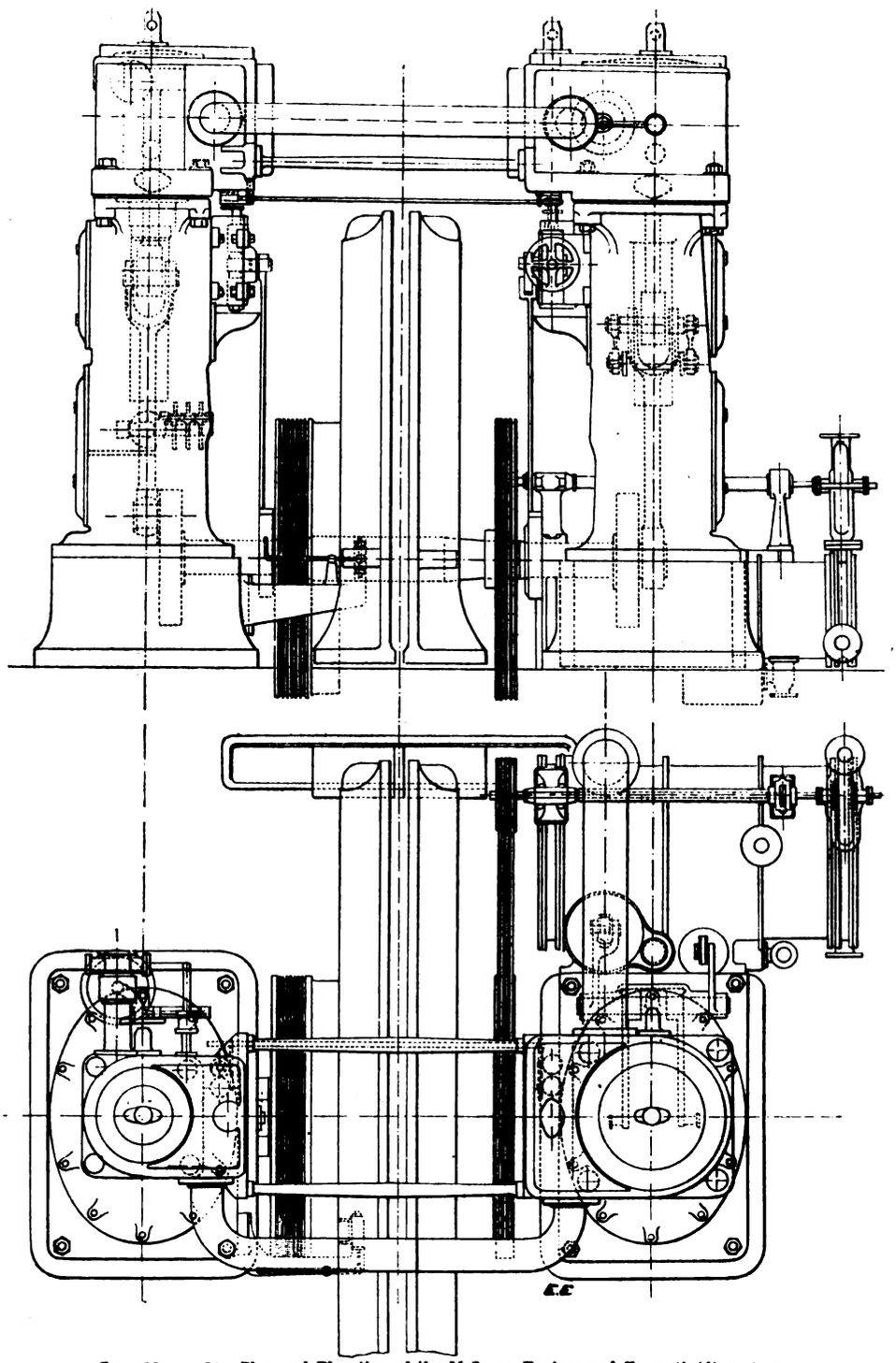
in this cylinder, so that each cylinder will give equal power at any load, thereby securing a steady turning moment. The condenser attached to each of these engines is of the surface-condensing pattern, being bolted up to the low-pressure bed-plate. It is fitted with brass tubes, having screwed glands packed with cotton. The circulating water is provided by means of a centrifugal pump placed on the top of the condenser, the pump being driven by ropes from a pulley on the crankshaft of the engine.

to go for any length of time with little attention. They are also constructed to work economically on light or heavy loads.

The special engine, mentioned above, for driving the day-load plant, consisting of a direct-coupled flywheel alternator having an output of 25 kilowatts, was supplied by Messrs. G. E. Belliss and Co., Limited, Ledsam-street Works, Birmingham, who are also sub-contractors to Messrs. Ferranti. The engine is one of Messrs. Belliss's E C/3 standard size, designed for a speed of 375 revolu-



FIGS. 13 AND 14.—Plan and Elevation of the McLaren Engines and Ferranti Alternators.

The air-pump is situated on the condenser top. By this arrangement the vapour in the top of the condenser goes straight into the pump instead of having to be drawn to the bottom. A separate pump takes the condensed water away and forces it to the hot-well. Both of these pumps are worked by levers from the low-pressure cross-head. All drain cocks and the auxiliary starting valve are worked from handles, which, for convenience sake, are grouped together near the stop-valve handle. These engines are very strongly made, being particularly massive, and have been designed to run very steadily and

tions per minute, and the cylinders are 7in. and 11in. diameter respectively. The body of the surface condenser, supplied with the engine, is of cast iron, with brass tubes, presenting a total cooling surface of 106ft. The tubes are secured in the tube plates by means of glands and tape packings. The air-pump, which is 5in. diameter by 2½in. stroke, is fitted with fibre valves, and works noiselessly at full speed, while the circulating pump is of the centrifugal type with a cast-iron casing, having 3in. inlet and outlet branches. A leather link belt from the engine shaft drives this condensing plant.

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Alternators and Switchboard.

The alternators are good examples of the latest type of flywheel machines manufactured by Messrs. S. Z. de Ferranti, Limited. They are three in number—two of large size,

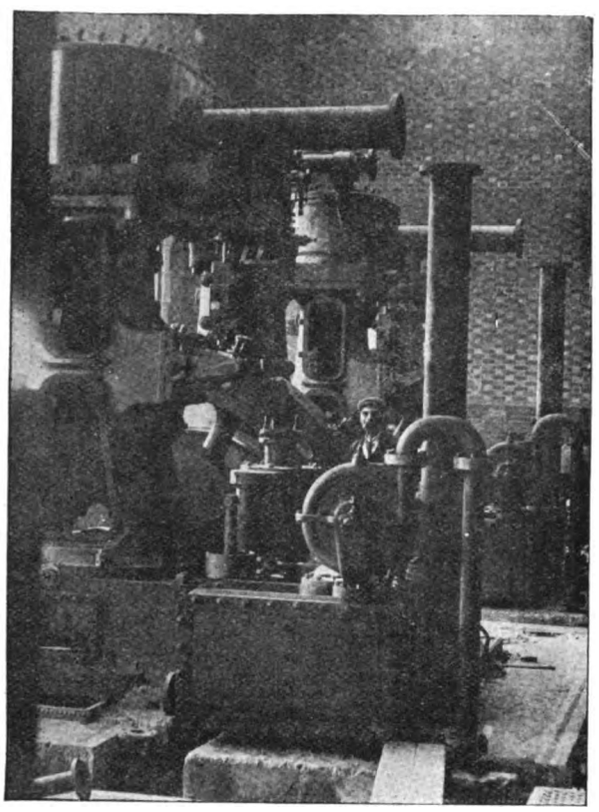

FIG 15.—View of the Engines being Erected.

directly coupled to their respective engines, as described under "Engines," and one of smaller size to take the day load, also direct coupled. The larger machines have been

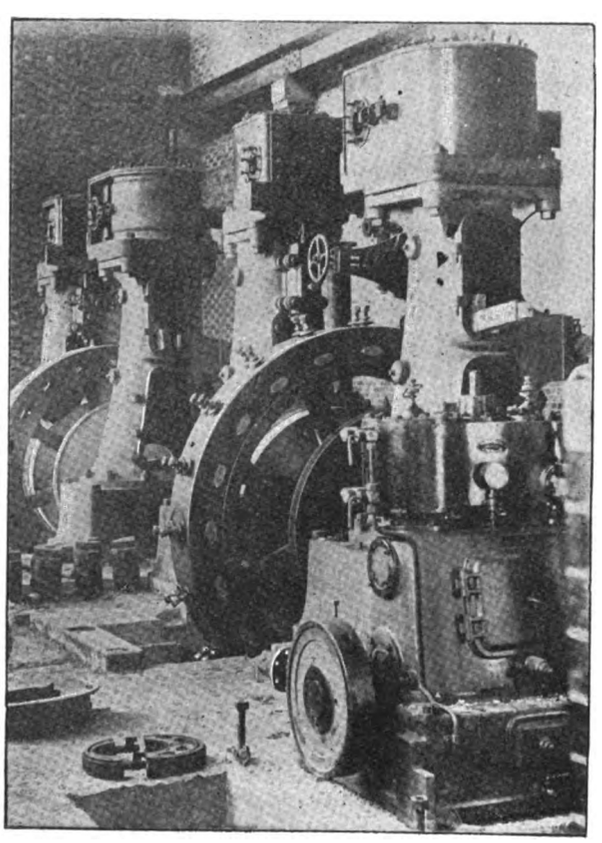

FIG. 16.—View showing the Flywheel and Armature Coil Supports.

designed for an output of 125 kilowatts each, at a pressure of from 2,000 to 2,100 volts, running at a speed of 100 revolutions per minute. The field of each machine is excited by a dynamo, mounted upon sliding rails fixed upon the engine bed at the end, remote from the cylinders, and driven from a pulley fixed upon the main shaft of the engine, by means of rope gearing. Each exciter is capable of supplying exciting current to two units of plant on emergency. The smaller alternator is a 25-kilowatt machine, and is also direct coupled. At a speed of 375 revolutions per minute it generates at a pressure of 2,100 volts. Each alternator is provided with a tachometer. The large sets are shown in Figs. 15, 16, and 17, in various stages of erection.

The station switchboard provides for three circuits and four alternators. It is constructed of enamelled slate, and its seven sections are arranged in separate panels divided from each other by deep enamelled slate partitions. Additional sections, either for alternators or distributors, can easily be added as required. The board is built upon the end wall of the engine-room above a raised platform. It can be seen in Fig. 17. The equipment of each section consists of a quick-break main switch, a synchronising contact, a main cut-out, and an ammeter. Two concentric mains are led from the switchboard. Their outer conductors are connected to a common omnibus

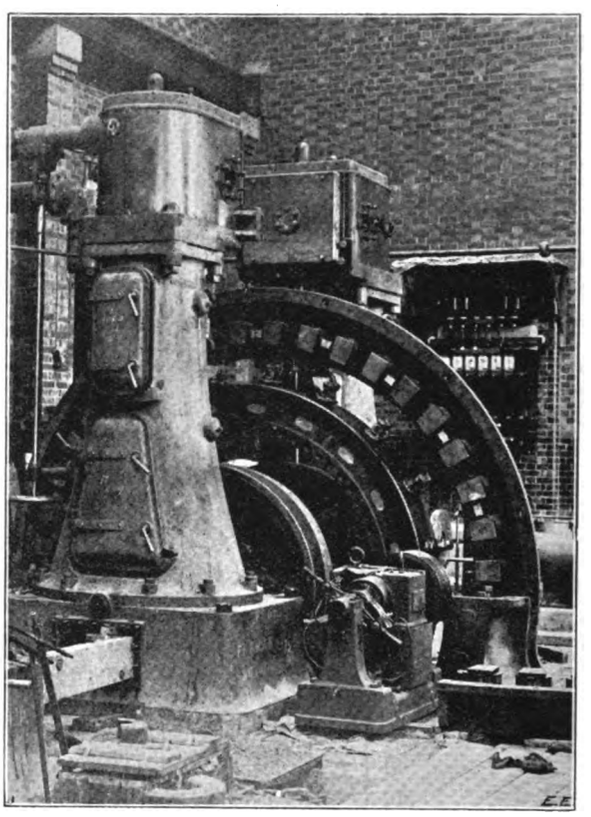

FIG. 17.—View of Half an Alternator, with Switchboard in the Background.

bar, the bar being connected to earth. The inner conductors are also connected to a common omnibus bar through plug contacts. The regulating switches, resistances, main switches, and ammeters in connection with the exciters are placed beneath the switchboard panels. Above the board is situated the synchronising gear and lamps, also three voltmeters connected to the alternators. The switchboard has thus been arranged solely for parallel running, and the alternators and engines have therefore been designed to run in parallel and to take a low synchronising current, the smaller alternator also being capable of running in parallel if required. Two station meters register the total current generated. One measures large and the other small currents.

Distribution.

High-Pressure Network.—The system of distribution, as previously mentioned, is a high-pressure system with transformer sub-stations for the main or compact portion of the town, while high-pressure mains, with transformers in the houses, are taken to remote and scattered properties. A plan of the principal streets of the town, with the mains marked in, will be found on reference to

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Fig. 18, while Fig. 19 is a diagram of the high-pressure mains laid. It will be seen from the latter that the high-pressure mains are essentially a duplicate system. Duplicate feeders are taken from the generating station to a point at the opposite end of the town, duplicate tappings being taken off these feeders to the several

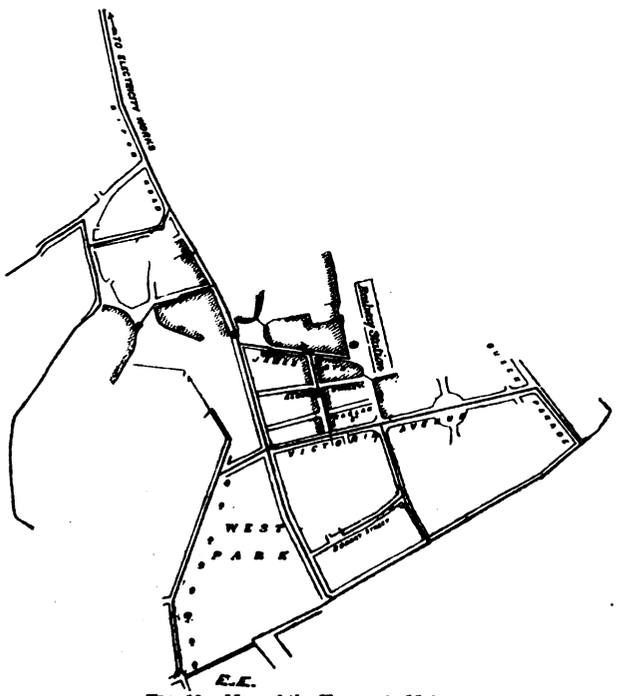


FIG. 18.—Map of the Harrogate Mains.

sub-stations *en route*. The sub-stations (Fig. 20 and 21) are five in number, and they have been built by the Corporation and equipped by the Brush Electrical Engineering Company, Limited. Four are fitted up with 18-kilowatt transformers and one with a 25-kilowatt transformer. The transformers are of the

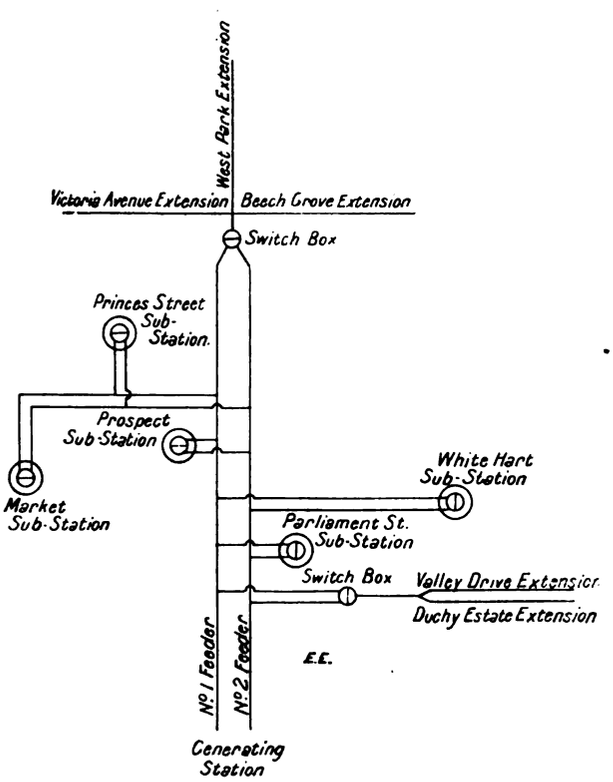
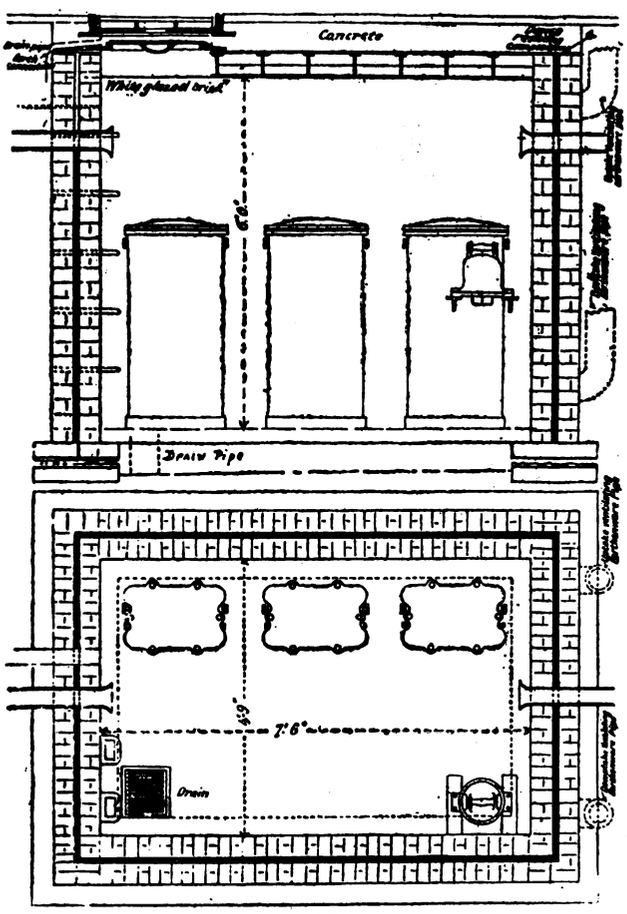


FIG. 19.—Diagram of the High-Pressure Network.

Mordey-Victoria type enclosed in cast-iron watertight cases, each provided with an earth shield, and designed to transform from 2,000 volts primary to 200 or 100 volts secondary on a three-wire system.

High-tension switches of the quick-break trigger type, enclosed in lock-up cast-iron cases, have been provided. Glass fronts to these cases enable the operator to see that the switching has been properly performed. The low-tension distribution-boards, shown in plan and section in Figs. 22 and 23 respectively, consist of gunmetal omnibus bars, with circuit fuses, mounted upon slate, together with switch fuses for connection to the secondaries of the transformers. Provision has been made on each board for two transformers and four triple-concentric cables. Fig. 20 is a plan of one of the sub-stations, and shows the careful provisions that have been made for ventilation. The high-tension switches mentioned above are a special feature in the equipment of the sub-stations, enabling the load to be placed on either or both feeders at will. On reference to Fig. 18 it will be seen that the first tappings taken off the feeders are for the Valley Drive and Duchy Estate high-pressure networks. A change-over switch-box is placed on each of these cables, as also at the end of the feeders, for the Beech-grove, West-park, and Victoria-avenue high-pressure networks. This is the portion of the system upon which isolated transformers are placed in consumers' houses.



FIGS. 20 AND 21.—Plan and Elevation of Sub-Station.

The high-tension feeders are of the well-known British Insulated Wire Company's concentric type. Each of the conductors is paper insulated, the whole being encased in a lead tube. They are each 2,050 yards long, and have a sectional area of ·075 square inch. These cables are drawn into 6in. cast-iron spigot and socket pipes, with lead watertight joints. The high-tension joint-boxes are placed in brick pits, 24in. by 24in. inside measurement, set in cement and provided with cast-iron ventilating covers. The boxes themselves are placed on brick piers inside the pits. They are of the B.I.W. standard type, and are made with disconnecting links, so that any section can be cut out for testing, etc. The high-tension network cables are of the same type as the above, but have a sectional area of ·025 square inch. They have, however, a double thickness of jute yarn outside the lead as an additional protection. The Valley Drive and Duchy Estate networks are drawn into 3in. cast-iron spigot and socket pipes, with watertight lead joints, and the West-park and Victoria-avenue networks are drawn into 4in. ditto. Owing to the Beech-grove network being placed under the grass on the Stray it is armoured with a double layer of steel armour and another double layer of jute yarn over that, and is laid direct in the ground.

(Continued on page 466.)

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BOUND VOLUMES.

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BOLD PROPHESYING.

Mr. W. W. Beaumont in his address at the Crystal Palace on Wednesday did not confine his remarks absolutely to the past, but ventured to take a peep into the future. An history of the development of the railway system of the world, illustrated by numerous transparencies, has little interest except to excite a comfortable feeling of satisfaction at having done so much within sixty years. Perhaps the comfortable feeling is opposed by an uncomfortable one of doubt as to the real value of the thousand million, more or less, pounds invested in our railway system. Our fathers stood aghast at the promises of steam; their children stand aghast at the promises of electricity. At the present time the gigantic railway system of the world is worked by steam. Engines capable of hauling hundreds of tons at a speed of fifty or sixty miles an hour are as commonplace as wheelbarrows. No one thinks very much about them, or wonders at their performances—unless, indeed, it be the first-class engineer. The ordinary populace see nothing extraordinary in an express engine. Mr. Beaumont, however, is not one of the ordinary populace, but a man of different calibre, knowing full well the magnificent achievement of engineers in obtaining such excellent and economical machines. When, then, he prophesies their downfall, and tells us to look forward into the not too far distant future, when the magnificent locomotives of to-day shall become things of the past, and be known only in museums, we must take notice of such prognostications. The successor of the existing locomotive is to be the gas-engine combined with an electric motor. The large gas-engine fed by Mond producer gas, or even by Dowson gas, may be expected to give a brake horse-power per pound of slack coal, a much less costly fuel than the gas-producing or steam-producing coal ordinarily used. The idea of large central stations in which such gas-engines with electric generators are installed is not new. It has been discussed before, principally in connection with Mr. Thwaites's paper before the Manchester Association of Engineers late in the year 1892, and received a generally moderate assent. The Mond producer gas has probably intensified that assent, and engineers only await a favourable opportunity of introducing the system. Those who live till the end of another sixty years may see the steam locomotive as dead as the old-fashioned coach now is, though that was very much in evidence sixty years ago. The energy will be obtained at stations along the line and conveyed by conductors to the terminals of the motors. There seems to be no impossible conditions. Possibly the existing rails could be utilised without much difficulty, as well as the present rolling-stock. As yet no one has gone carefully into the whole question. Nor can anyone say the initial cost of changing some great railway system, such as the Great Eastern, from steam or oil engined locomotives to electrically-equipped trains. The dead-weight to be carried would not be so very different to what it is now, though some engineers imagine that they would at once get rid of the eighty

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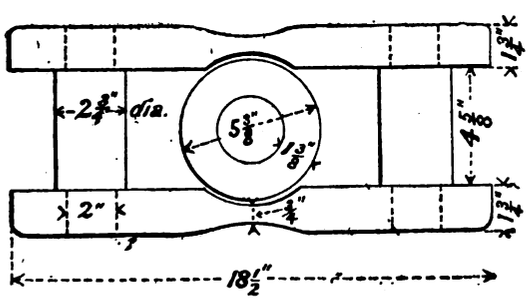
or ninety tons of the locomotive. The weight would, however, be far more evenly distributed, and though each carriage with its motor might weigh a ton or two more than at present, that extra two or even five tons per carriage would allow of a much less costly new line equipment so far as track and bridges are concerned. It is a vastly different thing to have an eighty-ton locomotive travelling at sixty miles an hour with its train of sixteen or eighteen carriages than to add five tons to each of those carriages, and then travel at the same rate of speed. At present all we can say in the matter is that it is quite practical, though the economy is as yet a matter of surmise only. We congratulate Mr. Beaumont upon his bold prophecy, and take it as one more corroboration of our view that the great future of electricity is for power purposes and not for light. There will be an enormous demand for electrical energy for lighting purposes, but there is every indication that this demand will be small compared with that for power.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

DYNAMO DESIGN.

SIR,—Would any of your readers give me the winding for the machine as under? I want 50 or 60 volts and



Armature Core 5in. long. Magnet Bore 5⅜in. diameter.

15 amperes. Armature is wound 60 sections, three turns each, No. 16 D.C.C. wire; length wire in one section, 36in.

Yours, etc., STUDENT.

FORTHCOMING EVENTS.

The following are some of the announcements for the forthcoming week:

TO-DAY (FRIDAY).—Prize distribution at the Crystal Palace School of Engineering (Crystal Palace), 12 noon.—Royal Institution (Lord Rayleigh on "The Limits of Audition"), 9 p.m.—Institution of Civil Engineers' students' meeting ("Poole Harbour," by Mr. Harold Berridge), 8 p.m.—Also, at Liverpool, visit of the Tramways Institute.

TO-MORROW (SATURDAY).—Royal Institution (Lord Rayleigh on "Electricity and Electrical Vibrations"), 3 p.m.

MONDAY, APRIL 12.—Camera Club meeting (Mr. C. Swinton exhibits a new Röntgen ray tube).

TUESDAY, APRIL 13.—Institution of Civil Engineers (discussion of the paper on the Blackwall Tunnel), Great George-street, 8 p.m.—Institution of Junior Engineers, Westminster Palace Hotel (Lecture VI. of the course on Dynamo Design, by Mr. F. A. Nixon), 8 p.m.—Also at Bournemouth, meeting of the Bournemouth Electric Supply Company, 2.30 p.m.

WEDNESDAY, APRIL 14.—Willans and Robinson, Limited, meeting at Cannon-street Hotel, 3 p.m.—Crystal Palace Wednesday lecture, 8 p.m.—And at Sunderland, meeting of the North East Coast Engineers (Mr. Cummin's paper on High-Pressure Marine Engines), 7.40 p.m.—Also at Liverpool, meeting of the Liverpool Engineering Society (Silting of Small Harbours).

Death of Dr. von Stephan.—Dr. von Stephan, the German Imperial Minister for Posts and Telegraphs, died in the early hours of yesterday (Thursday) morning. Dr. von Stephan was the last-elected honorary member of the Institution of Electrical Engineers.

THE RIBBE ACCUMULATOR.

The need of a good accumulator for traction work has been accentuated by the passing of the recent Act allowing motorcars to run on the public roads. Hence the endeavours of inventors to perfect the accumulator both as regards weight, efficiency, and durability. We have already noted one new type as being introduced into England this year, in which the first named quality was obtained at the expense of the second. This week we have inspected a car fitted out with accumulators of the type invented by Mr. P. F. Ribbe, of Berlin. The tramcar was at the Deptford depôt of the London, Deptford, and Greenwich Tramway Company. The car, with batteries, was brought over from Germany,

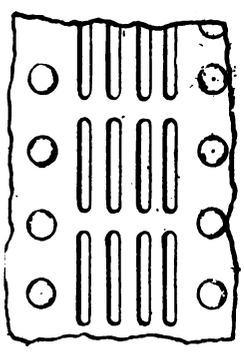


FIG. 1.—Plan of Lead Framework.

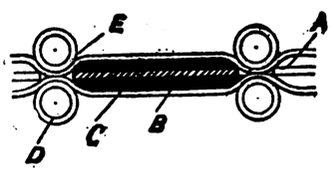


FIG. 2.—Horizontal Section of Plate.

and hence the latter was not designed to suit English tramlines. The wheel base was too long and the axles rigid, so that the curves could not be negotiated comfortably. Also, we heard that the police objected to the car because the consent of one of the local authorities had not been obtained. So the car was not taken out of the shed, and nothing could be gathered as to the speed and mileage capacity. There were 140 cells in the car, placed in 28 boxes—14 of which are fixed under each longitudinal seat. The car provided accommodation for 33 people. The cells weigh complete 6,160lb., or, say, 2¾ tons. The capacity of the battery is said to be 300 ampere-hours, giving a total of 81 kilowatt-hours. The distance this will run the car of course depends on the road traversed, but the inventor claims that it is sufficient for a working day of 16 hours. The question is, however, rather that of how long the cells will keep this capacity, and what life they will have in daily work. The following details of the construction of the cells may help our readers to form an opinion as to the durability of the plates. Beginning with the lead support, shown in Fig. 1, this consists of a lead sheet only ·035in. thick, which has holes and vertical slots punched in it. The slots form supports for the paste, and the holes give a means, as explained below, for binding the celluloid sheets together. The paste is

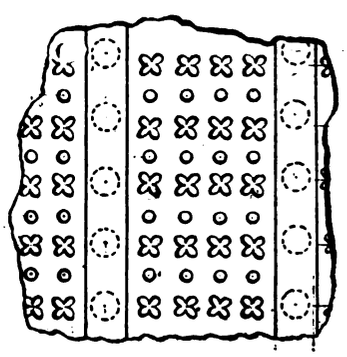


FIG 3.—Plan of Finished Plate.

applied only to those parts containing the vertical slots, as shown by B in Fig. 2. Then a sheet of thin celluloid, perforated somewhat, as shown in Fig. 3, is placed on each side of the plates. These are cemented together through the holes in the plate by the action of an acetone solution. This firmly binds the celluloid against the surface of the paste, and prevents that from falling off. The tubes of celluloid, D D, form vertical separating ribs between adjacent plates.

It will be seen from the above that the light support

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enables a light plate to be made, but it is a great question how far durability has been attained. The other vital point is the durability of the celluloid when in actual contact with the active material. We have known cases where a considerable wasting away has taken place in celluloid similarly situated. This may perhaps be prevented by using some special brand of celluloid. As the cell is practically a recent invention, many details may perhaps be improved on. We wish the inventor success in his undertaking.

HARROGATE ELECTRICITY WORKS.

(*Concluded from page 463.*)

The service cable has a sectional area of ·013 square inch, and is finished off with a special high-tension end connection, fitting into a cast-iron box which serves the triple purpose of earthing the transformer case, preventing tampering with

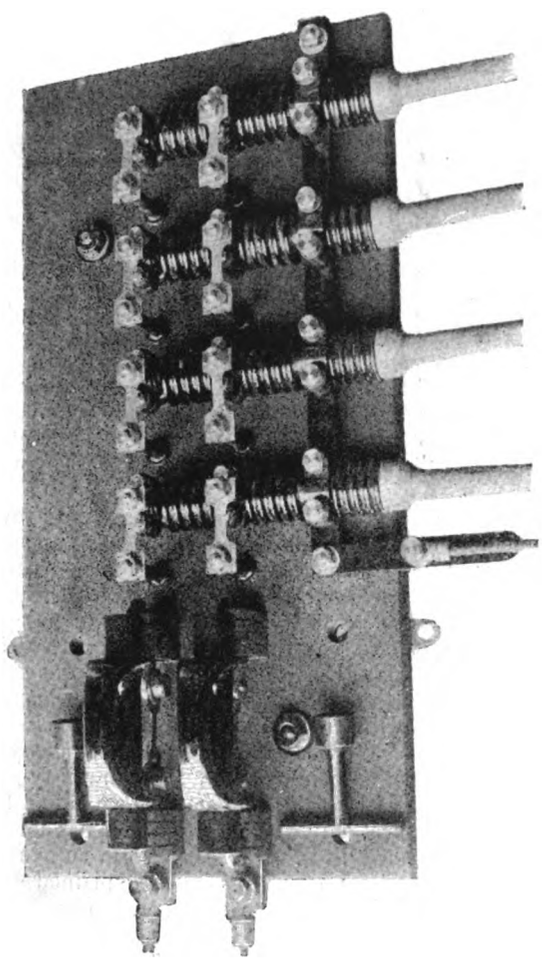


FIG 22.—Sub-Station Low-Tension Board.

high-tension cable ends, and preventing water or moisture from entering the transformer case. The service boxes are filled with a special compound manufactured by the British Insulated Wire Company. Sections of the various high-tension cables are shown in Fig. 24.

Low-Pressure Network.—From each of the sub-stations mentioned above a network of low-pressure triple-concentric cables, similar in type, but less heavily insulated, is carried from the low-tension 'bus bars through the principal streets of the town, and distribution is made on the three-wire system at 100 volts pressure on either side. The sectional area of the low-tension mains is ·1 square inch for the inner and outer conductors, and ·05 square inch for the neutral. In ordinary working the different sections of the network leading from the various sub-stations will be connected together, but each sub-station may readily be confined to its own separate section of network only by means of specially designed disconnecting boxes. These boxes are located at convenient centres in brick pits under the pavements. About 3,100 yards of low-tension cables have at present been laid. They are armoured and laid direct in the ground. The house-service boxes are of the clamp type, and are constructed to take two services. They are connected to the cable by means of wiped plumbers' joints, and are filled with a heavy insulating oil. Sections of the low-tension service cables are show in Fig. 25. Their sizes are $^{19}/_{16}$'s, $^{7}/_{14}$'s, and $^{7}/_{16}$'s respectively. They are of similar type to the above, and are run direct into cast-iron house cut-out boxes, which boxes not only act as cut-outs, but as permanent seals for the cable ends. Thomson-Houston

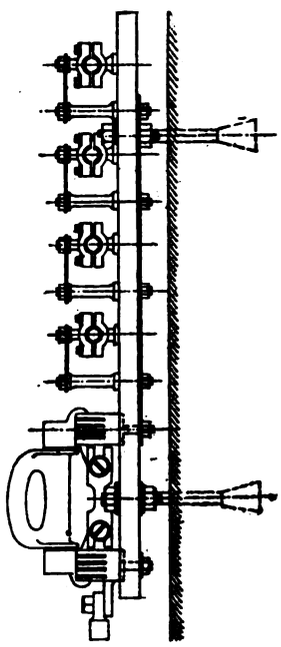
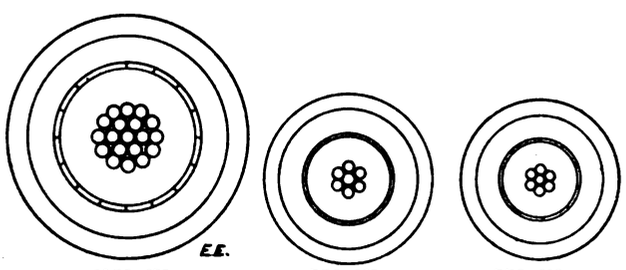


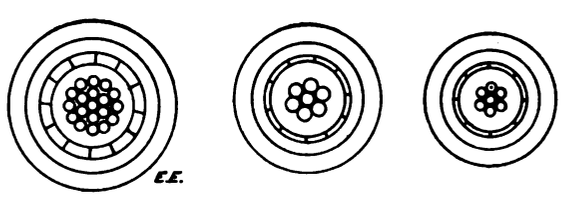
FIG. 23.—Elevation of Low-Tension Board.

meters are used in the houses. About 7¼ miles of high-pressure and 1¾ miles of low-pressure cables have been laid. Their distribution, and also the positions of the sub-stations, etc., will be seen at a glance from the accompanying map. The whole of the contract for the underground mains and accessories has been carried out by the British Insulated Wire Company, Limited, Prescot, Lancs., who have supplied, laid, and jointed the cables, conduits, joint-boxes, etc. The work has been executed under the



19/15 075 sq. 7/16 ·025 sq. 7/18 013 sq.

FIG. 24.—High-Tension Cables.



19/16 7/14 7/16

FIG. 25.—Low-Tension Service Cables.

supervision of their own engineer, Mr. H. L. Howard; Mr. S. Richardson, who originally had this work in hand, having to leave Harrogate to take up an appointment in Leicester as borough electrical engineer. The whole of the high-pressure network has been subjected to a pressure test of 5,000 volts alternating current, and successfully withstood it. We have already mentioned that no public lighting in the streets has yet been adopted, but perhaps this is not strictly accurate, for several arc lamps have been erected as an experiment, one of which we illustrate (Fig. 26). This has been erected in the railway station square, and has a very effective appearance.

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Conclusions.

The details which we have enumerated above tell their own tale. Harrogate may be congratulated upon the completion of an electricity supply station which bears evidence of careful and skilful designing throughout its various sections. The station buildings are neat and well adapted for their purpose, and the ratio between space occupied and power installed is not disproportionate. In fact, the equipment of the station has been so distributed as to utilise to the best advantage the space available without the slightest tendency to overcrowding, at the same time leaving ample room for extensions of plant without corresponding extensions of buildings at present. Everything that thought and care could suggest to ensure the safe and economical working of the station seems to have been provided, and superfluities are conspicuous by their absence. Mr. George Wilkinson, the consulting engineer, has personally supervised the carrying out of the work throughout, and has accepted an invitation to officiate as resident engineer at Harrogate during the first year of supply. The Southport station, it may be mentioned, is

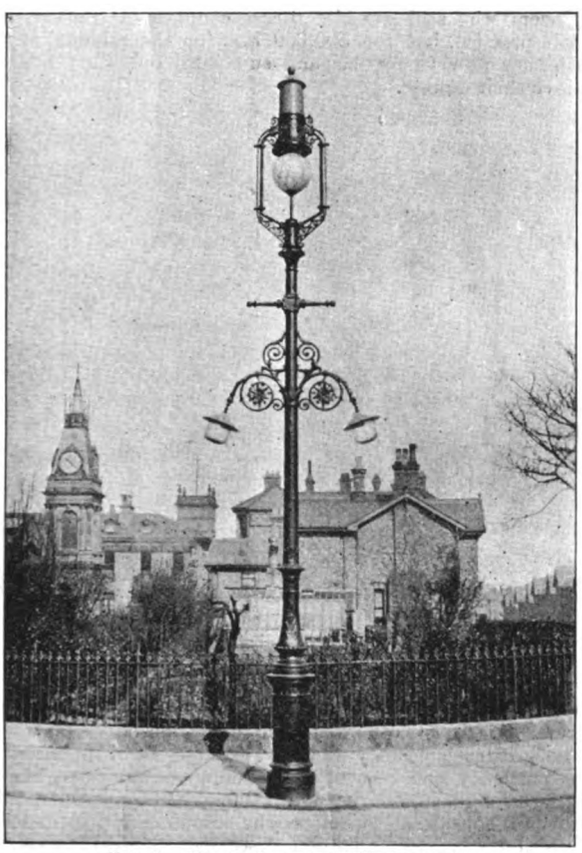

FIG. 26.—The Arc Lamp in the Station Yard.

another station the complete designs for which were prepared by Mr. Geo. Wilkinson. This gentleman has had a most varied and extensive experience, commenced in that nursery of talent, Messrs. Siemens Bros. After leaving that firm he joined the Brush Company, and has had to do with many isolated plants and central stations throughout the country before taking up consulting work.

The other gentleman to whom great credit is due for the carrying out of the work is Mr. Samuel Stead, the energetic borough surveyor of Harrogate. He was appointed to the post in 1888, and has designed and superintended many improvements for adding to the attractions of this famous watering place. Now, in the electric lighting scheme, he has had the street work under his charge, and the trenching and making good were entirely done by the municipal workmen. The question of street-lighting by arc lamps is now receiving Mr. Stead's attention, and will soon, we believe, be added to the improvements effected during his surveyorship.

With the moderate charge of 6d. per unit the whole electric light scheme should be a success, and the Corporation will in future years be able to congratulate themselves on the fact that such a valuable undertaking was kept in their hands.

INSTITUTION OF ELECTRICAL ENGINEERS, April 8.

At last night's meeting of the Institution the following were the candidates balloted for:

Members.—H Dickinson, the Yorkshire House-to-House Electricity Company. Limited, Leeds; J. W. Kempster, 1, Shakespeare-road, Bedford; F. H. Royce, Hulme, Manchester; K. A. Scott-Moncrieff, 4, Fairlie-place, Calcutta.

Associates.—H A. Barnett, Tettenhall-road, Wolverhampton; T. M. Colson, "Tyntesfield," Flax Bourton, Somerset; V. H. Gregory, 29 Shaftesbury-road, Ravenscroft Park, W.; E. A. Mitchell, 5, Maidstone-villas, Chapel-road, West Norwood; W. H. Smith, St. Mary Cray, Kent; H. A. Yerburg, 4, Summerhill-road, St. George, Bristol.

Student.—N. McL. Lawrance, Ceylon.

After the usual formal business, the following paper was read:

SOME RECENT DEVELOPMENTS IN ELECTRIC TRACTION APPLIANCES.

BY A. K. BAYLOR.

GENERATORS.

In comparing a modern traction generating plant with one of seven or eight years ago, the most striking differences are found in the average size of the units in proportion to the station output, and the absence of belting or other medium of transmission between engines and generators. This may be largely accounted for by the change in public sentiment regarding electric traction during that period, and the greater confidence that investors have now in such enterprises. When electric traction first began to gain a foothold it was looked upon, like all innovations, as experimental and of doubtful value. As a natural consequence, all investment in plant was minimised. Small generating units were used, as the number of cars to be run was small. For the sake of economy in first cost high-speed dynamos and slow-speed engines were generally employed, which necessitated the use of belts or ropes as a means of transmission. Now the conditions have changed, and in the design of power plants for traction work engineers are free to consider only what is best and most efficient in apparatus. Instead, therefore, of stations subdivided into small units, and filled with belts, ropes, countershafting, and clutches, we have in a modern plant a minimum number of separate units, and, with rare exception, the engine shaft carries the dynamo armature and is rigidly connected to it.

The first result of the call for increased sizes and greater mechanical efficiency was the introduction of multipolar instead of bipolar generators. Up to 1891, over nine-tenths of the traction dynamos in service were bipolar; to-day fully nine-tenths are multipolar. Multipolar generators possess decided advantages over those of the bipolar type; they permit of better distribution of the magnetic material, and are lighter in weight, requiring less floor space for a given output, which is of especial importance when the output is considerable. Belted machines of the four-pole type were made up to 500 kilowatts, and this is still the largest standard unit of that class, for the reason that satisfactory commutation cannot be economically secured in four-fold traction machines of a greater output. The violent fluctuations of load, incident to such work, necessitate a fixed point of commutation, and experience has shown that the economical limit when this condition is fulfilled is reached at 100 to 125 kilowatts per pole on a 500-volt generator. Therefore the number of poles and the speed must vary with the output, the poles increasing in number, and the speed decreasing, as the capacity of the machine increases; so that slow speeds have become standard for all large traction generators, entirely apart from any consideration of the prime mover.

A very important step in the development of this class of machinery was the adoption of steel instead of iron for the field frames and pole cores. All first-class traction generators to-day are built of steel. By its use the magnetic properties of wrought iron are obtainable, together with compact and complex forms of construction not possible with wrought iron. Machines with steel fields require proportionately less magnetising force, and are of better efficiency in consequence, and a saving in copper in the exciting coils is effected owing to the smaller cross-sections of poles for a given effect. Steel machines are lighter also, and the consideration of weight becomes of great importance when the unit is a very large one. With a 1,500-kilowatt machine, for instance, the weight of the lower half of the steel field frame is from 16 to 20 tons. If this should be multiplied by about 2 or 2½, which would be the result of making the same machine of iron, the field castings would become decidedly unwieldy and difficult to ship or handle. This question is not so practically serious in small units, but, generally speaking, the lighter a machine is for a given output the better.

Direct coupling was at first adopted only in the larger units, but this construction has now practically supplanted the older forms, and the sale of belted machines for traction purposes is

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now confined almost entirely to the smaller sizes—below 150 or 200 kilowatts. The severity of traction work led many engineers to protest against the rigid connection of engine shaft and armature. It was argued that the strain between short circuit and open circuit transmitted, without any medium for adjustment to the engine, would cause breakdown in a short time. To avoid this supposed danger flexible couplings were adopted, provided with various arrangements of spring cushions to absorb the strains; but all such devices have been found useless and unnecessary, and it has been demonstrated that with a properly proportioned flywheel the interconnection of engine and dynamo presents no difficulty, such a flywheel being amply adequate to prevent racing on an open circuit, or undue slackening of speed on a sudden overload.

The relative proportions of wheels vary with different engine builders, but average practice has shown the advisability of a

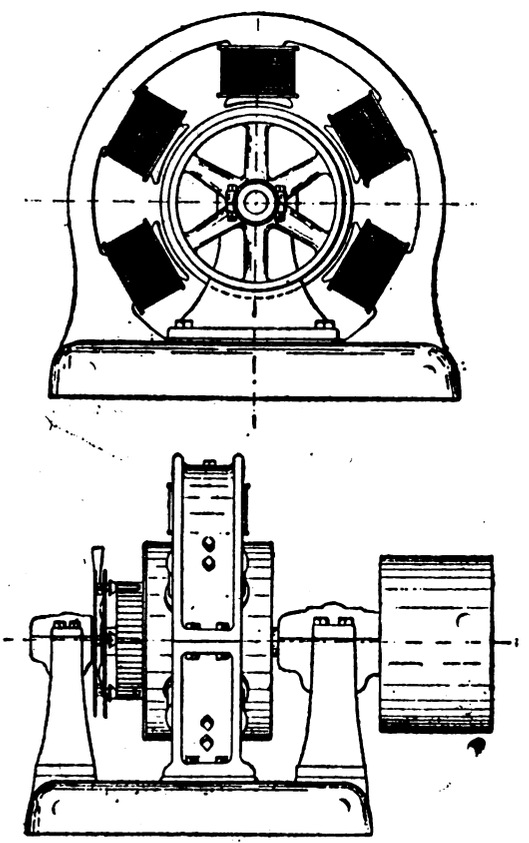

FIG. 1.—Typical Multipolar Traction Generator for Belt Connection.

wheel of such dimensions that it will carry the full load of the dynamo for about three revolutions with a variation of not less than 5 per cent. in speed. The method of connection between shaft and armature is different with large and small machines. In the former the armature spider is merely keyed to the shaft, but with large machines it is usual, in addition to keying, to bolt the spider to the arms of the flywheel at a diameter as far from the shaft as possible, in order to relieve the strain on key and shaft.

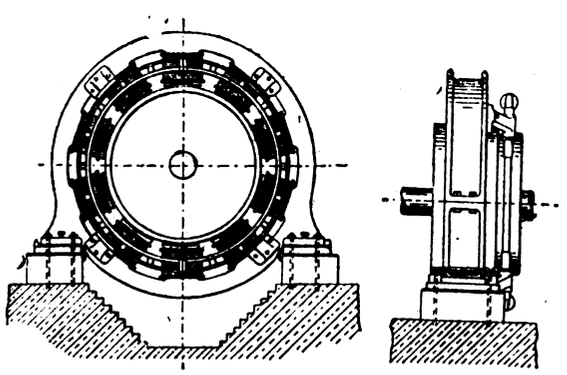

FIG. 2.—Typical Multipolar Traction Generator for Direct Connection.

As a precaution against bursting, the built-up type of flywheel has been used in some few cases for direct-coupled traction units. Fig. 3 shows the detail of such a wheel. As will be seen, it is made up of segments bolted and riveted together. This construction, of course, permits of a relatively greater peripheral speed than is safe with the ordinary cast-iron wheel, but the cost is increased about 25 per cent., and with a proper safety check upon the engine for cutting off steam at any predetermined increase of speed, danger of accident with cast wheels may be amply guarded against.

There are many points of commercial advantage in favour of direct-connected as compared with belt or rope driven generators that appeal to those interested in investment and operating expenses. The efficiency of a given plant is increased by direct coupling, and its operating expenses are decreased. The friction losses due to the use of belts or ropes will average about 5 per cent. of the indicated power of the engine at full load, and as this loss is a practically fixed quantity, the percentage of loss increases as the percentage of load decreases. Unless, therefore, the running units can be kept at approximately constant full load—which is possible only when the number of independent cars or trains in service is very large, or the stoppages and starts infrequent—these losses will exceed the minimum, and may be taken as about 8 per cent. in average practice. In operation a substantial economy is gained also by the reduced number of bearings and wearing parts by a saving in maintenance of belts or ropes (to say nothing of their first cost), and the possibility in general of running with a smaller staff for a given plant output. As affecting the total cost of plant, the reduced floor space occupied by direct-coupled machinery becomes a factor of much importance when it is desirable to locate the generating station in a district where land values are high. Again, the buildings may be smaller, and therefore less expensive, and something may be saved in foundations. There are undoubtedly some engineers who still consider direct coupling of traction units unsafe practice, but the 300,000 h.p. (or thereabouts) of such machinery now in regular and successful operation ought to remove their doubts.

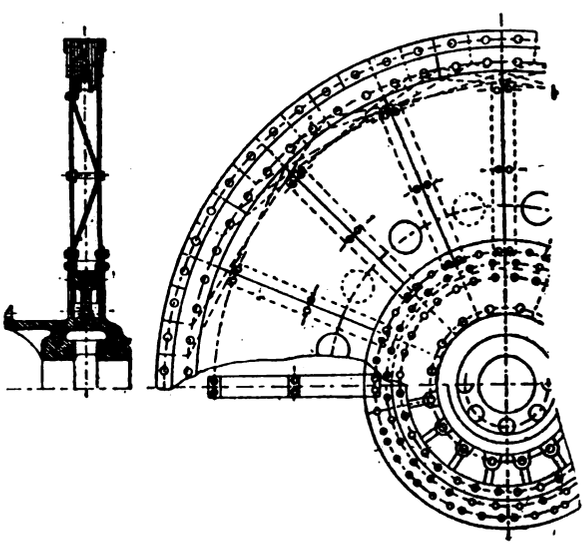

FIG. 3.

Compared with old-style machines, a modern traction generator is highly economical in operation, both on account of its greater efficiency and its lower cost of maintenance. The efficiency and cost of maintaining apparatus are the true measures of its superiority and value. First cost should be a secondary consideration, unless the machines are intended for exhibition purposes and not for service. Unfortunately, this order of things is usually reversed, and the selling price too often settles everything, without regard to the expense for fuel, maintenance, and repair, that the use of poorly-constructed (and naturally cheap) machines may lead to. In this connection it is to be borne in mind that, as a rule, dynamo ratings are arbitrary. With engines where the cylinder dimensions, steam pressures, speed, and economical point of cut-off are given, tests will establish accurately the rating that may be assigned to a given machine; but in dealing with generators and motors it is, unfortunately, common practice to give only the rating in horse-power or kilowatt capacity—a figure usually dependent on the conservatism, or otherwise, of individual engineers.

(To be continued.)

THE TRANSMISSION OF POWER TO LONG DISTANCES BY ALTERNATING CURRENTS OF ELECTRICITY.*

BY W. B. ESSON, M.I.C.E., M.I.E.E., ETC.

(Concluded from page 438.)

It will be evident from what has gone before that the pressure to be adopted is decided by the distance by the way in which the power is to be broken up at the receiving end, and by the

* Paper read before the Society of Arts, March 24.

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loss permissible in the line. In the example given I have merely indicated roughly how the engineer has to consider the matter before he can arrive at a decision. The copper and transformers are the chief items, and the rates for these may vary from the figures given, while, needless to remark, there is a host of minor factors which also have to be taken into account, and the influence of which cannot be neglected. It must not be thought that 10,000 volts is the limit of line pressure, though at the moment it is the exception. The pressure on the Hockfelden-Oerlikon line for the transmission of 900 h.p. for 25 miles is 13,000 volts, while the Ogden-Salt Lake line is to be worked at 15,000 volts. For the Niagara-Buffalo line, which is 25 miles long, the pressure will be 20,000 volts; while if currents from Niagara ever reach Albany, over 300 miles, in all probability they will have to be transmitted at a pressure of something over 50,000 volts.

Let us suppose that the pressure is decided upon, the table which follows gives the current in amperes per brake horse-power necessary to be transmitted. The pressure is, in all cases, taken at the motor end of the line, the pressure at the generator having to be higher by such amount as corresponds to the loss in the line. The current is for horse-power actually recoverable at the pulleys of the motors, it being assumed that the efficiency is about 90 per cent., and the power factor ·75.

TABLE I.

Pressure in volts.	Current required per b.h.p. at various pressures. Amperes.
220	5·0
440	2 5
1,000	1·11
2,000	·55
3,000	·37
5,000	·222
10,000	·111

These figures are only to be taken as approximate. In the case of two phases, half the above current flows in each circuit. For three phases, the pressure in the table would apply to the difference of potentials between the common junction of the three conductors and either of the lines, and one-third of the current given in the table would flow in each wire.

The current being ascertained, the volts which it is permissible to lose in the line will determine the size of the conductors. In Table II. are given the volts lost in the conductors per mile of transmission for different current densities, and from this, knowing the fall of pressure allowable, the best density to work at can be determined.

If the plant is three-phase, the volts lost per mile must be taken as half of what is given in Table II. Table III. furnishes us with the size of conductor for carrying any current at any density, and thus supplies the final figure for the line.

TABLE II.

Amperes per square inch of section of conductor.	Volts lost per mile at different current densities. Loss of pressure in volts per mile.
2,000	172
1 500	130
1,000	86
800	69
700	60
600	52
500	43
400	34
300	26
200	17·2

TABLE III.—SIZE OF CONDUCTOR REQUIRED FOR VARIOUS CURRENTS.

Gauge, S.W.G.	Diameter, inches.	Sectional area, square inches.	Resistance in ohms per mile at 60deg. F.	Weight lbs. per mile.	Amperes which the conductors will carry at a current density of: 2,000 amperes per sq. in.	1,500 amperes per sq. in.	1,000 amperes per sq. in.	800 amperes per sq. in.	700 amperes per sq. in.	600 amperes per sq. in.	500 amperes per sq. in.	400 amperes per sq. in.	300 amperes per sq. in.	200 amperes per sq. in.
37/15	·504	·1541	·2892	3142·	308·	231·	154·	123·	108·	92·5	77·0	61·6	46·2	30 8
19/13	·460	·1282	·3462	2625·	256·	192·	128·	102·	89 7	76·9	64·1	51·3	38·5	25·6
37/16	·448	·1219	·3661	2482·	244·	183·	122·	97·5	85·3	73·1	60·9	48·8	36·6	24·4
19/14	·400	·0973	·4579	1985·	195·	146·	97·3	77·8	68·1	58·4	48·6	38·9	29·2	19·5
0	·324	·0924	·5223	1678·	165·	123·	82·4	65·9	57·7	49·4	41·2	32·9	24·7	16 5
19/15	·360	·0789	·5652	1608·	157·	118·	78·9	63·1	55·2	47·3	39·4	31·5	23·7	15·8
1	·300	·0707	·6092	1438·	141·	106·	70·7	56 6	49·5	42·4	35 3	28·3	21·2	14·1
19/16	·320	·0624	·7154	1270·	125·	93·6	62 4	49·9	43·7	37·4	31 2	24·9	18·7	12·5
2	·276	·0598	·7197	1217·	119·	89·7	59·8	47·8	41·9	35·9	29·9	23·9	17·9	12·0
3	·252	·0499	·8633	1015·	99 8	74·8	49·9	39·9	34·9	29·9	24·9	19·9	15·0	10·0
19/17	·280	·0479	·9300	973·	95·8	74 8	47·9	38·3	33 5	28·7	23·9	19·2	14·4	9·6
4	·232	·0423	1·0186	860·	84·6	63·4	42·3	33·8	29·6	25·4	21·1	16 9	12·7	8·5
7/14	·140	·0356	1·253	727·	71·2	53 4	35·6	28·5	24 9	21·4	17·8	14·2	10·7	7·1
5	·212	·9353	1·253	718·	70 6	52·9	35·3	28 2	24·7	21·2	17·6	14·1	10 6	7·0
19/18	·240	·0349	1·271	715·	69·8	52·3	34·9	27·9	24·4	20·9	17·4	13·9	10·5	7·0
6	·192	·0289	1·487	589·	57·8	43·3	28·9	23·1	20·2	17·3	14·4	11·5	8·7	5·8
7/15	·216	·0289	1·543	589·	57·8	43·3	28·9	23 1	20·2	17·3	14·4	11·5	8·7	5·8
7	·176	·0243	1·770	495·	48·6	36 4	24·3	19·4	17·0	14·6	12·1	9·7	7·3	4 9
19/19	·200	·0243	1·831	496·	41·6	36·4	24 3	19·4	17·0	14·6	12·1	9·7	7·3	4·9
7/16	·192	·0229	1·953	465·	45·8	34·3	22·9	18·3	16·0	13 7	11 4	9·1	6·9	4·6
8	·160	·0201	2·142	409·	40·2	30·1	20·1	16·1	14·1	12 1	10·0	8·0	6·0	4·0
19/20	·180	·0198	2·261	402·	39·6	29·7	19·8	15·8	13·9	11·9	9·9	7·9	5·9	4·0
7/17	·168	·0174	2·552	356·	34·8	26·1	17·4	13·9	12·2	10·4	8·7	6·9	5·2	3·5
9	·144	0162	2·664	331·	32·4	24 3	16·2	12·9	11·3	9 7	8·1	6 5	4·9	3·2
10	·128	·0128	3·346	262·	25·6	19·2	12·8	10·2	9·0	7·7	6·4	5·1	3·8	2·6

In giving these figures I have simplified matters by ignoring the effects of the self and mutual induction of the line wires, but it must be understood that these are in many cases by no means negligible, especially in long distances with heavy conductors.

I have spent so much time on the line that there remains but little more for the motors. In concluding this section, I must just say that in no case should the conductor be less than No. 10 gauge, on account of the liability of smaller wire to get damaged by storms, while practical considerations place the other limit at about 37-15ths stranded. If a greater area is required it should be divided between two or more conductors. With this size of cable by two phases under ordinary circumstances about 1,500 h.p. may be transmitted.

III.—MOTORS.

On referring to the classification at the beginning of this paper it will be seen that there are two types of motors—synchronous and non-synchronous—and in their action these in several important particulars are alike. I set down below in parallel columns the chief points of difference thus:

Synchronous.	*Non-Synchronous.*
1. Requires direct-current exciter, and has consequently a direct-current commutator.	Does not require exciter, and has, therefore, no commutator.
2. Will only start with fraction of load.	Will start with full load, with two or three phases.
3. Runs always at same speed.	Speed drops as the load is increased.
4. Has a power factor at full load of nearly unity.	Has a power factor at full load of from ·65 to ·85 according to size.

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The first point is that synchronous motors require exciters. Such motors, as you are probably aware, are constructed on the same lines as alternators, whether for single, two, or three phase currents; in fact, they are alternators running as motors instead of generators. They must, therefore, have a direct-current machine to excite their field magnets, and this means a commutator as well as a pair of contact rings to keep in repair. The non-synchronous motor, on the other hand, requires no exciter, the E.M.F. in the armature windings being induced by the action of the oscillating or rotating field. On this account non-synchronous motors are more often styled "induction" motors. Being without exciter there is no commutator to keep in repair, though in the case of large size motors contact rings are sometimes used for the purpose of putting resistance into the armature circuit.

The next point is the starting. To do work a synchronous motor must run in step with the generator, and until it attains a speed such that its frequency corresponds with that of the generator; in other words, until synchronising speed is obtained it is not in a condition to take the load. To run the motor up to speed various plans have been adopted. The exciter furnishes us probably with the most simple means of starting a single-phase motor. Though giving a direct current, the exciter will, of course, run as a motor if supplied with an alternating current, provided its field magnets are properly laminated. To start the synchronous motor all we have to do then is to first turn the alternating current on to the exciter to get the speed up, then when it is obtained switch it on to the alternator, by the same action altering the connections so that the exciter afterwards performs the function of energising the field. Here I wish you to notice that though the synchronous motor will do no work by itself until it gets into synchronism with the generator, there is no reason why the motor and exciter combined should not do some work. It depends upon the size of the exciter and what margin of power it has beyond driving the alternator up to speed. Another plan is to combine with the exciter a set of secondary cells so that the energy necessary to start the motor by direct current is always available. During working hours the exciter is charging the battery. Polyphase synchronous motors can be started by a small induction motor provided for the purpose, or they may be designed so that currents induced in the field magnet by the action of the rotating armature field will pull the speed up to synchronism. Such currents might be generated in the masses of an unlaminated field magnets, or in copper loops properly disposed on the magnets. Of course, the combining of a secondary battery with the exciter works as well in the case of polyphase as single phase motors, and no further starting gear is requisite.

But induction motors have this advantage over synchronous motors, that they will start without any trouble at full torque. There are many notable instances of power transmission schemes being successfully operated by synchronous motors and with single-phase currents, but the system lacks range and flexibility. If the whole of the power is to be given up by a single motor or group of motors at the delivery end of the line, single-phase transmission with synchronous motors is perhaps as simple and reliable as any, but if the power has to be divided amongst a number of motors of various sizes situated at different parts, and each requiring to be capable of starting against a load without extraneous assistance, single-phase working is no longer suitable. Under these circumstances induction motors fulfil best the requirements of power distribution, and the attribute which singles them out as superior to other types is that they start without trouble, and, in starting, exert great effort. Polyphase working becomes necessary for them, as only with currents of more than one phase have the starting difficulties been entirely got over.

With regard to constancy of speed the synchronous motor has the advantage, as it runs absolutely in synchronism with the generator, but there are few cases in which the variation in speed between no load and full load in properly-designed induction motors cannot be permitted. Again, though in the matter of power factor the synchronous motor has the advantage, there is no doubt that for general work, taken all round, the induction motor is much superior, its great starting effort and extreme simplicity easily outweighing what advantages are possessed by motors of the synchronous class.

The chief qualities which should characterise a good polyphase induction motor are these: (1) the speed should vary as little as possible with change of load; (2) the effort exerted at starting should be large, and that without drawing an excessive current from the line; (3) the efficiency—*i.e.*, the ratio of power given out to power put in—should be high; (4) the light-load current should be as small as possible compared with the full-load current; (5) the power factor should be as large as possible; (6) it should stand overloading to a considerable extent without pulling up.

Great attention has been bestowed on these points by several designers. As regards the first, the increase in speed due to throwing off all the load does not in well-designed motors of large size exceed 3 per cent. with constant voltage supply, while in the case of small motors it is only 6 per cent. A 100-h.p. motor would comply with the former figure, while a 5-h.p. would about comply with the latter. With respect to uniformity of speed, it will be observed that polyphase induction motors are quite on a par with the best direct-current motors. In both the speed is, of course, reduced when loaded by just such amount as will permit the current necessary to balance the load to flow through the armature.

As regards the second point, it is important that the current drawn from the lines be not too great at starting. For small motors up to 5 h.p. or 6 h.p. a short-circuited rotor, or squirrel cage winding, as it is sometimes called, is only necessary, the excess of current at starting in the majority of cases not making much difference to the total current flowing. Such a rotor has an extremely small resistance, and when at rest it is to all intents and purposes the equivalent of a transformer with a short-circuited secondary. It would consequently never do for large motors to have such armatures on account of the enormous currents which would flow through the conductors and the correspondingly large currents drawn from the line at starting. When we come to sizes above 8 h.p. or 10 h.p. the armature bars are generally grouped in such a manner as to allow of a resistance being inserted into the rotor circuit at starting in much the same way as a resistance is inserted in the armature circuit of a direct-current motor. For this purpose the conductors are arranged in series of three, and are connected starwise to a common junction, with their free ends brought to three insulated rings on the shaft. This is supplemented by a set of three resistance coils, also connected starwise, and with their free ends terminating in brushes resting in the insulating rings. The resistances are provided with a regulating switch operating all three branches at the same time, and thus the resistance inserted in the armature circuit at starting can be gradually taken out as the motor gets up speed. Apart from the resistance preventing an excess of current at starting, it has also the effect of increasing the starting torque, as excessive currents flowing in the rotor conductors weaken the resultant field and throw it out of phase with the currents in the rotor bars. By using a resistance in this way then we can start against full running torque without drawing more than the normal running current from the line, while with twice the normal current we can get twice the torque. Here again the reduction motor is quite on all fours with direct-current motors.

The efficiency of polyphase motors, the third point referred to, is about the same as that of direct-current motors. The following figures give some idea of the efficiency which makers are prepared to guarantee for various sizes at the usual speeds and frequency:

	Efficiency per cent.
1½ h.p.	76
4 ,, ...	80
5 ,, ...	80
12 ,, ...	84
15 ,, ...	88
50 ,, ...	91
110 ,, ...	92

I now come to a point which is of considerable importance, and that is the power factor or ratio of actual watts to apparent watts given to the motors. I have already spoken of motors behaving to some extent like choking coils, and it will be obvious that running light a motor is nothing more than a transformer running on open circuit, a transformer, too, with an air-gap in its magnetic circuit, and requiring a large magnetising current relatively to the bulk of iron it contains. Now in this kind of transformer the apparent watts (or product of current and difference of potentials) given to it are very different from the real watts, and in a polyphase induction motor, say, of 50 h.p., the former may be as an ordinary thing when running light 10 times as great as the latter. It results, therefore, that the current flowing in the circuit when the motor is running without load is comparatively large, and it actually reaches from 20 to 30 per cent. of the full load current. This current lags behind the impressed E.M.F., and does not indicate that the efficiency of the motor is low; it may, in fact, be analysed and regarded as two separate currents, one of which is pushed forward until it is in phase with the E.M.F., while the other is pushed backward until it lags 90deg. behind the E.M.F. The product of the first current and impressed E.M.F. gives the watts actually put into the motor; the second being 90deg. out of phase with the E.M.F. is a "wattless" or "idle" current. So much, then, for the power factor of motors running light.

The idle current just referred to has to be supplied whether the motor is running light or loaded, but an addition is made to it as the load is put on. This arises from the fact that the field to which the current in the rotor bars is due, is the resultant of the primary field impressed on the stator and the cross field produced by the rotor current itself. The rotor currents, and with them the currents in the line, are thus caused to lag behind the impressed E.M.F., with the result that the idle current is largely increased. This does not mean that when loaded the power factor diminishes, for though then the idle current is

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larger, the proportion of the useful current to the idle current is much greater, the power factor rising in consequence. The power factor depends largely on the size of the motor, and below are figures which may reasonably be expected from motors of different sizes:

H.P.	Power factor.
1½	·65
4	·70
5	·72
12	·75
15	·78
50	·80
110	·82

These figures accord with the results given by actual tests, and you will be much less likely to be disappointed if you assume them as correct than if you take those given by most makers. They clearly indicate, as I have mentioned before, the necessity for rating the size of generators and transformers at not less than one kilowatt per horse-power.

I hope the desirability of getting a power factor as large as possible will be apparent, though I am sorry to say the efforts of designers in this direction have not been always appreciated. In an article which appeared last summer, for instance, Prof. Silvanus Thompson regarded it as "a piece of superstition" to demand anything higher for a small ¾-h.p. single-phase motor than a power factor of ·49! and went on to say that as the efficiency was 90 per cent. he should not mind if the power factor were smaller. In that article the professor, inveighing against "the pedantic demand for a high power factor," made the mistake of supposing that he was voicing the opinions of practical men, the very men, be it observed, who, fully conscious of the advantages which an increased power factor would confer, have been most persistently doing their utmost to raise it. This is indeed a very practical question. If the current were in phase with the E.M.F.—that is to say, if the power factor were 1 instead of averaging ·75, it would mean that the generators would require to be only three-fourths of the size we have now to make them, that the lines would only require three-fourths of the copper they now have, and that the transformers would only require to have three-fourths of their present capacity. The regulation would require less attention, and the regulating gear would be less costly. Notwithstanding that these advantages would accrue, we are told that the demand for a high power factor is a superstition. Why anyone should hold such an opinion I do not know. Probably it arises from the difference in ideas induced by theorising about power plant on the one hand and employing it practically on the other.

The lag of the current has not, however, led to much difficulty in working, and it is chiefly on account of the saving in outlay which would result that we should like to see the power factor higher. To some extent the difference in phase between the current and E.M.F. can be compensated by the use of over-excited synchronous motors, these tending to make the current lead instead of lag. A few synchronous motors, taking a fair proportion of the load, make a very perceptible difference to the power factor, and where the circumstances permit, there is rather an advantage in introducing them into the circuits. The Stanley Manufacturing Company, of America, supply with each of their two-phase motors as a usual thing a couple of condensers, which supply the idle currents to the motors. One of these is connected in parallel with each of the field circuits, and has a capacity such that the amperes at the working voltage equals the no-load current of each field. If there is no distortion of the current wave the apparent energy taken by the motor is equal to the real energy, and the power factor is, therefore, very nearly unity. The Stanley Company is the only company manufacturing condensers as part and parcel of power-plant equipment, though I believe the idea was rather to enable their motors to run satisfactorily at high frequencies than to increase the power factor at low ones.

I have now come to the end of my discourse, but with many sins of omission on my head. Though I have been able to deal in a measure with the principal factors in transmission of power work, I feel how inadequate have been my efforts to cover so large a field in such a short time. The points to be observed in the construction of transformers for power work I have not been able to touch. Discussion of these would take up a considerable amount of time, as would also the descriptions of switching arrangements in use. Again, there is the question as to whether, for polyphase working, the advantage lies with two-phase or three-phase transmission, a question which cannot be argued at length here. The three-phase system, as we have seen, enables some copper to be saved in lines, but this is practically the sole advantage, and it must be remembered that only when the distance exceeds 25 miles does the saving in copper over the two-phase system figure up to anything like 5 per cent. on the total cost of the scheme. Considering the simplicity of the two-phase system, and the ease with which it can be worked as compared with three-phase, especially where lighting is combined with power, it seems that the saving in copper is so small a fraction of the whole cost as not to be worth considering. The difficulty due to uneven loading of the circuits in three-phase working is particularly objectionable, and it must be remembered that not only have the currents to be balanced in the three branches, but the kind of load must be similar; it will not do to have an inductive load on one branch and non-inductive loads on the others. To get over this difficulty in a general system of distribution by three phases, a fourth conductor has to be used as a balancing wire or common return, so that in the end as many conductors are required as for the two-phase system. For the transmission of power only in large units the three-phase system is all right, but where lighting is combined with power two-phase is always preferable. In the latter the circuits are not electrically interlinked in the generator armatures, and as a consequence the regulation of the E.M.F. on the lines is much more satisfactory, and can be carried out without expensive and complicated gear. In fact, the two-phase system, with all the simplicity and ease of control of single-phase, possesses all the important advantages of three phases.

Discussion.

Mr. A. T. Snell regretted he had not seen the paper in print; he was not in a position to discuss it. The author seemed to have taken up the subject at the point where Mr. Kapp left it, and to have brought it down to the present time.

Mr. W. M. Mordey said he was sorry not to be able to speak from experience with regard to polyphase motors. He was glad Mr. Esson had alluded to the vexed question of a standard frequency, and he wished some arrangement could be made by which a standard could be fixed. It was impossible to decide on an absolutely best frequency, as there was no such thing for all purposes, but they might decide on one which would be best for all electrical engineers, simply because it would be standard. Mr. Esson referred to the question of sine as against saw-toothed curves, and seemed to express a preference for the latter under some conditions. He drew attention to the fact that nearly all published experiments on the forms of curves had been made at electrical colleges, on machines running light; none, or few, were made under the working conditions which obtained on distribution systems. A curve might be saw-shaped to begin with, but when you considered everything that took place in the way of self-induction, in the fact that machines were running in parallel, that there were motors, arc lamps on the circuits, and so on, he believed that it would usually be found very little of the form of the original curve would be left. He would recommend gentlemen who had experimental facilities, and were fond of experimenting on the shape of waves, to try and induce some central-station engineers to let them experiment in the first place on the form of wave with a light running machine, no load and no other machine running parallel, and then on the circuits supplied by the same machines under full load conditions, particularly if they could do this on a system where there were motors on the circuit. He agreed as to the desirability of getting alternators to give a good "characteristic," but he could not agree with the author's remark that for power work, where a good regulating machine was required, single-wound field magnets were not as much used as separate magnets. He believed that on the Continent, where far more power was used than here, single-wound magnets were used, and it was a mistake to suppose they were not as good regulators as machines wound with separate magnets. He thought the contrary was the case. He would like to show the author such a machine, which had a drop of not more than one-fourth that mentioned in the paper. With regard to insulators, he might mention a plan which he had found very useful for testing the insulation of porcelain, so that imperfect insulators might be weeded out before use. The insulators should be turned upside down in a tray of water, and the cups filled with water, and in each should be hung a little bit of copper wire connected with one terminal of a dynamo, the other terminal being joined to the tray. After running a few hours the water in the faulty insulators would be more or less coloured blue, according to the amount of leakage through the insulator, which caused a formation of copper salt. Those which showed no colouration could be safely used.

The **Chairman** (Mr. A. Siemens) said the subject of alternating-current motors really deserved much more discussion than gentlemen present seemed disposed to give it. It was, in his opinion, still an open question whether the continuous-current motor had been absolutely displaced, whether the great move in favour of alternating current was going to last, and whether Mr. Kapp's declaration that alternate-current working would form the ultimate solution of the problem how to transmit power over great distances was correct. Perhaps it was hardly appropriate to the paper to say anything about continuous-current motors, but he wanted, at least, to utter a warning that it must not yet be accepted as an axiom that the transmission of power to a distance was impossible with continuous currents. What decided the success of a system was the ease with which it could be worked Most great inventions commenced by being very complicated, and were gradually simplified until you almost wondered why the complicated thing was invented first. When, therefore, he met with any system which was complicated he distrusted it, and thought it could not be right. Another difficulty to which Mr. Esson called attention was the power factor, which averaged ·75 instead of unity, as in the case of the continuous current. If the power factor could be increased to unity, generators would only require to be three-quarter the size,

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and lines would only take three-fourths the copper, but even then there would be the transformers, which with the continuous current were not required. All this indicated that alternating-current motors had not got it all their own way, and in his view the simplicity of the continuous current indicated that it would yet prove to be the right solution of the problem. However, without any further criticism of the system, he would propose a hearty vote of thanks to Mr. Esson for the very able and thorough manner in which he had brought the subject before them.

Mr. A. W. Marshall said he gathered from the paper that the speed of the motor decreased when the load came on, but he did not understand whether there was any means of regulating or altering the speed if desired.

Mr. Esson, in reply, said with regard to continuous-current *versus* alternating-current motors, they all knew that the chairman was in favour of the former—for what reason he knew not; but the fact was that large powers had been transmitted to long distances by alternating currents, and as yet it had not been accomplished with continuous currents. All Mr. Siemens had to do was to show how it could be done; he would not say it could not be done, but it had not been done yet. The continuous current plants used were for comparatively small powers and short distances. It was, perhaps, unfortunate that there was a power factor to be considered, but still it had not prevented the system being a success. He concluded by inviting those interested to inspect two very interesting motors kindly lent him by Messrs. Langdon-Davies and Co., and the Motor Company, Limited: one a non-synchronous, self-starting motor, the other a synchronous, self-starting motor, each suitable for working with a single-phase lighting system.

The **Chairman** said his firm had executed some of the largest power transmission works with three-phase and two-phase currents, so that he knew something about them; but he was still of the deliberate opinion that the continuous current was the best.

Mr. Graham Harris said he had been engaged in very many cases of transmission of power by the alternating current, but after a good deal of consideration extending over some years, he was inclined to agree with the chairman that the alternating current had not as yet proved its superiority.

THE HAMPSTEAD ACCIDENT.

The following is Major Cardew's report on the fatal accident in connection with the electricity distribution system at Hampstead on March 6, 1897:

I have the honour to report that I have enquired into the circumstances connected with the death, on the 6th inst., of H. White, a labourer employed on the electric lighting works of the Hampstead Vestry. There is, I think, no doubt that the man was killed by an electric shock. The accident occurred at one of the transforming stations. These are small chambers under the pavement, in this case only 6ft. 6in. by 5ft. in plan, and 6ft. 6in. high to the crown of the arch. Two transformers were contained in this chamber—one of a power of 25 kilowatts and the other 18 kilowatts. These were arranged on each side of an iron ladder provided as a means of access, and nearly filled the whole of the available space. White's duty at the time was to empty the pans placed under the cover of the chamber to catch water. He was accompanied by T. Gill, a jointer in the service of the Vestry.

The chamber where the accident occurred is at the corner of Wedderburn-road and Lyndhurst-gardens. White was descending the ladder, and put one foot on the flat top of a transformer case. This case was evidently at the time charged to a high potential from earth, while the ladder on which he had his hands was in connection with earth by resting against the iron frame of the cover of the chamber, which was in contact with the wet earth under the pavement. His boots were very wet at the time, and made good electric contact. In this way the unfortunate man received a very severe shock, which fixed his muscles and prevented him making any movement to release himself. Gill, who was waiting close to the entrance to the chamber, observed White's condition, but apparently could not effectively assist him owing to the very limited space and the position of White's body. Gill therefore ran down to the generating station and had the pressure cut off from the circuit, and White was afterwards extricated, but it was found that life was extinct. Gill stated in his evidence at the inquest that White fell across the other transformer, and he was probably dead before this occurred. I was informed that White's hands and one foot were badly burnt, showing that it was while he had hold of the ladder that the fatal current passed. The accident was clearly due to the transformer case on which the man stepped having become charged. It should have been impossible for this to occur, but I regret to have to report that, in my opinion, the precautions taken were insufficient and illusory, and, moreover, were not in accordance with the system of supply approved by the Board of Trade.

In order to prevent the possibility that the transformer case should become charged from the high-pressure circuit, it is necessary that it should be connected to earth efficiently, so that before its potential can be raised to a dangerous amount the resulting current passing from the high-pressure circuit to earth by means of this connection shall cause the fuse or other automatic cut-off to act. In this case the only earth connection made was to an iron bolt, let into the wall of the chamber, and upon which an insulator was supported. This bolt could at best have a very limited extent of surface in contact with moist earth, and I do not think that it would have been considered sufficient even for telegraphic purposes. It is much to be regretted that a more efficient means of earth connection was not adopted.

The fault in the high-pressure connection, by means of which the transformer case became charged, was, I was informed, caused by the insulation of the connecting wire having become damaged where it passed through the iron case. It was with the greatest surprise that I ascertained that the holes in the iron case through which these connections passed were not bouched with non-conducting material in any way, and that an ordinary indiarubber-covered wire had been passed through this hole and then bent down through a right angle to reach the high-pressure terminal. In my opinion such an arrangement is well calculated to produce the fault that occurred.

In the description of system approved by the Board of Trade under the Hampstead electric lighting order it is specified that all metal used in the construction of the transforming stations, and all exposed metal contained within them, will be electrically connected to the armouring of the mains, and, further, that all high-pressure conductors and apparatus will be so protected as to prevent danger from electric shock. It is to be regretted that these arrangements had not been carried out.

This unfortunate accident again directs attention to the dangers to which the employés of electric light undertakers using high pressure are exposed, and the necessity for some supervision and control of the means adopted by these undertakers for the prevention of such dangers, similar to that provided under the Factory Acts for the protection of employés from other recognised dangers.

In the present case the following recommendations should, I consider, be brought to the notice of the Hampstead Vestry for their immediate attention:

1. They should improve the earth connection of all transformer cases, and test the efficiency of these earth connections at least once a month, by trying whether an artificially-made connection of the case to the high-pressure circuit will at once cause the cut-out provided to act, using for the purposes of this test a pressure of one-quarter the working pressure. Such a test can be easily arranged.
2. Electrically connect together the transformer cases and the iron ladders and any other metallic body contained within the chamber, and not forming part of the electric circuit.
3. Have all holes in the transformer casing through which high-pressure connections pass bouched with suitable and effective non-conducting material.
4. Have all high-pressure connections as far as possible enclosed in metal casing efficiently connected to earth.
5. It is also, I consider, very desirable that arrangements should be made for cutting off both the high and the low pressure from these transformer chambers conveniently from the outside.
6. Finally, the undertakers should carefully comply with the conditions specified in their description of system, and referred to above, which provide for an efficient earth connection and for the connection specified in recommendation 2. Had they been complied with this accident would certainly have been prevented.

The chambers constructed by the Hampstead Vestry are very restricted in size, and it is hardly possible to provide against every danger that may attend a man, especially if ignorant of the laws of electrical action, or careless by nature, if he has to enter and work in such a place when closely surrounded by conductors charged to high pressure.

COMPANIES' MEETINGS AND REPORTS.

WILLANS AND ROBINSON, LIMITED.

Directors: Mark Robinson, M.I.C.E (chairman); Sir Gilbert A. Clayton-East, Bart.; Captain H. Riall Sankey, R.E. (retired), M.I.C.E.

Sixth half-yearly report of the directors, to be submitted at the ordinary general meeting of the Company to be held at the City Terminus Hotel, Cannon-street, E.C., on Wednesday, April 14, 1897, at 3 p.m:

After writing off as depreciation from plant, patents, etc, the sum of £4,623. 12s. 10d., and paying interest upon debenture stock, the balance to the credit of profit and loss account for the half-year, including £489. 17s. 2d. brought forward, is £14,320. 7s. 6d. Out of this the directors propose that dividends be paid at the full rate of 6 per cent. per annum upon the preference shares, and at 7 per cent. per annum, as before, upon the ordinary shares, together amounting to £7,312. 10s. The amount payable

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to the directors, in accordance with the articles of association, is £1,955. 8s., leaving a balance of £5,052. 9s. 6d. Out of this the directors propose to carry £2,000 to a debenture redemption fund. and £1,000 to the reserve fund, leaving a balance of £2,052. 9s. 6d. to be carried forward. In accordance with the resolution passed at the general meeting held last October, the expenses connected with the issue of debenture stock, amounting to £1,151. 8s. 2d., were written off from the balance carried forward at the end of June, 1896, reducing the amount to £489. 17s. 2d., as stated above. The issue of 4,500 preference shares of £5 each, at a premium of £1, and of 4,500 ordinary shares of £5 each, at a premium of £2, has been successfully carried out in accordance with the resolution passed at the extraordinary general meeting held on February 2, 1897. The applications from existing shareholders greatly exceeded the number of shares disposable. The registered office of the Company was transferred from Thames Ditton to Rugby on March 18, the transfer of tools and stores having been in progress for some time previously. A serious interruption of work is inevitable under the circumstances, but every effort has been made to minimise it. In accordance with the provisions of the articles of association, applicable to the present occasion, all the directors retire, but offer themselves for re-election. At the extraordinary general meeting held in February last an opinion was expressed in favour of an addition to the Board. On the ground that they believe this opinion to be widely approved amongst the shareholders, the directors advise that the number of directors be increased from three to five, and they recommend the names of Lieutenant General Sir Richard Hieram Sankey, K.C.B., late chairman of the Irish Board of Works, and of Mr. Thomas Orger Lazenby, as those of suitable persons for election as directors. Both gentlemen have wide business experience; both are largely interested in the Company, and both were shareholders in the company which preceded the present one. Sir Richard Sankey holds 1,338 and Mr. Lazenby 1,190 shares. Should additional directors be elected it will be necessary to settle their remuneration, and it is suggested that a fee of £500 per annum for the two directors, to be divided between them as they may arrange, would be a suitable remuneration. The auditors, Messrs. Cooper Bros. and Co., retire, but are eligible for re-election.

WEST COAST OF AMERICA TELEGRAPH COMPANY.

An extraordinary general meeting was held on Saturday at Winchester House—Mr. J. Denison Pender in the chair—to consider the confirmation of the resolutions passed at the meeting on the 19th ult.

The resolutions expressed the desirability of reconstructing the Company and accordingly winding it up voluntarily, and appointing Mr. F. L. Robinson (the secretary) liquidator; authorised the latter to consent to the registration of a new company with the same name; and approved an agreement, dated the 9th ult., between the Company of the one part, and Mr. Robinson (on behalf of the new company) of the other part.

On the motion of the **Chairman**, seconded by **Mr. Frederick Walters**, the resolutions were unanimously confirmed.

BOURNEMOUTH AND DISTRICT ELECTRIC SUPPLY COMPANY, LIMITED.

Directors: Aymor H. Sanderson, A.I.E.E. (chairman); J. Atkinson Hoeker, M.R.C.S.; R. Percy Sellon, M.I E.E. Consulting engineer: A. J. Lawson, M.I.E.E. Managing engineer: F. W. Clements, M.I.E.E. Secretary: H. B. Renwick.

Report of the directors to be presented to the shareholders at the sixth annual general meeting of the Company, to be held at the Registered Offices, Verulam House, Yelverton-road, Bournemouth, on Tuesday, April 13, at 2.30 p.m.:

The capital account shows an expenditure during that period of £7,780. 9s. 10d., chiefly upon buildings, machinery, and mains, the funds for which were obtained by loan from the County of London and Brush Provincial Electric Lighting Company, Limited. The revenue account shows a total income of £8,243. 12s. 1d., as against £7,431. 3s. 10d. in the previous year, and the total costs amount to £5,960. 5s. 8d. If, however, the following items of exceptional expenditure be deducted—viz., £326. 1s. 9d. for repairs to condensing apparatus, and £395. 11s. 10d. for replacement of meters—the total costs amount to £5,238. 12s. 1d., as against £5,272. 12s. 7d. in 1895. A sum of £400. 16s., representing the difference between the cost price and the amount realised on sale of old plant, has been charged to suspense account. The net revenue account, after payment of interest charges on loans and debentures, shows a debit balance of £928. 10s. 9d., which has been carried to general balance-sheet. The connections to the Company's mains on December 31 last were equivalent to 23,203 8-c.p. lamps; the increase for the year being equivalent to 2,636 8-c.p. lamps. Notwithstanding the increased sale of 38,000 units, the fuel costs have been reduced by £204 6s. 7d. as compared with the previous year. Application has been made to the Board of Trade for a provisional order for the districts of Poole and Branksome, and the local authorities concerned have given their consents. The present plant capacity of the station will probably prove sufficient to meet the increased demand for current which may be anticipated from the extended area of supply for the next few years, and it is expected that in the near future additional capital expenditure will only be required for mains and meters on consumers' premises. The retiring director is Mr. R. Percy Sellon, who, being eligible, offers himself for re-election. The auditor, Mr. R. H. Marsh, chartered accountant, also retires, and is eligible for re-election.

REVENUE ACCOUNT YEAR ENDED DEC. 31, 1896.

Dr. To Generation of Electricity.	£ s. d.	£ s. d.
Coal or other fuel	£1,675 14 7	
Oil, waste, water, and engine-room stores	481 3 9	
Proportion of salaries of engineers, superintendents, and officers, as certified by engineer	386 16 8	
Wages and gratuities at generating station	716 8 11	
Repairs and maintenance as follows: buildings, £156. 2s. 4d.; engines, boilers, £484. 19s. 6d.; dynamos, exciters, transformers, motors, etc., £101. 19s. 4d.; other machinery, instruments, and tools, £44. 19s.	788 0 2	
		4,048 4 1
To Distribution of Electricity.		
Engineers' salaries	125 9 6	
Wages and gratuities to linesmen, fitters, labourers	149 2 7	
Repairs, maintenance, and renewals of mains	58 14 8	
Repairs, maintenance, and renewals of apparatus on consumers' premises	415 8 4	
Repairs, maintenance, and renewals of apparatus at distributing stations	41 18 8	
		790 13 9
To Rents, Rates, and Taxes		
Rents payable	143 18 8	
Rates and taxes	49 18 11	
		193 17 7
To Management Expenses.		
Directors' remuneration	65 17 0	
Salaries of secretary and office staff	253 16 9	
Stationery and printing	55 17 11	
General establishment charges	184 8 4	
Auditor of Company	17 17 0	
Auditor appointed under the provisions of the order	10 10 0	
Carriage	9 9 3	
Advertising	18 8 7	
Stores and works expenses	149 6 4	
		765 11 2
To law and parliamentary charges		16 12 4
To Special Charges.		
Insurances	122 11 6	
Leaseholds redemption fund	10 8 5	
Bad debts written off	12 6 10	
		145 6 9
Balances carried to net revenue account		2,283 6 5
		£8,243 12 1

Cr.	£ s. d.	£ s. d.
Sale of current per meter	7,588 6 9	
Rental of meters	413 4 4	
		8,001 11 1
Transfer and probate fees	0 7 6	
Balance of abatements account	20 15 7	
Trading account	16 6 6	
		37 9 7
Rents receivable		70 8 8
Proportion of pupils' premiums		129 18 9
Testing fees account		4 4 0
		£8,243 12 1

Dr. Liabilities.	£ s. d.
Capital account—amount received	86,141 9 10
Sundry creditors	3,587 17 5
Unclaimed dividends and interest	4 19 0
Leaseholds redemption fund account	60 6 10
	£89,794 13 1

Cr. Assets.	£ s. d.
Capital account—amount expended	79,334 2 1
Stores on hand at December 31, 1896	957 9 4
Board of Trade deposit	150 0 0
Sundry debtors	2,843 4 1
Suspense account	4,676 17 6
Balance of revenue account, 1895, £237. 15s. 9d.; ditto 1896, £928. 10s. 9d.	1,166 6 6
Cash at bankers and in hand	666 13 7
	£89,794 13 1

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units	394,724
Quantity sold to private consumers by meter	281,310
Quantity used on works	10 269
Total quantity accounted for	291,579
Quantity not accounted for	103,145
Total maximum supply demanded (kilowatts)	401

BRITISH ALUMINIUM COMPANY.

As announced in our last issue, the annual meeting of this Company was held at the Westminster Palace Hotel yesterday.

Mr. R. W. Wallace, Q.C., took the chair and moved the adoption of the report, an extract from which we gave last week. In the course of an able speech Mr. Wallace referred to the diffi-

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culties always found in training men to a new employment. The Company had been spared much expense in this way by the experience of kindred companies on the Continent, and he could congratulate the shareholders that the cost of production at the Foyers and Larne works was now lower than that of their friends on the Continent. They had built since last year a carbon factory at Greenock, and were able there to get all the raw material required at very cheap rates. They also obtained all the coal required at Larne from the same place at the low cost of 4s. 8d. per ton. They would also supply electrolytic carbons to others engaged in similar electrical processes, and he believed that would tend to profit and reduced cost of production. In the past year the demand for aluminium had increased rapidly, and he was doubtful how long their present plant could cope with it. They had therefore ordered more plant from Switzerland to supplement their power. The water power owned by the Company in Wales was now to be developed, and the Acetylene Illuminating Company had agreed to rent power there. The storage lake and tower would be completed in the summer, and would hold 3,000 million gallons, or 100 days' supply. The law-suits pending to prevent the import of aluminium from America had been prosecuted with vigour, but there was a likelihood of a mutual arrangement preventing further litigation. There was also a probability of the Neuhausen works buying alumina from the Larne works.

The report was adopted unanimously, and then the retiring directors and auditor were re-elected.

LEGAL INTELLIGENCE.

A MOTOR COMPANY CASE.

In the Lord Mayor's Court on Thursday, before Sir Forrest Fulton, Q.C., the Common Serjeant, and jury, the case of Gamage *v.* Marshall came on for hearing. It was an action for damages for breach of contract brought by plaintiff, a well-known athletic outfitter of Holborn, for underwriting 40 shares in the London Electric Omnibus Company, Limited.

Counsel said that early last year Mr. Marshall was bringing out the London Electric Omnibus Company, and entered into an agreement with the plaintiff to underwrite 400 shares, for which it was agreed that he should receive 5 per cent. in cash and 10 per cent. in fully paid-up shares. He was eventually required to take up 160 £1 shares, 10s paid. For about a fortnight in November last there was a great boom in this sort of shares, and plaintiff was able to dispose of the 160 allotted to him; but at the present time they were practically unsaleable Although he had applied several times for his commission he had not yet received it. In the boom he was able to sell his 160 £1 shares, 10s. paid, at a premium of 3s. 1½d., so that if he had had his 40 shares for commission he would have made £46 more.

After hearing counsel for the defence, the **Common Serjeant** said that the action was practically undefended, and the only question was that of damages. He found altogether for the plaintiff for £66. 5s., including the sum of £20 paid into court.

CLAIM FOR ELECTRICAL WORK.

In the Westminster County Court on Tuesday, the case of Butler *v.* Hurst was before his Honour Judge Lumley Smith, Q.C.

Plaintiff's Representative said the debt was for £25 worth of electrical fittings supplied to the order of the defendant, who was living in a West end flat, and was in receipt of an income of £1,200 a year. He was well able to pay, but although judgment had been recovered against him he had done everything he could to evade payment of a just debt.

His **Honour** said if people must have luxuries they must pay for them. In this case the defendant would be committed to Holloway for 12 days unless he paid the amount due within a month.

DISPUTED LIABILITY FOR ELECTRIC WIRING.

In the Westminster County Court on Monday the case of Wilson *v.* Cook was before his Honour Judge Lumley Smith, Q.C.

The plaintiff, an electrician of Wardour-street, sued to recover the sum of £5. 15s. for electric wiring done to the order of the defendant a builder of York-street.

The defence was that the work was done to the order of the defendant's wife, and that she was liable for payment. It was also alleged that she was in a good position, and was perfectly willing to pay.

His **Honour** said he was satisfied that the defendant was personally liable, and gave judgment for the plaintiff with costs.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Aberdeen.—The Corporation want tenders by the 27th for a storage battery (125 cells and 400 ampere-hours). Further particulars will be found in our advertisement columns.

Liège.—Tenders will be received by the Provincial Government of Liège on May 3 for the construction, maintenance, and working of an overhead electric tramway from Grivegnée (Bonne-Femme) to Chênée.

Bedford.—Tenders will be received by the Electric Lighting Committee on the 20th inst. for two water-tube boilers, Vicar's mechanical stokers, and an alternating-current motor. Particulars are to be found in our advertising columns.

Edinburgh.—The Council require tenders for the supply of steam coal for the electric supply station from May 15, 1897, to May 15, 1898. Specification, forms of tender, and conditions of supply can be obtained at the Resident Electrical Engineer's Office, 5 Dewar-place. Sealed tenders to be lodged with Mr. Thomas Hunter, W.S., town clerk, City Chambers, by 10 a.m. on April 10.

Amsterdam.—The Consul-General of the South African Republic invites tenders for the supply of (1) insulators and (2) hard-drawn copper wire. Tenders which have not been received before 17th inst., Doelenstraat No. 8, at Amsterdam, will not be regarded. Specifications (in two tenders) will be procured on demand by Mr. F. J. Belinfaute, late A. D. Schinkel, Paveljoensgracht, The Hague, at the price of 1sh. each.

Bath.—The Corporation invite tenders for the extension of the buildings of the electric light works, situate at Dorchester-street. Plans and specifications and all information, together with copies of the quantities, at 1, Belmont, Bath. Forms of tender may be obtained from Mr. F. H. Moger, clerk, 3 Wood-street, Bath, and tenders must be delivered to him, sealed, and endorsed "Tenders for Works at the Electric Light Station," by noon on April 12.

London, W.—The Hammersmith Vestry invite tenders for the supply of about 1,000 tons of best Welsh smokeless steam coal as may be required during the 12 months at the electric lighting works. Forms of tender and conditions of supply can be obtained on application to Mr. W. P. Cockburn, vestry clerk, 57, Fulham Palace-road, Hammersmith. Sealed tenders must reach Mr. W. P. Cockburn by 4 p.m. on 14th inst., marked on the outside "Tender for Coal."

Salford.—Tenders are required by the Corporation for the fittings, etc., required (including fixing) for lighting with electricity certain rooms in the town hall. Plans of the town hall may be obtained from the Borough Engineer, Town Hall, Salford. Tenders, endorsed "Electric Lighting of Town Hall," together with drawings, etc., to be sent to Mr. Samuel Brown, town clerk, Town Hall, Salford, addressed to the Chairman of the Town Halls, etc., Committee, by 19th inst.

Cardiff.—The Corporation are prepared to receive tenders for the manufacture and delivery and laying of high and low pressure compound concentric cable and sundry transformers. Particulars may be obtained on application to Mr. Neville Appelbee, electrical engineer, Town Hall, Cardiff, upon the deposit of £1. 1s., which will be returned upon receipt of a bona fide tender. Sealed tenders, addressed to Mr. J. L. Wheatley, town clerk, and endorsed as directed in the specification, must be delivered at the Town Hall not later than 14th inst.

Brighton.—The Town Council require tenders for the supply and delivery of armoured lead-covered electric cables and jointing sundries at the Corporation electricity works. Specifications can be obtained on application at the office of Mr. Francis J. Tillstone, town clerk, at the Town Hall, Brighton. Sealed tenders, addressed to him, and marked "Tender for Electric Cables," must be left at his office before 10 o'clock in the forenoon on April 12. A fee of £1. 1s. will be charged for the specification, which will be refunded on the return of the same, accompanied by a bona fide tender, on or before the above-mentioned date.

London, N.W.—The St. Pancras Vestry are prepared to receive tenders for the wiring and other works in connection with electric lighting of the Whitfield-street baths and wash-houses. Copies of the specification and conditions of contract can be obtained, and a plan of the general positions of the lights inspected, at the Electricity Department Offices, 57, Pratt-street, N.W., on payment of a deposit of £1, which will be returned on receipt of a bona fide tender. Tenders to be sent to Mr. C. H. F. Barrett, vestry clerk, Vestry Hall, Pancras-road, London, N.W., endorsed "Tender for Wiring Baths and Wash-houses," by 12 noon on 27th inst.

Colchester.—Tenders are invited by the Electric Light Works Committee for the erection of an electric light station, consisting of a boiler-house, engine-house, cast-iron tank, and chimney shaft, to be built on land adjoining the Osborne-street depôt. Plans may be seen, and specification, quantities, and all other information can be obtained at the office of Mr. H. Goodyear, A.M.I.C.E., borough engineer and surveyor, Colchester, on a sum of £2. 2s. being deposited with the Borough Engineer, which sum will be retained by the committee, and deemed to be forfeited if a bona fide tender is not made by the depositor. Sealed tenders, endorsed "Electric Light Station and Chimney Shaft," must be delivered by 15th inst.

Egremont (Cheshire).—The Wallasey Urban District Council require tenders for supplying for 12 months, from June 30, the following among other articles, being the principal stores required for the use of their electrical works—viz., paper-insulated concentric cables, electric meters, lamp columns and lamps, main switches and cut-outs. Further particulars, with forms of tender, may be had and samples inspected on application at the Gas and Water Engineer's Office, Great Float, near Birkenhead. Sealed tenders, which must be on the printed forms, properly endorsed, and addressed to the Chairman of the Gas and Water Committee, to be left at the office of Mr. W. Danger, clerk, Public Offices, Egremont, Cheshire, by 4 p.m. on 22nd inst. The contractors will be required to enter into formal contracts, and may also be required to give security, in conformity with the Public Health Act, 1875.

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West Ham.—The Town Council require tenders for the erection of electric lighting buildings at the Abbey Wharf, Stratford, London, E. Plans may be seen, and specification, form of tender, and further particulars obtained, at the office of Mr. Lewis Angell, engineer to the Corporation, Town Hall, Stratford, E, on deposit of a £5 Bank of England note, which will be returned on the receipt of a bona fide tender. Tenders, endorsed "Tender for Buildings," to be sent to Mr. Fred. E. Hilleary, town clerk, Town Hall, West Ham, by 4 p.m. on April 13. The contractor will be required to enter into a bond, with two sureties, for the performance of contract, and no work will be ordered under the contract until such bond has been duly executed. The contractor whose tender is accepted, and with whom a contract is entered into, will be required to pay the whole of his workmen such rate of wages and observe such hours of labour as are recognised by the workmen's trades unions and in force at the time of signing the contract. In the event of any breach of such agreement the Council will enforce the penalty clause in its entirety.

RESULTS OF TENDERS.

Boston.—The Harbour Commissioners have accepted the tender of Messrs Spagnoletti and Crookes, of London, to erect an electric light installation at Boston Dock, at a cost of £1,682.

Dortmund.—The following were the lowest tenders in connection with the municipal electricity works on March 20: Masonry—Rudolph, Dortmund, 45,168 marks. Earthwork—Dirks, Dortmund, 6,020 marks.

Boston.—At a meeting of the Harbour Commissioners the Dock Management Committee reported that they had considered eight tenders for fixing an installation of electric light at the dock, and they recommended the trust to accept the tender of Messrs. Spagnoletti and Crookes, of London, at £1,682. The estimate of Mr. A. Collins, the consulting engineer, amounted to £1,267. The recommendation of the committee was approved.

Cardiff.—The following tenders were received for wiring the judge's lodging, The Walk, for the Corporation. Mr. N. Appelbee, electrical engineer:

Clay Bros. and Co., Cardiff (accepted)	£95	10	0
Alger and Sons, Newport	97	0	0
Baker and Co., Newport	113	0	0
Lewis and Fletcher, Cardiff	135	0	0
J. B. Saunders and Co., Cardiff	136	16	0
Sydney Walker and Co., Cardiff	145	0	0
Duncan, Price, and Co., Cardiff	148	10	0
Hatcher and Co., Cardiff	170	0	0

BUSINESS NOTES.

Western and Brazilian Telegraph Company.—For the past week the receipts were £2,234.

Great Northern Telegraph Company.—For the month of March the receipts were £22,800.

Tramways Institute.—A general meeting of this institute was held yesterday (Thursday) at the Town Hall, Huddersfield.

Darwen.—The Board of Trade have decided to grant a provisional order to the Corporation to supply electricity within their borough at a cost of £20,000.

The Proposed City and West-end Railway.—The Select Committee of the House of Commons will give their decision on the City and West-end Railway Bill this (Friday) afternoon.

Acetylene Light Syndicate, Limited.—A company has been registered under this title, with a capital of £3,000 in £1 shares, to acquire and develop certain undescribed patents and rights.

Provisional Orders.—The Board of Trade have decided to grant a provisional order to the Corporations of Brighouse and Morley to supply electricity within their boroughs at a cost of £10,000 and £15,000 respectively.

Appledore.—The street in front of the public hall has been fitted with electric light, the installation being by Messrs. Tardrew and Son, of Bideford. The light was switched on on the occasion of a recent Conservative ball.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended April 4 amounted to £1,323, as compared with £1,256 in the corresponding week of the previous year, being an increase of £67.

Stourport.—The promoters of the electric tramway scheme between Kidderminster and Stourport have deposited plans with the Corporation showing how they propose to deal with the canal and river bridges in the New road.

Bristol Tramways and Carriage Company, Limited.—The traffic returns for the week ended April 2 were £2 025. 7s. 10d., compared with £2,018. 15s. 5d. for the corresponding period of last year, being an increase of £6. 12s. 5d.

A Large Combination.—The Electric Construction Company, Limited, have just received an order from the Manchester Corporation for one of their continuous-current multipolar dynamos coupled to a Musgrave engine of 2,500 i.h.p.

Electrical Time-Recording Company, Limited.—This Company has been registered, with a capital of £12,000 in £1 shares, to carry on the business of electrical, general, and mechanical engineers in all or any of their respective branches.

Hampstead.—The Lighting Committee stated at the Vestry meeting that the clerk had reported that he was taking all necessary steps in the matter of Mrs. White, the widow of the workman who met with the fatal accident in a transformer station.

The Jandus Arc Lamp.—We started to read through the list of testimonials sent us by Messrs. Drake and Gorham which they have received from users of the Jandus arc lamp, but time and the printer wait for no man, and the testimonials fill up 22 pages!

Price of Arc Lamps Reduced.—Mr. A. W. Richardson, of Skew Bridge Works, Worsley-road, informs us that, having made improvements in construction, and with the aid of special machinery, he has been able to reduce the price of the "I. R." arc lamp.

Birmingham.—A motor omnibus, constructed to carry about six persons, was placed on the streets on Tuesday by the Birmingham Motor Omnibus Company. Several journeys between Colmore-row and Five Ways, and between New-street and Five Ways, were made.

Glasgow.—Mr. D. M. Stevenson has given notice to move at the next meeting of the Corporation "That the Telephone Committee be instructed to ascertain the cost of providing the various departments with a Corporation telephone service equal to the present service, and to report."

Anglo-American Telegraph Company, Limited.—The directors, after placing £6,000 to renewal fund, have resolved to declare an interim dividend for the quarter ended March 31 of 12s. 6d. per cent. on the ordinary stock and £1. 5s. per cent. on the preferred stock, less tax, payable on May 1.

Electric Fittings.—The Edison and Swan United Company send us another section of their catalogue being a fittings supplementary list. The pages are principally devoted to reflectors, ball fittings, lamp guards, wood blocks, cable connectors, cigar and pipe lighters, insulating staples, etc.

City and South London Railway.—The returns for the week ended April 4 were £1 026 compared with £815 for the corresponding period of last year, being an increase of £211. The total receipts for the half-year 1897 were £14,818, compared with £13,471 last year, being an increase of £1,347.

Poole.—The Town Clerk made a statement at the Town Council meeting with reference to the amendments which the promoters of the Poole and Branksome electric lighting order had agreed to, and these being fair and reasonable the Council passed a resolution consenting to the granting of the order.

Trunk Telephone Service.—It was reported at the Liverpool City Council that the Glasgow Chamber of Commerce had notified their intention of asking the Government to take over the whole telephone system of the country and sent a copy of their memorial to the Postmaster-General to that effect.

The Torquay Trams.—At the meeting of the Town Council Alderman Callard moved that the question of the proposed electric tram be deferred until the draft order was laid before the Council. Then they would have something tangible to consider. Mr. Cole, seconded, and, after some discussion, the motion was agreed to.

Authorised Charing Cross, Euston, and Hampstead Railway. The Unopposed Bill Committee of the House of Commons have passed a Bill reviving and extending the powers for the construction of the underground electric railway from Charing Cross to Hampstead, which was originally authorised by Parliament in 1893.

Bradford.—The Corporation Gas and Electricity Committee have decided to recommend the Town Council to advance the salary of Mr. Alfred H. Gibbings, the electrical engineer, from £300 to £500 per year, and to apply to Parliament for powers to include the whole of the borough within the electrical lighting area.

Gloucester.—At the City Council meeting Councillor Clutterbuck moved that Councillor Allen be added to the special committee appointed at the last Council meeting for the purpose of considering what steps should be taken by the Corporation under the Gloucester Corporation Electric Supply Order, 1896. The motion was agreed to.

Yarrow and Co, Limited.—This Company has been registered, with a capital of £160,000 in £10 shares, to acquire the business now carried on and belonging to the firm of Yarrow and Co., at Poplar, Isle of Dogs, and the freehold and leasehold properties held in connection therewith, and to construct or build electric works, telegraph and telephone systems, etc.

Salford. At the meeting of the Borough Council on Wednesday, the following resolution was carried by 33 votes to 8: "That in the opinion of this Council it is desirable that the electric lighting department should be under separate management, and that the duties thereof be deputed to a special committee, to be nominated and appointed at the next meeting of the Council."

Northwich.—The River Weaver Trustees have accepted the offer of the Liverpool and London and Globe Insurance Company to lend for 30 years at 3 per cent. £35,000, to be expended in the improvement of the navigation, the Cheshire County Council acting as guarantors. The improvement works include the erection of two swing-bridges at Northwich, both to be worked by electricity.

Cables in the Philippines.—A Royal order has been published by the Spanish Colonial Ministry in the Madrid *Gaceta*, setting out the terms in which the offer of the Eastern Extension, Australasia, and China Telegraph Company, Limited, has been accepted for laying, working, and maintaining of cables in the Philippine Islands. Cables are to be laid between Manila, Panay, Negros, and Cebú.

Rishton.—Under the auspices of the Technical Instruction Committee in connection with the District Council, the sixth popular lecture was delivered last week by Mr. H. H. Cormack (chairman of the committee), on the subject "Electricity and its Uses." The lecture was illustrated by the oxy-hydrogen lantern

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There was a large attendance. Councillor Ormerod (vice chairman of the Council) presided.

Kingswood.—A letter was read at the Urban District Council meeting from the Electric Light Syndicate requesting a draft of the agreement for the purchase of the Kingswood installation. The Clerk mentioned that there was no use to send a draft, as there was already an agreement between the Council and the syndicate. Instructions were given for a letter to be sent to the electricians in accordance with the clerk's remarks.

Worcester.—At a meeting of the Council the report of the electrical engineer upon the past year's work was considered, and his recommendations were adopted. They include the expenditure of upwards of £9,000 upon additional plant at the generating station at Powick, and an alteration of the system of payment from 5d. per unit to 6d. per unit for the first hour's daily average use, and 2½d. per unit for all current consumed in excess of this amount.

Wednesbury.—At the Town Council meeting the General Purposes Committee reported that the Board of Trade had granted the South Staffordshire Tramway Company an extension of time for the use of steam on the tramways within the borough for three months from March 25, 1897, and that the promoters of the Birmingham, Wolverhampton, and District Tramways scheme did not propose to proceed further with their Bill in the present session of Parliament.

Liverpool.—The Lighting Committee of the City Council have decided on the extension of electric lighting at a cost of £22,000. At the City Council meeting Alderman Sir William Forwood said the Library and Museums Committee hoped soon to see their way to extend the electric light to the Walker Art Gallery. They only had £15,000 to do all their work, and it was simply a financial impossibility for them to put libraries and reading-rooms in all places where members of the Council appeared to desire them to be placed.

Ramsgate.—At the meeting of the Town Council, the Mayor said he had received a memorial signed by Captain Hammond and other gentlemen of importance in Ramsgate with respect to the Isle of Thanet electric railway. He also had a memorial signed by the vicar and many other influential gentlemen, and a third one from Messrs. Tomson and Wotton and signed by many gentlemen who had a great stake in the town. After hearing a deputation, it was decided to discuss the whole matter at a meeting of the Council in committee.

Pembroke.—A letter was read at the meeting of the Township Commissioners from the Board of Trade with reference to electric traction on the Dublin Southern District Tramways, and containing Major Marindin's report on the matter. The Chairman said that the Board of Trade were going to allow the electric motors to proceed at the speed of 14 miles an hour. The Secretary (Mr. Manly) said that 14 miles an hour was the maximum speed, which was not to be exceeded, but the local authority had power to make by-laws reducing that rate of speed.

Derby.—The Electric Lighting Committee submitted at the Town Council meeting the report which was held over from the last meeting, and which has already been published. In connection therewith the following resolutions were also proposed: (1) "That Messrs. Bramwell and Harris be engaged as consulting electrical engineers on the terms mentioned in the report." (2) "That the sum of £20,000 be granted for the purposes set out in the report of this committee, and that application be made to the Local Government Board for sanction to borrow the sum of £20,000 for these purposes." After discussion, the committee's recommendations were adopted.

Birmingham, Wolverhampton, and District Tramways.—The Local Government Board has specially drawn the attention of Parliament to the limitations which it is proposed by Clauses 72 and 73 of the Birmingham, Wolverhampton, and District Tramways Bill ("As to purchase of existing tramways by local authority," and "as to purchase by local authority of mechanical plant") to impose on the power of the various local authorities to purchase, under Section 43 of the Tramways Act of 1870, so much of the tramway undertaking as may be situate within their respective districts.

Greenwich.—The District Board have consented to the grant of the Blackheath and Greenwich District Lighting Order, 1897, subject to the second schedule of the order being amended so as to include Greenwich-road, Nelson-street, Trafalgar-road, London-street, Romney-road, Church and Stockwell streets, and the Lower Woolwich-road as far as the workhouse, on condition that Mazehill and Creed-place be struck out, it being wished to carry the mains down to Trafalgar-road by some more convenient road, probably from Westcombe-hill direct (it being stated the generating station will probably be near that hill).

Birkenhead.—The Town Council have decided to make application to the Local Government Board for sanction to borrow, under the powers and provisions of the Electric Lighting Acts and the Birkenhead Electric Lighting Order, 1890, the sum of £20,000 for the following purposes: for costs, charges, and expenses incurred in excess of the amount of £20,000 originally authorised to be borrowed and to meet other expenses, £5,000; for providing and laying feeding mains, distributing mains, street boxes, and other main connections in the districts of Oxton and Claughton, £10,000; and for providing additional generating plant, £5,000.

Telegraph Estimates.—The *Times* says that, in consequence of the ordinary Post Office and Telegraph Estimates having been issued before the report of Lord Tweedmouth's Committee on Post Office Establishments was made public, the Treasury has now prepared additional estimates to meet the increased expenditure for these services in the current financial year. One hundred and nine thousand eight hundred and seventy-five pounds will be required for the Post Office, and of this sum salaries and allowances in London amount to £32,950, and in the provinces (England and Wales) to £61,100. For the telegraph service a total of £28,800 is asked for.

Leeds.—The City Council have given sanction to the Lamp Committee to make an experiment in the way of lighting the streets by electricity. They are going to take the opportunity afforded by the erection of the central poles for the electric tramways, to light the route from the Great Northern Station as far as the dispensary at the top of New Briggate. The only difference of opinion is as to the size of the lamps to be used—whether 6·8 amperes or 10 amperes. The cost of the larger lamps would be £510; of the smaller, £465; the annual expenditure on the former would be £574, and the latter £422. Further extensions will be carried out as soon as possible.

Electric Motor Vehicles.—Messrs. New and Mayne have sent us two price-lists of motors, one of which gives particulars and a highly-coloured representation of a brake driven by electric motor. The machinery and accumulators are attached to a separate underframe, and the driving gear is carried on the front axle. The cells may be recharged in position, or the box containing them may be removed and another put in, which the makers claim to be a special feature of their design. They also say that they can provide the carriages with ample power to attain a speed of 12 miles an hour on macadamised roads, and to climb hills at four or five miles an hour. The price of these brakes is £450.

Blackburn.—The Parks, etc, Committee reported at the Town Council meeting that, in the opinion of the Gas Committee, the pillars for carrying the overhead line, in connection with the proposed electric tramways, could be utilised for the lighting of the streets with electricity. The matter was referred to the Joint Lamp Sub-Committee, who would confer with the Gas Committee and act. The Council adopted the recommendation of the Gas Committee to reduce the charge to 6d. per unit for the first hour and 3d. per unit after from July 1 next, with an allowance of 5 per cent. discount on early payment, commencing with the current quarter's accounts; also the price of electricity for power purposes to 2½d. per unit.

Newington.—At a "smoker" given by the St. Mary's Ward (Newington) recently, Mr. L. W. Chubb gave a short address on the electric light in Newington. He urged every Newington ratepayer to support the Moderates at the next Vestry election, and so save the parish from a ruinously extravagant scheme. The Vestry proposed to spend £40,000 in providing light for a few of the principal thoroughfares. Experience taught that original estimates were always exceeded, and the £40,000 would reach £100,000 before the electric lighting scheme was done with. The Vestry could not hope to succeed where private corporations had failed. The Vestry had no mandate from the ratepayers to spend money on an electric lighting scheme.

National Telephone Company.—Mr. Justice Vaughan Williams on Wednesday, in the Companies' Court, dealt with the petition of the National Telephone Company, Limited. The Company (whose capital is four millions) petitioned under the Memorandum of Association Act for an alteration in its articles. The "object" of the Company, according to these, was to carry on the business of a telephone company "in the United Kingdom." It was desired now to extend the business to the Channel Islands and the Isle of Man, and there appeared to be some question whether these places are included under the phrase "United Kingdom." To be on the safe side, the Company asked to add the necessary words. His Lordship sanctioned the alteration.

Tramways on the Continent.—From the annual statistics of electric tramways and railways, published in *L'Industrie Electrique*, it appears that new electric lines are projected in the following towns on the Continent. The work has not yet been begun, but is expected to be in progress in the course of the year: In Germany at Breslau, Beuel, Konigswinter, Carlsruhe, Coblenz, Darmstadt, Dresden (extension), Frankfort, Görlitz, Halle, Heilbronn, Cologne, Gladbach, Rhey, and Saarthalbahnen; in Spain at Madrid, Barcelona, and Cadiz; in France at Avignon, Besançon, Bourges, Chapareillan, Donai, Gerardmer, Le Mans, Limoges, Montpellier, Nevers, Paris, Pierrefitte, Luz, Rochefort, St. Etienne, and Vals-les-Bains; in Italy at Cagliari; in Russia at Koursk; and in Switzerland at Freybourg.

Electric Locomotives on Belgian Railways.—The Belgian Government have, it is said, decided upon a trial of electric locomotives on the ordinary State railways, starting with the nine-mile run between Brussels and Tervueren. No conductors are to be used, the electric cars taking their place in the ordinary train, and the result will be watched with interest in view of the smoke nuisance on the London underground railways. The Belgians are adopting the accumulator system, notwithstanding its weight, so that the financial results will be valuable for comparison. The speed is to be 31 miles, reduced to 18½ miles on the steepest gradients. The accumulators weigh 12 tons, the electric motors and appliances 10 tons, and the cars, which are 52½ft. long, on two bogies, and carrying 80 passengers, weigh 20 tons.

Eccles.—The Electric Lighting Committee, having fully considered the resolution passed by the Council at the last meeting with regard to the electric lighting of the borough, and having discussed the question with the consulting electrical engineer (Mr. Clirehugh), recommended that the public lighting of the borough by electricity be limited to the main road extending from Gilda Brook to New-lane, with suitable provision for branches into the side streets being at any time carried out. It was resolved that

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the consulting electrical engineer be instructed to report the cost of supplying the same number of private consumers with electric light as was originally included in his scheme for private lighting, and also the cost of lighting the main road from Gilda Brook to New-lane by the incandescent and arc systems of electricity.

Birmingham Tramways.—A meeting of the Public Works Committee was held last week to receive the report of the deputation that visited a number of Continental towns to report upon the various systems of tramway traction in view of the application by the City of Birmingham Tramway Company to use electricity upon the local routes. The deputation had drawn up a report of 50 pages, and this was read to the committee, who after some discussion gave it their approval. A vote of thanks was accorded to Alderman Pollack, who accompanied the deputation as interpreter, and to the corporate authorities in the towns where the tramways were inspected. The report gives a concise and lucid description of each of the systems that were seen in operation at the various places visited. These were Bristol, Blackpool, Paris, Rouen, Brussels, Vienna, Budapest, Dresden, Berlin, Hamburg, Bremen.

Portsmouth.—A Local Government Board enquiry has been held by Mr. R. Walton, C.E., touching applications to borrow £10,000 for electric lighting. From statements by the town clerk, Alderman Ellis, and Mr. Manville, C.E, it appeared that of this sum £700 was required for the purchase of two freehold houses adjoining the electric lighting station in order that a new boiler-house might be erected there; £5,000 for additional accumulators and generators, and £3,000 for a duplication of the feeders from the station to King's-road, and from the station to Charlotte-street. In reply to a question by the inspector, Alderman Ellis said that already the electric lighting works were supplying 34,400 lights independent of the 260 arc lamps in the streets. The Town Clerk said that £600 was required for six additional transformers, and the balance was for street openings and contingencies. There was no opposition.

Croydon.—St. Matthew's Church was lighted for the first time by electric light at the evening service on Sunday last. The body of the church is lighted by eight electroliers of five lights each, the chancel and nave by four electroliers of seven lights each. Two standard lights are provided in the organ, and a lamp placed below to illuminate the pedals. Three-light electroliers and two-light brackets are fitted in the vestry and side aisles. The lights are controlled by a main switchboard placed at the west end of the church. The fittings, which consist of wrought-iron coronas, are supported from suitable brackets, fixed over the arches in the nave and transepts, and have been specially designed to suit the architecture of the church. The whole of the installation has been carried out by Messrs. Peto and Radford, Limited, of London and Croydon, and has been under the supervision of Mr. G. Frisch, F.R.I.B.A., of 12, Addiscombe-road, Croydon, and 17, St. Swithin's-lane, London.

Chelmsford.—In reference to the complaint about the incandescent electric lamps, a letter was read at the Town Council meeting from the electric lighting company saying that at times a small proportion of the public lamps had been below the normal candle-power on account of the long burning of the lamps. Special instructions had now been given for the lamps to be thoroughly inspected and replaced where necessary. As to the burning of the lamps of private consumers, nothing had been found wrong with that. The Town Clerk reporting that he could only discover one town where an electric lighting inspector had been appointed, it was resolved that this matter stand over for the present. Alderman Whitmore called attention to the unsatisfactory burning of the arc lamp against the railway station, which, he said, was out four nights every week, and Councillor Britton (chairman of the Lighting Committee) said the company were being written to respecting it.

The Output of Copper.—From the fortnightly copper statistics it appears that the stock of the metal is steadily growing, although the addition this time is only 665 tons, the total having advanced from 32,559 tons at mid-March to 33,224 tons at the end of the month. Taking March as a whole, the total supplies have been 19,917 tons, as against 17,552 tons of deliveries, or a surplus of 2,365 tons in favour of supply as compared with demand. The result has been that the price of G.M.B.'s fell from £51. 2s. 6d. per ton at the end of February to £50. 7s. 6d. at the middle of March, and to £48. 17s. 6d. at the end of the month. This fall of £2. 5s. per ton in March appears to discount very decidedly an addition to the stock of only 2,365 tons, and it would seem as if the dealers expected the release of a large quantity of the metal in the immediate future from America, where the metal has of recent months been kept back, although now coming forward.

Poplar.—At the meeting of the District Board the Electric Lighting Committee submitted the following recommendation: "That the offer of the County of London and Brush Provincial Electric Lighting Company, Limited, expressing the terms upon which they are prepared to take over the transfer of the provisional order obtained by the Board in 1892, be accepted subject to the draft deed of transfer being submitted to your committee, and as approved again submitted to the Board." After a long discussion it was decided by a large majority that the matter be referred back to the committee for further consideration and full report: (1) as to the advisability of the Board carrying out its own electric lighting by direct means in connection with the dust destructor; and (2) that tenders be invited for the transfer of the provisional order. The Board have accepted the tender of Bell's Asbestos Company for coating the boiler and disinfector at Bromley depôt with composition for £24.

Electric Light in Cabs.—According to the daily papers, Mr. A. M. Armstrong has exhibited on the Thames Embankment an invention called the "Self-generating Electric Light for Vehicles." He claims for it a distinct advantage over the methods hitherto adopted, as the light is obtained by the revolution of the wheels instead of through accumulators which have to be charged at generating stations. The dynamo is fixed to the axle, and the gearing is driven by the motion of the wheels. Sufficient electricity can be generated in this way to produce a light of 20 c.p., or more if a bigger dynamo is used. When the vehicle is at rest the light grows dim, and it can be switched off altogether by the passenger touching a button inside. The side lights are controlled in the same way by the driver.

Bridlington.—At the meeting of the Urban District Council the Chairman moved the confirmation of the minutes of the Building and Lighting Committee, remarking that the gas company had met them in the cost of the street lamps, which was £980 for the year, by allowing them 2½ per cent. in consideration of being cash customers. They had also approached the company about the lighting of the North Cliff. It would be remembered that the electric lighting on the cliff for the present had practically failed, or to put it more correctly, to put the electric lamps in order for the coming season would involve a considerable outlay. It would be easy, if thought desirable, in the future to revert to the electric light, but the committee did not see their way to continue it this season, as it would involve an expenditure of £150 at once. Mr. Pool asked if anything more than a new cable to cost £150 would be needed to continue the electric light, and in reply the Chairman admitted they would have to get a new dynamo. The minutes were passed.

Tramways and Electric Lighting Orders.—At the meeting of the London County Council the Highways Committee reported as follows: "In accordance with the resolution of the Council of February 2 last, we submitted to the Board of Trade a clause for the protection of the Council's tramways in the event of the adoption of electrical traction, and asked that such clause might be inserted in all electric lighting orders which might be granted in this and future years. We have now to report, for the information of the Council, that a communication has been received stating that the Board is unable to insert the proposed clause. The Board points out that the question of the relations between users of electricity for tramway purposes and other users of electricity was fully considered in 1893 by a joint committee of both Houses of Parliament, which settled a clause to be inserted in all Bills and provisional orders authorising the use of electricity on tramways, and that should the Council be authorised to adopt electrical traction on its tramways, the clause so settled will apply to them."

St. Pancras.—At the meeting of the Vestry, the Electricity Committee reported they had had under consideration the question of providing additional plant for the Regent's Park station. The present engines and dynamos, with the assistance of the King's-road station, would enable the coming winter load to be dealt with, but for the following winter additional plant will be required. The committee were informed that reputed makers of engines and dynamos would not accept any orders for delivery in less time than 14 months, and in view of that the committee considered that immediate steps should be taken to ensure additional plant being ready to meet the winter load of 1898-9. They recommended, therefore, that the Vestry sanction tenders being invited by advertisement for supplying two large engines and dynamos, condensing plant, etc., for the Regent's Park station, at an estimated cost of £11,600. This the Vestry agreed to do. The engineer and surveyor have been authorised to confer with Messrs. Beaman and Deas and obtain from them an estimate for constructing the six south cells of the St. Pancras destructor on the principle of the new destructor at Leyton.

Reading.—At the meeting of the Town Council the Mayor said he wished to bring before the Council the matter of the tramways. A memorial had been handed to him, and he saw that there were 103 signatures, several in pencil, and some of them were not burgesses. The total number of burgesses on the register in the borough was 11,384, so that the number of signatures was only 1 per cent. of the burgesses. The comparatively small number of signatures would have made him hesitate to call a public meeting, but further, it appeared to him that he should put himself and the Council in an awkward position at the present time. He therefore thought it respectful to the Council as well as helpful to himself to take the opinion of the Council as to the course he should pursue, especially as the matter was under the consideration of the Council, and it had been referred to the borough surveyor to go into the question most fully and bring up a report as to the various methods of traction on tramways. When they had that report he took it that they should go fully into the matter as to the course they should take with regard to whether they should purchase the Reading tramways or not, whether they should consider it would be necessary to have an extension of the tramway service generally. It was decided not to call a meeting.

York.—The Tramways Sub-Committee reported at the City Council meeting that the Board of Trade had appointed Tuesday, March 16, for a conference between the tramways company and the Corporation to discuss the points in difference with the company in regard to their application for further powers in relation to the tramway system. The town clerk and city engineer attended the conference, and wired to say that the Board decided to give the Corporation an absolute veto as to electrical traction for the cars, and had also struck out the clause in the draft provisional order for an extension of the time for purchase by the Cor-

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poration. Alderman Dodsworth moved, "That the whole question of the electric lighting of the city be referred to a special committee to be appointed by the Council, and that all resolutions inconsistent with this resolution be rescinded." The object of his motion was to relieve the Streets and Building Committee of that task, to which, it was obvious from the history of the past, they were not able to give that amount of time and attention which the subject deserved. The important business of the electric lighting of the city should be dealt with by a special committee, which he suggested should be composed of one councillor from each ward and four aldermen, making a total of 10 members. Mr. Shaftoe seconded the amendment, but on a vote being taken it was lost, and the minutes of the committee confirmed.

The Madras Electric Tramways.—The *Madras Mail* writes: The shareholders of the Madras Electric Tramways Company cannot be congratulated on the report and accounts presented at the recent annual meeting. "From the accounts it will be seen," remark the directors in their report, "that a large sum of money is owing by the company, chiefly to the trustees for the company's debenture-holders and to the Electric Construction Company, Limited. In order to meet these liabilities, and to extinguish the existing debentures, which were created for temporary purposes only, and also to provide funds for working capital, it is proposed to create and issue a new series of debentures sufficient for these purposes. As this is the only means whereby the company can again secure full ownership and control of their property, the directors trust that, when offered, the issue will be largely subscribed by those already interested in the company." Anxious as the shareholders must be to see the company's affairs put straight, they will require much fuller details, not only of the scheme itself, but of the financial position of the company generally, before "largely subscribing" to the new issue. Under the energetic and capable management which has superseded that of the company's directorate, the Madras tramways seem in a fair way to justify their existence, but no reconstruction scheme that gives the company back the management will be satisfactory which does not provide for the transfer of the company to Madras, and also for the supersession of the present directorate.

Electric Lighting on Bridges.—The Bridges Committee of the London County Council reported at the last meeting as follows: "At a recent meeting of the Council a desire was expressed that we should state the reasons why the Council's bridges are excluded from the orders made under the Electric Lighting Acts so far as they affect the areas within which the Council's bridges are situated. Under those Acts 'the undertakers' have within their area of supply general powers conferred by the Gasworks Clauses Acts to break up streets for the purpose of laying pipes. In the absence of special provision these powers apply to streets over bridges where the 'street,' as distinguished from the structure of the bridge' will admit of the laying of mains or pipes. To us the principal objection in the case of most, if not all of the bridges, appears to be the want of available space for carrying electric lighting cables. In some instances, such as Waterloo and Westminster bridges, the former of which is paved with heavy granite slabs, which are difficult to move, the Council is under statutory obligation to afford a certain space for the use of some of the electric lighting companies. This space is as much as ought to be given for the purpose, and it is is therefore necessary to exclude these bridges from the provisions of any future orders, and in general the space may be said to be so limited that the safest plan to adopt is absolutely to exclude the bridges from the companies' areas. There is also the possibility of electrical objections which would have to be discussed in each particular case. We therefore think that it is advisable for the Council to have its bridges excluded from any electric lighting order that might affect them."

West Ham.—Mr. Ernest Baggallay, the West Ham stipendiary, held a public enquiry on Tuesday at Stratford in connection with the allegations that the West Ham Town Council had been corruptly influenced in dealing with the contract for the electric lighting of the borough. The enquiry arose out of a letter sent to the Corporation in December last from the Electric Construction Company, pointing out that the lowest tender had not been accepted, and that a gentlemen had called on them offering to influence a member of the Council in their behalf. The company called their secretary, who spoke to a man named Paris calling on them in reference to the contract, and saying he could procure the assistance of a member of the Corporation in obtaining the contract, but that the member would want to be paid for his services. Then Mr. D. Smith, an accountant in the same service, said that Mr. Councillor Hunns called on the company and strongly advised them to go in for the contract, and when asked directly the object of his visit he said he supplied different kinds of goods required in electrical work, and if those at the works were told he was to get a share of the orders he would get them Mr. Paris and Mr. Councillor Hunns each gave their version of the affair, Mr. Paris saying he hoped to get a commission if he succeeded in convincing Mr. Hunns, as he believed that the Electrical Construction Company stood high in the estimation of all engineers. He had no communication with or authority from Mr. Hunns to pay the visit. Mr. Hunns said he called merely in the course of his business, and had no thought whatever of a commission in connection with the contract. After a long sitting Mr. Baggallay said he would reserve his decision.

Gas v. Electricity for Church-Lighting. — The following interesting statement appeared in the *Sheffield Daily Telegraph* of April 6: "Many conflicting statements having from time to time appeared as to the relative cost of gas lighting and electric lighting, the following figures, showing the actual cost of the two systems of lighting at St. Barnabas's Church, Highfield, will be compared with much interest. The vicar and churchwardens of St. Barnabas vouch for the accuracy of the figures. It should be explained that gas is charged at 2s. 2d. per 1,000ft., and that electricity is charged at 4d. per unit, which is the special rate of the electric light company for places of worship. The figures come out thus: Cost of gas lighting for nine months ending March 31, 1896: July, August, September, 1895, £4. 3s.: October, November, December, 1895, £12. 1s. 6d.; January, February, March, 1896, £7. 15s. 9d.—total, £24. 0s. 3d. Cost of electric lighting for nine months ending March 31, 1897: July, August, September, 1896, £2. 12s.; October, November, December, 1896, £6. 5s. 8d.; January, February, March, 1897, £5. 14s. 10d.; add for gas used in vestry during above period, £3. 17s. 2d.; total cost of lighting, £18. 9s. 8d.; add for additional fuel used for heating church during above period, £2. 1s. 9d.—total, £20. 11s. 5d. Early last year the church council decided to introduce the electric light in order that the intolerable heat and stifling atmosphere due to the use of gas at the evening services might be avoided. The council was warned by people who love to cling to the old order of things that it was entering upon a career of extravagance, and, moreover, that without the heat caused by the use of gas the atmosphere of the church would be arctic. It is true that the removal of the gas necessitated the use of more fuel in the heating furnaces, but with the cost of this additional fuel included, the figures still show a substantial saving in favour of electricity. It is said that there is 50 per cent. more light than when gas was used. The church is pleasantly warmed by the heating apparatus, the atmosphere is no longer oppressive, and the improved conditions are highly appreciated by the large congregation and the officiating clergy."

Rochdale.—At the Town Council meeting Alderman J. W. Petrie moved, "That the Council be recommended to make application to the Board of Trade for a provisional order authorising the Corporation to supply electricity within the borough, and also to authorise this committee to take such steps as may be required to obtain such order." The proposal was one of considerable importance, as it involved a new departure in local municipal work—one which would affect the comfort and happiness of the population of the town. They knew that for a long time some members of the Council had felt strongly that the Corporation ought to adopt the electric light in Rochdale, and that in neglecting to do this they were not keeping abreast of the spirit of the times. On the other hand, there were gentlemen who argued that the electric light was still a luxury, and that the Corporation ought to be content with gas and the profits they got from it for a while longer. The committee had seen one department of the Corporation after another adopting the electric light. The Health Committee were quite old users of it, at the free library it had given pleasure to many people for some time past, and at the sewage works it had also been adopted. The Market Company and that important body the Rochdale Equitable Pioneers' Society were also using the electric light, and it had become time that the Gas Committee themselves began to provide it. He asked them to say that now was the acceptable time for empowering the committee to proceed. He was not going to trouble them with figures—the time for figures had not come yet—but if the Council passed the resolution before the meeting, as he sincerely hoped they would do, the committee could engage professional assistance and draw up their scheme. Then they would be able to place further particulars before the Council. In the meantime he thought he had said enough to make the Council feel the desirability of passing the resolution empowering them to apply for a provisional order. Though this, as he had said, was a new undertaking, the committee were not asking the Council to take a leap in the dark—it was rather, he hoped, a leap into a more brilliant light. Councillor Ford seconded the motion. Councillor Cunliffe thought no difficulty whatever should be thrown in the way of the tramway company if they made any application for the use of electricity for traction purposes. The resolution was carried unanimously.

Douglas Southern Tramway.—Since last season the Southern electric tramway, which then had its temporary terminus at Keristal, has been extended to Port Soderick, and has this week been completed. The extension, which involved the filling in of a deep gully, is about three-quarters of a mile in extent, making the total length of the completed line—from Douglas Head to Port Soderick—about 3¾ miles. Besides this extension the line has been considerably improved by the levelling down of its steepest gradient. This gradient, which was 1 in 8, and therefore a little too steep for perfect safety, has been levelled down to about 1 in 16. The road is for the most part cut out of the face of the cliffs. The tramway runs over three steel bridges: one at Pigeon Stream, 120ft. long, supported on two piers; one at Walberry, 256ft. long, two spans with a centre pier; and the third at Horse Leap, 120ft. long, of a single span. At present it is a single line with eight loops or passing places, ten with the finishing loops. One of the features of the line is that there is hardly any straight line in it. The line is worked on the overhead system of trolley wires. The trolley wires are divided into half-mile sections, with a switch to each section pole, so that part of the line can be off if necessary. Marshall's patent spring points are fixed over the whole of the road. The generating station is conveniently situated along the line, and is completely equipped. There are two Babcox and Wilcox tube boilers, each of 120 h.p., working at a pressure of 120lb. There are two engines by Browett, Lindley, and Co., Limited, of Patricroft, Manchester, of 130 h.p. each, which run at 240 revolutions minute. The dynamos run at 650 revolutions a minute, with an out put of 100 kilowatts at a pressure of 500 volts. There are 16 cars, each capable of seating 78 passengers. They are of the American type, and on the lower floor are fitted with seats running com-

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pletely across the car, the entrance being made from either side, as both sides of the car are completely open. The roof is fitted with garden seats. As the tramway will be reopened for the Easter holidays, a preliminary trial has been made of its condition. Mr. G. W. Lowcock, M.I.E.E., of Manchester, the managing director; Mr. T. Hutchinson, director; and Mr. Sharples, of Manchester, the secretary, have been over at Douglas this week for the purpose. Accompanied by Mr. J. H. Lynn, the general manager, Mr. Lowcock drove one of the cars from Douglas Head to Port Soderick and back. The line was found to be in excellent order, the carriage running with remarkable smoothness over the new extension as well as over the older portion of the line. The tramway will be opened for traffic on Good Friday, Saturday, Easter Sunday, Monday, and Tuesday. It will then be closed to Whitsuntide, when it will be reopened for the season.

Belfast.—At the meeting of the Corporation, a deputation from the Trades Council urged an extension of the tramways, and after discussion the matter was referred to the whole Council in committee. The Electric Committee reported: "Your committee have accepted the tender of the Zurich Incandescent Lamp Company for lamps, and that of Messrs. Edison and Swan for switches and fuses. By direction of your committee their engineer has prepared plans and specifications for the proposed new installation, and they propose to submit these to a consulting engineer for his opinion previous to commencing operations, and they recommend that they be authorised to apply to the Local Government Board for authority to borrow the moneys required for the first section of the undertaking, which they hope to have in working order for the coming winter. In moving the adoption of the report, Councillor Andrews said the committee had arranged to submit the draft plan of the extended station to Prof. Kennedy for his approval, but Prof. Kennedy declined to act as consulting engineer in regard to a plan that he did not prepare. Therefore the committee decided to proceed with the erection of an extension of the present system without employing a consulting engineer. In that decision the committee were practically unanimous. Councillor Jaffe seconded the motion. Councillor Young was anxious to know what was the probable cost of these new works. The Electric Committee, he went on to say, had already got about £33,000 out of the Gas Committee's surplus funds. He that day signed a cheque for the electric committee for £7,500, which was to enable them to carry out their works, and the result of these sums being handed over was that the Gas Committee had been obliged to overdraw their account to the extent of £10,000. If the Electric Committee were going to expend £100,000 upon the new electric station he did not know where the money was to come from. He considered, however, that they had done a very wise thing in saving the large fee which would have had to be paid to the consulting engineer. There were local gentlemen in Belfast whose services in this respect could be secured. Councillor Andrews said the detailed estimate had not yet been made up; therefore he could not specifically answer the question, but would be in a position to do so next month. The committee had, of course, been supported by the Gas Committee, of which the Electric Committee was originally an offshoot. They had received from that committee £32,500, but they hoped that, as the Gas Committee had nursed the Electric Committee in the days of their infancy and weakness, the latter would be able in the days of decrepitude of the Gas Committee to reciprocate their generosity. They did not intend to ask the Gas Committee for the other £15,000, for which they intended to apply to the Local Government Board. Councillor Masterson moved, and Councillor Woodside seconded, that the report be adopted, omitting the last paragraph. After some discussion, Councillor Andrews consented to the alteration, and the report as amended was passed.

Aberdeen.—Last Saturday the Gas and Electric Lighting Committee of the Aberdeen Town Council had a conference with Prof. Kennedy on the subject of the proposed extension of the electric lighting undertaking. Councillor Johnston presided. There were submitted reports prepared by Mr. Alex. Smith, gas manager, and Mr. Alfred Blackman, electrical engineer, to the Corporation. During the past winter the electricity mains have been taxed to their utmost, and it has become necessary that their capacity should be increased. Two schemes were submitted dealing with the subject, and Prof. Kennedy, after hearing the committee, recommended the adoption of one of them. In this scheme the proposal put forward is to change the three-wire system of 110 and 220 to one of 220 and 440 volts. The consumers who are now using 110-volt lamps, it is explained, would have to be supplied with lamps suitable for 220 volts, at an estimated cost of £357. The consumers at present using arc lamps might, it is anticipated, be induced to run them four in series in place of two in series. Failing this, the Corporation would have to supply them with arc lamps of a different type at an estimated cost of £572. In addition to this, the Corporation would have to replace sundry switches and fuses, and, generally, put consumers' premises in a fit condition for the double pressure, at an estimated cost of £475. The amount which will thus have to be spent on consumers' premises is about £1,404. It is estimated, however, that the cost would be considerably lessened by the sale of the arc lamps at present in use. With regard to the mains, it is reported that they are in as good condition as on the day they were laid. As the present battery is very small for the requirements, it is proposed that it should not be interfered with, but utilised to feed one side of the system, and an entirely new battery of a similar capacity put in to feed the other side of the system. During the past 3½ years batteries have very much improved, and the proposed new one, while it would cost about 15 per cent. less than the old one, would only occupy 55 per cent. of the space, and would be greatly reduced in weight. The total expenditure is estimated at £3,754, and the capacity of the mains will be increased by 22,000 lamps. The reporters think the importance and significance of this scheme cannot be over-rated, and they consider it to be the first step towards the supply of electricity to the west end and to Greater Aberdeen generally. The cost of the mains for the lighting and supply of power to the harbour had been estimated at £6,700 on the assumption that the supply would be at the present pressure. If, however, by the scheme now suggested the electric department were enabled to supply at double that pressure the mains would cost only £4 810, a saving on the harbour lighting alone of £1,890. This would apply with quite as much force to all future main extensions to the harbour. It is proposed that the work in consumers' houses should be carried out by workmen in the employment of the Corporation, who would be specially taken on for the purpose. Contracts would, of course, be obtained for the supply of materials and lamps necessary, but from the very nature of the work it would be almost impossible to employ a contractor. In conclusion, it is pointed out that in going over to the high pressure of supply, Aberdeen is only following the example of Bradford, Edinburgh, and St. Pancras Vestry, London. The Town Council at the last meeting agreed to these suggestions. The Council have also agreed, in order to make the system of discounts fairer in its operation to large consumers, to fix the charge for the first hour's consumption at 6d. per unit, after which the charge should be 3d. per unit. It was also decided to abolish the charge for meter rents. The new system is to come into force on July 1.

Torquay.—At the Town Council meeting the Electric Lighting Committee reported the result of their consideration of the proposals received with respect to the free wiring of houses, the object of which is to remove the difficulty of the large expenditure involved in introducing the light to private houses. Pearson and Co., Bath; Messrs. Massingham and Mann, Torquay; and Williams Bros. and Co., London, tendered. Messrs. Massingham and Mann wrote: "We are prepared to undertake the free wiring of lamps of 32 c.p. and under at a fixed charge of 1s. 10½d. per lamp per quarter. We find that the average units consumed per lamp at Brighton, Bath, and Hastings are 25 units per annum for an 8-c.p. lamp, 50 for a 16-c.p., and 100 for a 32-c.p. lamp. Under the above system of free wiring the large majority of lamps used are 32 c.p., which are equal in illuminating power to an ordinary incandescent gas-burner, and a charge of 1s. 10½d. per quarter per lamp is equivalent to a charge of less than 1d. per unit consumed; but in our system we also include free maintenance, which means the renewal of all fuses, cut-outs, and worn-out lamps. This reduces the charge to less than ½d. per unit, plus the cost of maintenance; and a still further advantage that we offer is that at the end of seven years the installation becomes the property of the consumer without any further payment whatever. The method of charging upon the consumption only for free wiring is not the best policy of the Corporation, as it encourages the short-hour consumers, who are found to be least profitable to a corporation, whereas the long-hour consumers, who are very profitable to a supply works, are discouraged by having to pay considerably more for their installation than their neighbours. The fact that our free-wiring system also includes free lamps and maintenance, and that the installation becomes the absolute property of the consumer at the end of seven years is an advantage to the consumer which cannot be over-rated, and necessarily tends to popularise the electric light. If our charge of 1s. 10½d. per quarter, or 7s. 6d. per lamp per annum, is analysed, it works out as follows: long-hour consumers, who are the ones most affected by our system of free wiring, burn out on an average two lamps per annum, which at the price charged by the Edison Swan Company—viz., 1s. 9d. each—amounts to 3s. 6d., and in this we also include the renewal of all cut-outs, fuses, and general maintenance, leaving 4s. per annum, or a sum equal to less than ½d. per unit consumed, for rental and purchase of installation. Of this sum 2s. 6d. is for purchase of the installation during the seven years, and the remaining 1s. 6d. is for rental, being equal to only two-thirds of a farthing per unit of the consumption, or a quarter of the sum asked by free-wiring firms who suggest ¾d. per unit as a fair price for rental only. To simplify matters, we collect the odd 1½d. on each instalment of 1s. 10½d. in one lump sum directly the work is completed, leaving an even sum of 1s. 9d. per quarter to be collected by the Corporation." Mr. Trentham, the engineer, reporting on Manningham and Mann's schemes, stated that the first proposal was a hire-purchase agreement, pure and simple, extending over seven years, and was one which might commend itself to those consumers who owned houses or who might have them on a comparatively long lease. It was obvious that it would not be adopted by tenants having a three years' agreement. The contractors collected 3s. 6d. per lamp on completion of the work, and the Town Council had to collect 1s. 9d. per lamp per quarter, making a total of £2. 12s. 6d. in the seven years for each and every lamp installed, exclusive of the cost of the current, the Council handing over the amount collected to the contractors. Of this sum, 10s. 6d. represented rental, 17s. 6d. purchase of wiring, £1. 4s. 6d. supply of lamps and maintenance. Proposal No. 2 was also a hire-purchase scheme, having for its basis a rental of ½d. per unit supplied in addition to a fixed charge of 1s. 6d. per lamp per quarter. A further communication from Massingham and Mann stated that they did not ask for any monopoly. On the motion of Mr. Beavis, the committee adopted Massingham and Mann's alternative scheme, without that firm being considered the sole contractors.

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PROVISIONAL PATENTS, 1897.

MARCH 29.

8019. Improvements in incandescent electric lamps. Charles John Peach Robertson, 6, Bream's-buildings, Chancery-lane, London.

8025. Improvements in electrical connections for tables and the like. Oscar Thomas Banks, 21, Wingfield-road, Walthamstow, London.

8036. An improved power storage system and secondary motor for traction systems. Alfred Charles Brown, George Richard Neilson, and Robert Burn, 50, Old Broad-street, London.

8041. Apparatus for transmitting motion to a distance by means of electrical energy. Siemens Bros. and Co., Limited, 28, Southampton-buildings, Chancery-lane, London. (Siemens and Halske, Germany.)

8048. A new or improved regulator for governing the pressure of electric circuits connected with primary or secondary batteries. Leopold William Heath and James Hermann Field, 14, Victoria-street, Westminster, London.

8059. Improvements in elements for secondary batteries and electrodes for electrolysis. Desmond Gerald Fitz-Gerald, 53, Chancery-lane, London.

8070. Improvements in and connected with electric signalling on railways. George Henry Clarkson, 70, Chancery-lane, London.

8092. A method of and apparatus for preventing the sticking through leakage currents of electric railway section switches. Frederick Carleton Esmond, Norfolk House, Norfolk-street, Strand, London.

8095. Improved construction of socket or holders for incandescent electric lamps. Alfred Julius Boult, 111, Hatton-garden, London. (Deutsche Elektricitäts-Aktien Gesellschaft, Germany.)

MARCH 30.

8115. An invention for facilitating the application of electric communication on railway trains. John Taylor and James Edward Duckworth, Lower Chesham, Bury.

8131. Improvements in primary electric batteries or generators. Samuel Van Buren Essick, 55, Chancery-lane, London. (Complete specification.)

8185. Improvements relating to the generation and distribution of alternating electric currents for light and power. Jasper Wetter, Essex street, Strand, London. (The Elektrizitäts Aktien Gesellschaft vormals Schuckert und Co., Germany.)

8226. A method of and apparatus for preventing the sticking through leakage currents of electric railway section switches. Frederick Carleton Esmond, Norfolk House, Norfolk-street, London.

8231. Improvements in storage batteries. George Frederick Redfern, 4, South-street, Finsbury, London. (Charles Riordon, Canada.) (Complete specification.)

8239. An improved electricity meter for registering the amount of current consumed on direct or alternating polyphase, triphase, or quadruplephase circuits. Frederick John Beaumont and Frederick Hallows, 166, Fleet-street, London.

MARCH 31.

8277. Improvements connected with electrical distribution. Thomas Cooper, 69, Mill-street, Walsall, Staffs.

8295. Improvements in or relating to electric traction and in apparatus employed therein. Edouard Vedovelli, 111, Hatton-garden, London.

8313. Improvements in dynamo-electric machinery. Frederik Wilhelm Andersen, 40, Chancery-lane, London.

APRIL 1.

8350. Improvements in or relating to electric contact makers and breakers. Edwin Perks, 18, Hertford-street, Coventry.

8416. Improvements in electrical switches. William James Davy and George Thomas Davies, 40, Chancery-lane, London.

8420. A method and apparatus for preventing the sticking through leakage of electric railway section switches. Charles Sinclair Drummond, Norfolk House, Norfolk-street, Strand, London.

APRIL 2.

8438. Improvements in arc lamps. Robert Hurry and Oswald Cox-Walker, 15, Rosefield-avenue, Portobello, Midlothian.

8442. An electromagnetic tempering apparatus. John McKay, 76, Meldon-terrace, Heaton, Newcastle-on-Tyne.

APRIL 3.

8537. Improvements in or connected with electric batteries. Herbert Stanhope, 183, Cardigan-road, Leeds.

8554. Improvements in electrical switches. William Durant and Thomas William Baron Durant, 3, Burlington-arcade, Barnsley.

8588. Improvements in electrical resistance apparatus. Henry Alexander Mavor, William Arthur Coulson, and Sam Mavor, 46, Lincoln's inn-fields, London. (Complete specification.)

SPECIFICATIONS PUBLISHED.

1896.

5479. Alternating-current electric motors for operating commuting devices for converting alternating into continuous currents and other purposes. Frazer.

5584. Use and treatment of carbon in electro-chemical or electrolytic processes and apparatus therefor. Coehn.

5794. Manufacturing insulating material for underground electric wires, cables, or the like. d'Humy.

6069. Method of electrically coating wire and apparatus therefor. Rawson.

6197. Electric traction on the conduit system. Doyle and McKenny.

7668. Road vehicles propelled by steam, oil, electric, or like motor mechanism. Lister.

8684 Telephones. Muirhead.

9619. Incandescent electric lamps. Eastick and Sayer.

11647. Electric couplings. Forbes.

12360. Variable gearing applicable to wheeled vehicles driven by electricity, petroleum, steam, or other motive power. Wellington and Allam.

20035. Electrical batteries Mathieu.

20961. Incandescent electric lamps. Lister and Chamberlain.

29107. Telephone exchange. Hill.

29350. Electrically-conducting soles and heels for rubber and other non-conducting soled footwear. Redfern. (Pennycuick.)

1897.

646. Phonographs. Obelt.

1657. Electro-deposition of metals and alloys. Webb and Thoms.

1936. Electricity-distributing boxes. Willatt.

2107. Brake shoes for electric braking apparatus. The British Thomson-Houston Company, Limited. (Case.)

3019. Joint-pieces for electrical conductors. Ivins.

3812. Current collector for use in connection with electrically-propelled vehicles and for like purposes. Heusch and Brandt.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	9¼-9¾
Brush Company, Ordinary	2	¾-1
—— Non. Cum., 6 per cent. Pref.	2	1¼-1½
—— 4½ per cent. Debenture Stock	100	104-108
—— 4½ per cent. 2nd Debenture Stock	100	95-99
Callender's Cable Company, Debentures	100	106-111
Central London Railway, Ordinary	10	9½-10
——	6	5¼-6
Charing Cross and Strand	5	10¼-11¼
Chelsea Electricity Company	5	8¾-9¼
—— 4½ per cent. Debentures	100	112-116
City of London, Ordinary	10	19-20
—— 6 per cent. Cumulative Pref.	10	16½-17½
—— 5 per cent. Debenture Stock	100	132-136
City and South London Railway, Consolidated Ordinary	100	59-61
—— 4 per cent. Debenture Stock	100	139-141
—— 5 per cent. Pref. Shares	10	15½-16
County of London and Brush Provincial Co., Ordinary	10	11¼-12
—— 6 per cent. Cum. Pref.	10	14½-15
—— 4½ per cent. 2nd Debenture Stock	10	14¼-14¾
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	1¾-2¼
—— 5 per cent. Debentures	—	90-95
Edison and Swan United Ordinary	3	1¾-2¼
—— 5 per cent. Debentures	5	3-4
—— 4½ per cent. Debentures	100	105-110
Electric Construction, Limited	2	1¼-1¾
—— 7 per cent. Cumulative Pref.	2	2¼-2¾
Elmore's Copper Depositing	1	¾-1⅛
Elmore's Wire Company	2	⅞-1
W. T. Henley's Telegraph Works, Ordinary	10	19-20
—— 7 per cent. Preference	10	18½-19½
—— 4½ per cent. Debentures	100	107-112
House-to-House Company, Ordinary	5	7¼-7¾
—— 7 per cent. Preference	5	9¼-9¾
India Rubber and Gutta Percha Works	10	20½-21½
—— 4½ per cent. Debentures	100	104-107
Kensington and Knightsbridge Ordinary	5	11¾-12¼
—— 6 per cent. Pref.	5	8-8½
London Electric Supply	5	1¼-1¾
Metropolitan Electric Supply	10	15½-16½
—— 4½ per cent. First Mortgage Debenture Stock	100	120-124
National Telephone, Ordinary	5	6¼-6½
—— 6 per cent. Cum. First Pref.	10	15-17
—— 6 per cent. Cum. Second Pref.	10	15-17
—— 5 per cent. Non. Cum. Third Pref.	5	6-6½
—— 3½ per cent. Deb. Stock	100	102-105
Notting Hill Company	10	11½-12½
Oriental, Limited, £1 shares	1	1¼-2
—— £5 Shares	5	8½-9
—— £4½ shares	4½	7½-8
Oriental Telephone and Electric Company	1	⅝-¾
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	101-106
St. James's and Pall Mall, Ordinary	5	14-15
—— 7 per cent. Pref.	5	9½-10½
Telegraph Construction and Maintenance	12	34-37
—— 5 per cent. Bonds	100	103-106
Waterloo and City Railway, Ordinary	8	10¾-11¼
Westminster Electric Supply, Ordinary	5	13½-14½
Yorkshire House-to-House	5	8½-9

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NOTES.

Beyond the Straits.—Telegraph communication is now established between London and Sandakan, and North Borneo is, therefore, in telegraphic communication with the world at large.

Mathematics.—In the *Centralblatt der Bauverwaltung* there is a long article on the necessity of mathematical training as a prelude to the technical training of all classes of engineers. The advantage of it is undoubted, but it is not much good attempting mathematics too young.

Institution of Electrical Engineers.—We have the April issue of the *Journal* of the Institution. This contains the long debate on signal interlocking, and also Mr. Wilson's short paper of weights and prices of dynamos, and the brief discussion which succeeded it; then the abstracts, to some of which it is hoped to refer further.

Obituary.—The death is announced of Mr. Besak, formerly director of the Russian Postal and Telegraph Department.—The death is also reported from Nice, at the age of 60, of Mr. Paul Giffard, brother of Henri Giffard. He assisted his brother in constructing the Giffard injector, and inherited some of his money, most of which, however, was bequeathed for public purposes.

Students' Visit—The next visit of the students of the Institution of Electrical Engineers will be on April 24 to the works of the City and South London Railway. The party will meet at 195, Clapham-road, at 11 o'clock. As the number will have to be limited, those who wish to attend must send in their names at once to the hon. secretary of the Students' Committee (Mr. W. Bunn, 23, Oxford-road, Stroud Green, N.).

Pole Finder.—The Germans appear fond of "pole-finding" papers and such things. In the *Elektrotechnischer Anzeiger* there is described and illustrated a "pole-finding" apparatus, intended to be worn as a charm on the watch chain. It is something like a horseshoe magnet with a compass (for what purpose one knows not) inserted in the loop. The negative terminal gives a red stain, so the action is of the same kind as the chemical paper, and probably about as reliable.

Acetylene.—Now that experience has taught the French the really dangerous nature of compressed acetylene, they are naturally casting about for a convenient method of storing it. One way suggested by Messrs. Georges Claude and Albert Hess, at the Paris Academy of Science, depends on the fact that it has been found that acetone is a good solvent for acetylene, one kilogramme of acetone dissolving 300 litres of acetylene under a pressure of 12 atmospheres.

Telegraph Poles.—Pine forests are an important matter in Scandinavia and telegraph poles an article of export. It has been remarked there by Mr. Petersen that in early times it was customary to prepare the wood to be used for posts in the summer of the year before the tree was cut down by cutting off the bark for 10ft. to 12ft. The result of this was that the trunk, and especially the lower part, became more rich in resins, which increased its resistance to decay. Such a process, it is suggested, would increase the life of telegraph poles perceptibly without increasing their cost.

A Physical Laboratory for India.—A memorial has been handed to the Secretary for India by Mr. Schwann, M.P., calling attention to the importance of the establishment of a central laboratory for advanced teaching and research in connection with the Presidency College, Calcutta, the most important educational institution under the Government of India. Among the signatures occur the names of Lord Kelvin, Lord Lister, Sir Robert Ball, Profs. G. Carey Foster, G. F. Fitzgerald, W. Garnett, J. H. Gladstone, Dr. J. Hopkinson, Mr. W. Huggins, Prof. W. Ramsay, Sir Henry Roscoe, Prof. Rücker, Prof. A. Schuster, Sir George Stokes, and Dr. Silvanus Thompson.

Crookes Tube Work.—In *Wiedemann's Annalen* there is an account of the investigations of the visibility of Röntgen rays by Messrs. G. Brandes and E. Dorn. According to these, when the vacuum tube is highly exhausted, the rays produce a sensation of light in most eyes, which is, however, difficult to localise. Also in *Wiedemann* is a proposal by Mr. F. Braun to use the Crookes tube as a current indicator. The method is to make the current traverse an electromagnet which deflects the cathode rays in the vacuum tube. The spot of light on a fluorescent screen consequently shifts. It is considered applicable to rapidly-varying currents, as the inertia of the galvanometer mirror is eliminated.

The Calculation of Current Curves.—We have received from America a reprint of the paper by Prof. W. F. Durand, of Cornell, on the determination of the current curve corresponding to any form of alternating E.M.F. in a circuit without iron. The paper presents various methods of obtaining approximate solutions of differential equations which present themselves in a mathematical treatment of the problem proposed, and which do not admit of treatment by the ordinary methods. A summary is hardly possible. When there is iron in the circuit, and the coefficient of induction becomes a variable, the problem is much more complicated, and more general methods have to be employed. The author promises a development of these on the same lines in another paper shortly.

Acetylene.—At a meeting of the South Staffordshire Institute of Iron and Steel Works Managers, held at the Institute, Dudley, last Saturday, under the presidency of Mr. W. Yeomans, a paper was read by Mr. Le Neve Foster on "Acetylene." As some people who are not chemists seem in danger of forgetting that acetylene is no new substance, there is no harm in repeating Mr. Foster's opening remark that it was first discovered in 1836, and its properties have been long well known, though it is only within the last few years that it has been manufactured on a commercial scale. Mr. Foster, of course, had little but good to say of it. A discussion followed, and votes of thanks were afterwards passed to the lecturer, the firm of acetylene manufacturers who had lent the experimental apparatus, and the chairman.

Crystal Palace School.—Last Friday the awards and certificates gained by the pupils at the Crystal Palace School of Practical Engineering were distributed in the theatre of the school. Mr. Jeremiah Head, past-president of the Institute of Mechanical Engineers, presided, and in an address to the students begged them to remember that their paymaster was an exacting public, which, however, sought out the most talented and skilled craftsmen. Mr. Hodson, superintendent of the Educational Department, read the reports of the several examiners. Mr. J. W. Helps, in his report, noted the pleasure with which he observed the excellent lines upon which the educational system of the school was based. He was specially struck by what was shown him in the pattern shop, several of the students having produced work which would not disgrace a trained patternmaker.

Argentine Telegraph Deadlock.—The River Plate Telegraph Company has applied to the Argentine Courts for permission to open its offices pending a full investigation into the matter of their compulsory closing by the

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Argentine Postmaster-General, but has been refused permission to do so under any circumstances. The judgment of the Court, it is stated, includes a sort of lecture to the company on its impertinence in presuming to attempt an action-at-law against the Government. (And to sue the State is a treason high.) As a matter of fact, authorisation of Congress is necessary for such a suit, and meantime the company must submit, or shut down, as the authorities, apparently, are determined to hold to their present course. Diplomatic interference is talked about. Of course, the *ultima ratio regum* applies to republics as well; but the quarrel is a complicated one.

Extra High-Tension Continuous.—A well-known Continental engineering firm is putting up at Steinamagger, in Hungary—so says a Continental contemporary—a power transmission plant to carry 1,200 h.p. at 12,000 volts continuous. When finished, there are to be three groups of six six-pole dynamos, wound for 1,500 volts and run by turbines. At present there are eight machines running in series. The distance of transmission is under 19 miles, and the line is an overhead bare conductor. Twenty-five per cent. of the available energy is lost by the time the current reaches the end of the line, and then, of course, it has to be transformed down to a reasonable voltage by motor-generators with more loss. Commenting on this plant, *L'Elettricità*, which has experience of high-tension continuous plant by the same firm at Genoa and elsewhere, wonders what possible reason there can be for trying such a system. In that wonder one can well concur.

The Railway Yard and Works.—The *Bulletin* of the Société des Ingenieurs Civils de France has an illustrated communication by Mr. G. Baignères on the application of electricity to the work of the shunting yard and of the railway construction works. American, French, Spanish, and German work in this direction is noted and examples described. Turn-tables and shunting pulleys present nothing especially novel, and the "surface traveller," if that is the correct expression for "transbordeur," has been already described in our columns. The carrying of engines and trucks sideways from one rail to another is not a practice that has found favour in this country, but of course where space is limited it is effective enough in overcoming the difficulty of marshalling. Much space is devoted to electric cranes, and the conclusion of the author is that "when electric energy is to be obtained more cheaply" great things will be done with it in railway work.

Communication with Colonies. — According to a telegram from Berlin, it is reported there that the plan of connecting German South-West Africa with the telegraph system of the Cape Colony by a cable starting from the southern frontier on the Orange River has been abandoned, "on the ground that the scheme presents difficulties and would make telegraphic communication dependent upon the English." The scheme has been rejected in favour of a plan to connect Swakopmund with the submarine cable to Mossamedes, which is in Portuguese territory, "the cable being the property of a private company." Swakopmund is the nearest the Germans can make to Walfisch Bay, which is the only place there that can even by compliment be called a port. When the Germans annexed the country that happened to be in the possession of the Cape Colony, and is likely to remain so. One would imagine the amount of private messages over such a line would not be enough to pay the wages of a telegraph clerk.

Conductivity of Mixed Electrolytes. — The *Transactions* of the Royal Society of Canada (vol. ii., section 3) contain a paper "On the Calculation of the Conductivity of Electrolytes" by Prof. J. G. MacGregor, of Dalhousie College, Halifax, N.S. According to the dissociation theory of electrolysis it is possible to calculate the conductivity of complex solutions of electrolytes provided we know the quantities of the electrolytes present in a given volume of the solution, their states of dissociation, and their specific molecular conductivities at infinite dilution. The cases of solutions containing various numbers of electrolytes with and without common ions are treated. As the author remarks: "The possibility of calculating the conductivity of complex solutions of electrolytes is probably of no practical value, but it affords a means of subjecting the dissociation theory of electrolytes to severe tests, the greater the complexity of the solution the greater being the severity of the test." The calculated values appear to agree fairly well with observed results so far as these have gone. The proof of the dissociation theory (as it is usually presented) is not, however, so complete as might be inferred. No one complains that the ionic theory does not explain the facts. The assumption is that it is the complete explanation, and that no other and more easily conceivable hypothesis is possible.

An Arc on the Engine.—The New York *Electrical Review* describes the electric lighting and signalling on the Cincinnati and Southern Railway. Track circuits are largely used, and the signals are automatic—*i.e.*, the train leaving the section lowers the signal without the intervention of the signalman. Level-crossing bells are used to warn persons crossing the line of the approach of a train. The Cincinnati and Southern has a bad crossing with another line at Nicholesville in Kentucky. This is electrically interlocked. In America, even when the lines are fenced, the tradition is of the old unfenced track, and the headlight is a much more highly developed affair than our little oil lamps. On the Cincinnati and Southern the locomotives of the fast passenger trains are equipped with electric headlights, which have been found to be extremely practical and advantageous in service, and which are well liked by the enginemen. "The general outside appearance of the electric headlights is very similar to the ordinary standard oil light Current is furnished by a combined engine and dynamo set of 4 h.p. capacity, located behind either the headlight or the steam-dome, or else under the running board of the locomotive. The arc light is of 2,000 c.p. The electric headlight is controlled from the cab of the locomotive; all that is necessary to start the light burning is to turn the steam-valve so as to start the engine."

In Praise of Electric Switchers.—In reference to the use of electric shunting locomotives in America, the most striking thing about the behaviour of the locomotive, says *Cassier's Magazine*, is the certainty with which it may be moved over short distances, varying from a few inches to a few feet. The obedience of the motors to the controller is practically instantaneous, thus doing away at one stroke with one of the chief drawbacks to steam switching engines, with which there is a noticeable delay between the time when the throttle-valve is opened and the pistons begin to move, in this way often causing the engineer, no matter how careful he may be, to overshoot his mark. From the fact that the movement of the electric locomotive can be graduated so nicely, a great deal of time can be saved. Again, the acceleration of the electric locomotive is so even that the freight cars of a comparatively long train are started, one after another, without jerking and without apparent strain. A weak draw-bar is thus protected against sudden fracture. The handiness with which an electric locomotive may be operated is another point made much of. As a matter of fact, of course, the electric locomotives have proved a success for the special shunting work for which they were

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designed in connection with the cars on the Brooklyn Bridge. But their general introduction into the railway goods yard will probably come only as a part of the larger problem of the electric working of heavy railways.

Dr. von Stephan.—It was only possible last week briefly to mention the death of Dr. von Stephan, which was the result of an illness of long standing. To the last, even after undergoing a severe operation, he continued to manifest his well-known energy in the transaction of public business in his sick-room. The precise social status of the parents of Heinrich Stephan, who was born on January 7, 1831, at Stolp, in Pomerania, is uncertain, but in a country where to be born "noble" meant so much, it did not prevent his merit being recognised. In 1856 he had become confidential secretary to the Post Office in Berlin. The great period in his career began with the North German Confederation of 1866, when the old Imperial system in the hands of the family of Thurn and Taxis was taken over by the Prussian Government. In 1870 he was appointed Postmaster-General on the nomination of Prince Bismarck, and organised the German Imperial post. In 1875, mainly after the action taken by Stephan, the universal Postal Union came into existence. In 1880 the Emperor William I. conferred upon him the rank and title of Secretary of State, and in 1885 his patent of nobility, and in 1895 he received the title of a Minister of State. His friendliness to this country and his constant desire for the improvement of international communication, whether postal or telegraphic, will be remembered if only from the letter of reply sent when he received only so short a time before his death the intimation of his election as honorary member of the Institution of Electrical Engineers.

The Institution of Naval Architects.—The annual meeting of the Naval Architects took place last week at the Society of Arts. Lord Hopetoun, the president, occupied the chair. A paper was read by Rear-Admiral FitzGerald on "Water-tube Boilers in Warships," which was followed by a long discussion on the relative merits of water tube and cylindrical boilers; and a paper by Mr. Durston really dealt with the same subject. There was a discussion which followed the usual lines that a discussion of the water-tube *v.* cylindrical boiler question usually does. On the following day the Hon. Charles Parsons had much to say about the success of the compound steam-turbine on board the "Turbinia." The history of the launch engine is not altogether unconnected with that of the direct-coupled dynamo, so that it is always well to have an eye on what is being done in these matters. Among the dozen or so "advantages claimed for the compound steam-turbine over ordinary engines" may be included: increased speed; increased economy of steam; increased safety; reduced weight and reduced space for machinery; reduced initial cost; reduced cost of attendance on machinery; diminished cost of upkeep of machinery; and largely reduced vibration. This seems so much, not to mention other "advantages" which are purely naval. But they did get 32½ knots out of the "Turbinia," which is something like a speed. Another paper was on "Acetylene and its Probable Future Afloat," by Prof. Vivian B. Lewes. Mr. Beardmore praised nickel steel; and some notice of a paper on the "Application of Electrical Transmission of Power in Marine Engineering and Shipbuilding," by Mr. F. von Kodolitsch, finds its place in another part of this journal. There was the usual dinner.

Waves.—Last Friday evening Lord Rayleigh, who has been lecturing on Saturdays on electrical vibrations, left electricity for air, and gave a discourse at the Royal Institution on "The Limits of Audition." Sir Frederick Bramwell was in the chair, and the audience included Sir Douglas Galton, Sir J. Crichton Browne, Sir H. T. Wood, Dr. Frankland, Mr. W. H. Preece, Prof. Dewar, Dr. J. H. Gladstone, and Prof. S. P. Thompson. As to what frequency gave a "note," Lord Rayleigh said the lower limit was 24 complete vibrations a second, while about 20,000 a second was the upper limit of audition, but this was ill-defined, depending largely on the individual ear. Old people did not hear high notes which were audible to young persons of 20 or 30, and he had reason to believe that babies heard notes which the latter could not detect. As to the movement necessary, a vibration having an amplitude of 0·8 millionths of a millimetre could affect the ear. (Considering that the lengths of sound waves lie between 1·5mm. and 15 metres, the extraordinary smallness of this is apparent at once.) Lord Rayleigh put it in another way, which is more striking—namely, that the sensitiveness of the ear was such that it could distinguish differences of pressure 100 times less than the residual pressure of the best vacuums, which was to be measured in millionths or less of an atmosphere. Of course it is obvious (after one is told) that it must be so or one could never have got the telephone invented. But the matter has another point of interest now that so much attention is given to various forms of electric and magnetic undulations, and that is, that the actual physical or mechanical changes, whatever they may be, which really underlie the process, may be absurdly out of proportion to the ordinates we draw in the wave curves by which we represent them.

The Institution.—There was something like what an audience should be at the Institution of Electrical Engineers for Mr. Baylor's paper on "Electric Traction Appliances" last week. Also there were apparatus and models. These did not, as on the record night of the railway signalling discussion, actually flow over on to extra additional side tables, but they occupied the area and climbed on to what tables there were, so that, except on the seats of the council and the sacrosanct front bench, there was not much space left unoccupied by somebody or something. At the beginning of the proceedings Sir Henry Mance referred briefly to the death of Dr. von Stephan, and announced that a letter of condolence would be sent. Mr. Baylor, recognising that his paper was long, shortened it by sections, but could not resist the temptation of occasionally amplifying it by sentences. In the end there was time for three speakers. Mr. Dawson agreed with the paper, and said the polyphase trams at Lugano upset the telephones. (Something of the sort might be expected.) Mr. Raworth displayed a disposition to pull feathers from the tail of the American eagle, which everyone knows is the most wide-awake bird in creation. Also he prophesied what Mr. Mordey was going to do when he had improved upon Mr. Sayers. Mr. E. W. Rice's was an excellent speech and a valuable contribution to the discussion. He demonstrated that the American eagle had its eyes open and was not left behind when it saw a good thing. Then he summarised the drift of things in tramway work on the other side, and was just getting to the technically interesting part of the best way of converting from high-tension alternating to 500-volt continuous when the bell rang. Not realising that this was a time-reminder rather than a speech limit, he promptly sat down in the middle of an unfinished sentence and was with difficulty persuaded by the President that by strictest Institution law he had a minute more as of right, and after that was at the mercy of the audience. In the result his description of the rotary converter and its advantages over the motor-generator was very much compressed. Then the adjournment, coffee and cakes. Were it not full Eastertide, a good discussion might be expected on the 22nd.

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Lamp Exhausting.—The exhaustion of incandescent electric lamps has up to the present been mainly done with mercury-pumps. From time to time mechanical vacuum pumps operated without mercury have been brought before the public; but now, the New York *Electrical Engineer* says, the Edison Lamp Works at Harrison, New Jersey, are using a small mechanical vacuum pump, whose rate of exhaustion is such that it can practically be employed to exhaust only one lamp at a time. "Experiments showed that lamps could be exhausted to a degree much nearer perfection than by any previous method employed." Lamps exhausted by the new process, "when compared with those exhausted on mercury-pumps, have proved to be superior to them in every respect, including length of life and ability to maintain their initial candle-power during their life." The final perfection of the vacuum, however, is not obtained by the pump alone. The last traces of residual gas are very hard to remove from the lamp, and are very injurious if not entirely removed. Their removal requires a long time with the mercury-pump generally used. "By the new method, usually called the chemical exhaustion, when a pump has taken out all but the residual gases, a gas capable of combining with these residual gases is introduced into the bulb. Previous to this introduction, the bulb, while the carbon is at a high degree of incandescence, is filled with a sort of blue glow; shortly after the introduction of the gases, and while the carbon is still at a high degree of incandescence, the blue glow suddenly disappears, indicating that a combination has taken place between the natural residual gases and the introduced gas. When this combination takes place the lamp is ready to be sealed off, and the vacuous space is found to be in a thoroughly insulating condition." Why make a mystery of the "introduced gas"? The idea is not a new one, and by no means unheard of here or in Germany. Whatever may be the precise process that is described above, it is rather a confession of weakness than a testimony of the efficiency of the particular pump employed. But a mechanical pump would lend itself to that sort of thing better than the slower mercury.

The Supersession of the Shaft.—In a paper on "The Equipment of Manufacturing Establishments with Electric Motors and Electric Power Distribution," read by Prof. Dugald C. Jackson before the Western Society of Engineers (America), it is contended that the theoretical treatment which the subject has heretofore received in papers before technical societies or articles in current periodicals has been inadequate. Prof. Jackson has therefore collected a summary of the views held in a number of manufacturing establishments where experience has been had with electrical transmission and distribution of power. The experience in all the establishments from which information was received shows that for plants using not less than 100 h.p. the electrical transmission is so much more satisfactory and economical that it is a misfortune for a new manufacturing plant, except under very exceptional conditions, to be constructed with any type of transmission except the electric. It is understood that the electric equipment should be such that crane motors can be operated from the generators and transmission wires which are laid down for the regular factory power distribution, and, for the best results, the generators should also be adapted to the purpose of factory lighting. "These conditions are fulfilled," says Prof. Jackson, "by either a 220-volt continuous-current system, using compound-wound generators, or by a polyphase alternating-current system. In the average manufacturing establishment the former seems to promise the best results, though more experience with the latter may prove it to give equally satisfactory results. The 220-volt continuous-current plant allows the use of 220-volt incandescent lamps connected directly between the positive and negative transmission wires, or arc lamps may be used in sets of four." As to shops already built and equipped with mechanical transmission, establishments which turn out heavy products, such as locomotive works, engine works, boiler works, machine-tool works, iron mills, etc., profit so much by electrical cranes that an electric plant is an invaluable accessory. It is then a natural step to do away with countershafts and belts running to the larger tools, which may then be equipped for driving by electric motors and placed in a more convenient position with reference to handling the product. This change always results in a large reduction of the cost of manufacturing, and if carried out with caution and judgment is invariably satisfactory. A somewhat similar condition exists in establishments which turn out a bulky product, such as agricultural works, carriage works, etc. In the discussion which followed, some question was raised as to what had been said above as to polyphase motors. It appeared that Prof. Jackson was able to get data from only one establishment, outside of the electrical manufacturing establishments, which was equipped with polyphase motors; and the statement from this establishment was that the fuel expense was greater now than it was formerly with mechanical transmission (shafts and belts). Mr. Coster said that this particular plant was an experimental one to test the reliability of electric power. It was worked in connection with the steam plant, and was not a complete one. From which it would appear that it is no use going to the States to learn polyphase.

Cathode Rays.—In a paper on "Some Experiments with Cathode Rays" by Mr. A. A. C. Swinton, communicated by Lord Kelvin to the Royal Society, the author remarks that hitherto the usual method of investigating the characteristics of a cathode ray discharge apart from its mechanical properties, and beyond what is visible to the unassisted eye, has been by allowing the rays to fall upon a screen of some brightly fluorescent material, such as glasses of various descriptions or screens covered with fluorescent salts. With all of these the maximum amount of fluorescence appears to be produced by such comparatively weak cathode rays that in some cases the special effects produced by the more powerful rays seem to be more or less entirely masked, while the well-known phenomenon of the fatigue of fluorescent substances when exposed to the more active rays conduces to the same result. Mr. Swinton therefore replaces the usual screen of fluorescent material by one of ordinary electric light carbon, and finds that much appears which was previously invisible. When a concentrated stream of powerful cathode rays are focussed upon a surface of carbon in this manner, a very brilliant and distinctly defined luminescent spot appears on the surface of the carbon at the point of impact of the rays, the remainder of the carbon remaining black. This luminescent spot seems to have a very close relation to the fluorescent spots on glass and on other fluorescent materials under similar influence. It is a purely surface effect, as when the cathode stream is rapidly deflected by means of a magnet, the luminescent spot on the carbon moves with no perceptible lag. Glass is known to become fatigued under the influence of cathode rays, so that after a time it refuses to fluoresce as brightly, and carbon is similarly fatigued, though only after having been very strongly acted upon. Carbon, like glass, also recovers its property of giving a surface luminescence, though not at all rapidly. As it is exceedingly difficult, if not impossible, to obtain carbon plates which do not contain hydrocarbons which

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are given off and reduce the vacuum very quickly when the carbon becomes at all heated, it is necessary to keep the tube connected to the mercury-pump, so that the vacuum can be restored after each experiment. Details of experiments follow. With a concave "focus" cathode the rays naturally form a cone. With a platinum or aluminium screen the effect is a uniformly heated spot, as it should be, but with carbon the effect is as though the cone was hollow, a white-hot ring being produced. Sometimes, however, there is a central spot. "From the experiments it appears that the diverging cone of cathode rays acts as though it were not of uniform density throughout its section, but, at any rate, in some instances as if it were completely hollow." Further experiments showed that the cathode rays crossed at the focus, and there was no rotation there. Carbon cathodes were tried for higher vacua, and ultimately a tube with two concave carbon cathodes, placed exactly opposite one another, and the anode at right angles in an annex. The two cathodes were connected together by a wire outside the tube. At a very high exhaustion, this tube gave very beautiful effects, and showed clearly the form of the cathode discharge at a degree of exhaustion when it is usually in itself quite invisible. Immediately on the current being turned on and the discharge passing, a straight and thin stream of bright golden-coloured particles of apparently incandescent carbon passed between small luminescent spots at the centres of each cathode. This did not last, as the vacuum fell rapidly. Mr. Swinton suggests that "the particles of carbon become heated to incandescence either by the action of the cathode rays upon them while they are flying through space, or by their friction in passing through the residual gas, and possibly by their mutual collisions." After the experiment has been repeated several times the glass of the tube becomes perceptibly blackened. A similar tube with cathodes of aluminium shows no stream of bright particles, and it is therefore inferred that the particles consist of carbon torn off the surfaces of the cathodes. The carbon cathodes give feeble Röntgen radiations, as, of course, does the glass of the tube also where the cathode rays strike it. No such radiations, however, appear to be produced, except where the cathode rays strike some solid surface. In conclusion, Mr. Swinton acknowledges the assistance of Mr. J. C. M. Stanton and Mr. H. Tyson Wolfe in the experiments and for valuable suggestions.

Electrical Vibrations.—On Saturday last Lord Rayleigh finished his course of lectures on "Electricity and Electrical Vibrations" at the Royal Institution. After showing an experiment to illustrate resonance, he remarked that the word belonged properly to acoustics, but its metaphorical use was now so established for electrical vibrations that some people seemed to think that it had its origin there. To get resonance it was necessary that the secondary should be "tuned" to the primary—*i.e.*, the natural period should be the same—as, otherwise, as the primary waves got out of step with the induced waves they proceeded to undo the effect they had produced, instead of continually augmenting it. From the degree to which it was advantageous to carry this "tuning" it was possible to judge, roughly, the number of oscillations there were large enough to be effective. Now, it was found in the discharge experiments that he had been and was showing that the tuning should be within about 5 per cent. (in acoustics this would be considered decidedly out of tune), and, therefore, there must be something like 10 or 20 vibrations. Lord Rayleigh then proceeded to discuss the rapid electrical vibrations which had been investigated by Hertz and Lodge. For the detection of these, different arrangements were required from those which sufficed in the case of the vibrations already spoken of. Observation of small sparks across an almost microscopic spark-gap was the method employed by Hertz himself, who found that when an all but complete metal hoop was within the influence of strong electrical disturbance, minute sparks occurred at the gap. The essential point which he was able to prove experimentally was the wave-propagation of such disturbance, and on the Continent his experiments did much to bring about the acceptance of Maxwell's electromagnetic theory of light. In this country, of course, they had little or no doubt of it before, but the experimental work of Hertz caused the attention of the Continental men of science to be drawn to what they had before not properly appreciated. To detect rapid vibrations, Rutherford surrounded a small piece of steel, magnetised to saturation, with a helix of wire, the ends of which were connected to long copper rods. The electric waves impinging on these set up an alternating current in the helix, which produced partial demagnetisation of the steel, which would be indicated by a magnetometer. (The complete theory is complex, but it is obvious that, if the steel is already saturated, if any effect is produced it must be one of demagnetisation.) By this device electric waves had been detected at a distance of a mile from their source. Lord Rayleigh, though not without some difficulty, showed it across the lecture theatre. Prof. Lodge's coherer, consisting of a tube full of metal filings, was another method of making apparent these vibrations, dependent on their power of improving the electrical contact between the filings, and thus decreasing the electrical resistance of the tube as a whole. What exactly happened in the coherer was not clear, but he thought there was some analogy with what occurred at the meeting of two jets of water or fountain drops, which normally rebounded from each other, but under electric influence united. The explanation was by no means certain. After referring to Mr. Appleyard's interesting experiments with coherers—which he had only read of, and had not yet seen—Lord Rayleigh said a liquid coherer could be made with a globule of greasy mercury. If this were divided into two globules lying against each other, these would coalesce if a weak current were passed through them or if a spark were produced in their vicinity. There were at present difficulties which required clearing up in the way of all the explanations which had been offered of the action. They had seen Mr. Bose's instrument, and Mr. Preece had promised a discourse on Mr. Marconi's after Easter, so he might be excused from referring further to that. In conclusion, the lecturer said that, while the waves with which Hertz experimented were several metres long, the smallest electric waves yet produced had a length of about six millimetres. The next shortest waves known were the dark heat rays of the lower end of the spectrum, but these were still an enormous way (about seven octaves) from the six-millimetre electric waves. To bridge over the gap would probably be the work of the next generation of physical investigators. On the other side of the visible spectrum, Schumann, using specially-prepared photographic plates which contained no gelatine—since gelatine was opaque to them—had carried on the investigation of very small waves until he met with the difficulty that as they got smaller the air became opaque to them. That was as far as they had measured. The Röntgen radiations remained, and there was little doubt that these were still smaller. No one had actually yet measured them, but he supposed everybody was now almost certain (everybody clearly includes Sir George Stokes) that they were really only very minute waves of the same character as the rest.

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THE MECHANICAL CONSTRUCTION OF ELECTRICAL MACHINERY.

BY F. M. WEYMOUTH.

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THE DYNAMO.

(Continued from page 423.)

Rails (continued).—Slide rails may, generally speaking, be divided into two classes—those having fixed pedestals for the pinching screws, and those with shifting pedestals. The example illustrated (Figs. 130 to 133) belonged to the former class. We now show two examples appertaining to the latter class. Of these the first is represented (Figs. 134 to 137). This is a simple form. It will be observed that the pedestal, or bracket, *a*, is held down to the rail by the square-necked bolt, *b*; and by slacking the nut of the latter the bracket may be shifted forward or backward to a new position.

An advantage of this system, thus, as compared with the other, is that it is not necessary to have such long pinching screws, inasmuch as the bracket itself can be moved on: and, again, the awkwardness is obviated that attends the use of the long screws that are demanded by the fixed

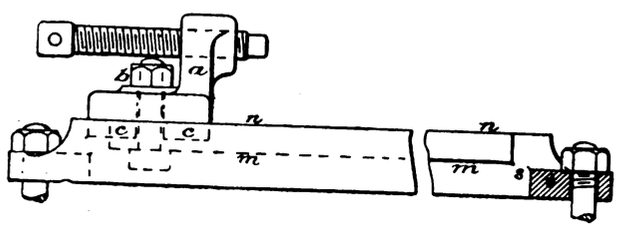

FIG. 134.

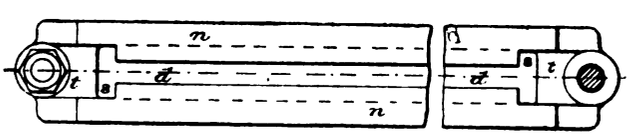

FIG. 135.

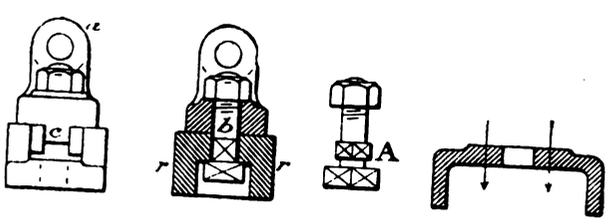

FIG. 136. FIG. 137. FIG. 138.

pedestals. For these long screws, when the belt is short, and the dynamo is close up to the pedestal end of the rails, project over the end of the rails not infrequently just about the level of a man's ankles; and so, especially in cases where there is not much floor space, they are apt to be very inconvenient. This difficulty is therefore surmounted by the use of the shifting brackets and short screws, which form a more compact and less straggling arrangement.

Reverting to Figs. 134 to 137, we may note that the top of the rail, as at *n n*, is faced: and this facing is the full width of the rail. As the dynamo itself will rest on this same facing, it is thus assured that the weight of the dynamo will come well over the tops of the side walls, *r r*, of the rails. This may be compared with the undesirable section of rail shown (Fig. 138), where the facing is narrow; and the weight of the dynamo, not coming directly over the side walls, but acting as indicated by the arrows, tends to tip the walls inwards; and has the effect, in fact, of putting the sides of the rails into torsion between their ends.

It is optional to face the under surfaces, *m m*, where the bolt-head impinges. From a strictly mechanical point of view this should be done; and the side of the bolt-head that bears on the faced surface, *m m*, should be machined true also. This thus insures that the bolt-head will bear equally on both sides of the slot, *d d*; and the bolt itself is exactly in line with the tension to which it is subjected. On the other hand, to machine the surfaces, *m m*, is an expense; and sufficient length must then be given the rail to allow of the clearances at *s s*, between *m* and *t*, to be great enough to enable the machining of *m m* to be accomplished, especially if done by planing. Again, as the square neck of the bolt is in practice usually continued up to the head, as shown at *b* (Fig. 137), the under, or bearing side, of the bolt-head cannot be turned—unless, indeed, a portion of the square neck be also turned off, as represented at A (Fig. 137), where the bolt is shown slightly rotated so as to make this cut under the head more conspicuous. It thus becomes, on the whole, cheaper and simpler to use "black" bolts, and not to machine *m m*; and a little extra size allowed to the bolts will make them sufficiently strong to do their work, notwithstanding that the load on them may come more on one side than the other. The machining of *n n*, and on the bottom of the bracket, *a*, and also on the bottom of the rail itself, is, of course, necessary in any case. The inner sides of the slot, *d d*, must also be planed. Likewise, the sides of the projections, *c c*, shown dotted in

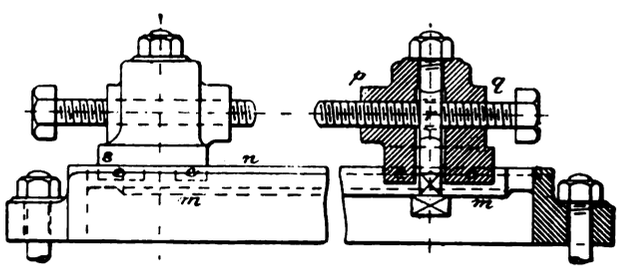

FIG. 139.

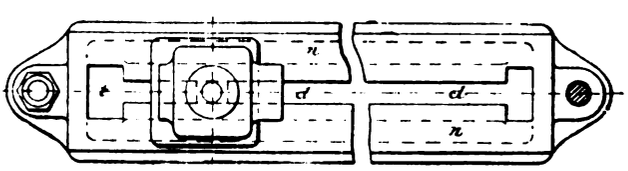

FIG. 140.

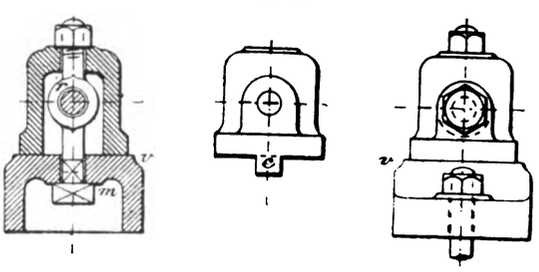

FIG. 141. FIG. 142. FIG. 143.

Fig. 134, though in full lines in Fig. 136, which are added to maintain *a* in proper alignment, should be machined and made an easy sliding fit in the slot. This general type of movable bracket has been used with the Lahmeyer dynamo, and is also adopted by Messrs. F. H. Royce and Co., Manchester.

Figs. 139 to 143 herewith show another design for attaining the same ends as the last. The chief difference is in the method of holding down the movable pedestal. In Fig. 139 the pedestal is shown in elevation, and also in sectional elevation. Fig. 142 is an outside end view of this casting alone, and Fig. 141 is a transverse section. It will thus be observed that the pedestal is here an inverted cast-iron box; also that the centre lines of the pinching screw and the holding-down bolt are in the same vertical plane, and so cut each other. To render this feasible in practice, the holding-down bolt has an eye, *r*, forged in it through which the pinching screw can pass. As in the last case, the moving pedestal here also has projections, *c*, cast below it, planed to an easy fit in the slot, *d d*. This general design is apparently used by Mr. E. S. Hindley, of Bourton; and an example may also be found with an Elwell Parker dynamo, on plate VI. of Prof. S. P. Thompson's "Dynamo-Electric Machinery" (fourth edition).

A point to be noted in this arrangement relates to the

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question of putting all these parts together. For with the eye in its middle, the holding-down bolt may not be able to be passed up through the slot, *d d*. It is therefore necessary to cast a gap as at *t* (Fig. 140), either at one or both ends of the slot, *d d*, so that the bolt-head may be passed through it from above. Although two pedestals are shown in elevation in Fig. 139, it is not usual in practice to place these on both sides of the dynamo. An advantage, however, that incidentally attends the use of movable pedestals is that, when a belt is going to be shortened, and it is required to shift the dynamo back toward the engine, the pedestal can be removed to the far side of the dynamo away from the engine, and so the pinching screw can be used for this purpose. Thus gaps *t t* at the ends, required in any case for machining the slots, become doubly essential. Sufficient clear length of rail must, of course, be left on the far side to take the pedestal; but this is obviously a neater method of shifting back the dynamo than pinching it along with a crowbar. It will be noted, further, in Fig. 139, that whereas the forward boss, *p*, is carried well out so as to lengthen the screwed bearing, the tail end of the flange at *s* is taken well back. This latter thus increases the stability of the pedestal in respect of the pressure on the end of the pinching screw, tending to throw it over backwards on the lower corner at *s* as an axis or fulcrum.

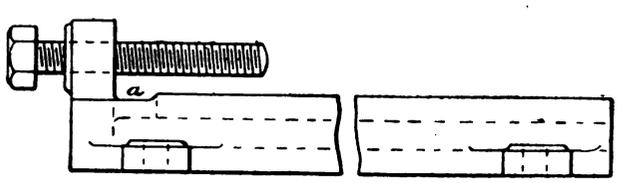

Fig. 144.

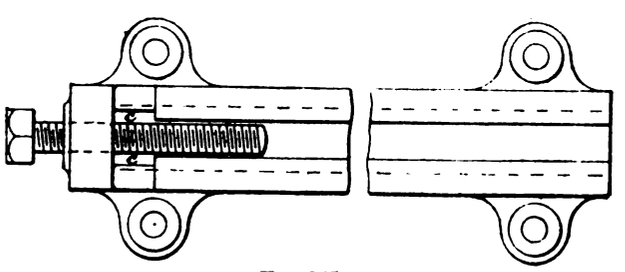

Fig. 145.

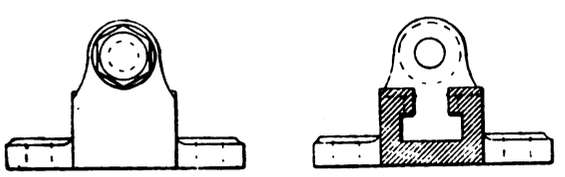

Fig. 146.

Fig. 147.

In this particular example, underneath machining strips are added as shown at *m m*; though, for reasons above stated, they may better be dispensed with. An advantage attending the design (Figs. 134 and 135) was that in machining the slot, *d d*, the planing tool could pass clear at the ends, over the portions, *t t*, uniting the sides. To this a further attendant advantage is that when many rails require machining, a number can be put on a large planing machine, not only side by side, but also end on. Thus the tool, when cutting the slot, as well as when doing the facing, *n n*, can pass through one rail after another. Hence, by being able to machine a quantity at a time, expense is saved. In Fig. 139, however, the ends are closed as shown, which is of course the best disposition of the metal as regards the strength of the casting and weight of metal used. But the tool cannot pass through when planing the slots.

It will be noted that the upper facings, *n n*, do not here take the whole width of the rail; so that, for the sake of a more finished appearance, an ogee, as at *v*, can be put on. Yet the edge of the facing is not so far back as to prevent the weight of the dynamo from coming directly over the side walls.

A final benefit derived from the use of these movable pedestals, especially with square threaded pinching screws, is the much greater ease with which the screwing of the pedestals can be accomplished than when these are cast solid on the rails. For the small separate bracket can be chucked in a screw-cutting lathe, and is generally less awkward to deal with than a whole rail. It will be noted that the design of pedestal in Fig. 139, as compared with that shown in Fig. 134, more readily lends itself to a good length of screwed bearing for the pinching screw, as from *p* to *q*, which is thus much better for wear.

Figs. 144 to 147 are typical of another variety of slide rails with fixed pedestals, which appear to be used by the Brush Electrical Engineering Company, and also by Messrs. J. P. Hall and Co., Oldham. As will be seen clearly in the section (Fig. 147) the chief peculiarity here is that the bottom is closed; and consequently the slot must be cored out in the operation of casting. Another point, however, is that instead of the rail being held down to the foundation by a bolt at each end, as in the foregoing cases, we here have four holding-down bolts, arranged two each side, though also near the ends. The top facing takes the

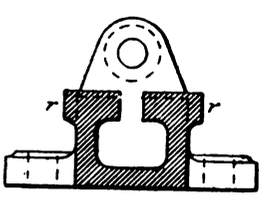

Fig. 148.

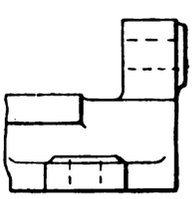

Fig. 149.

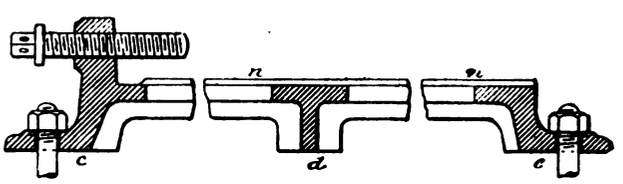

Fig. 150.

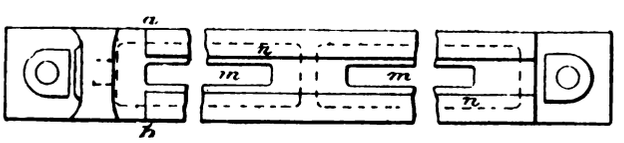

Fig. 151.

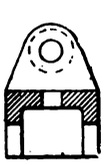

Fig. 152.—Section at *a b*.

Fig. 153.

whole width; and to enable this to be planed lengthways a dip in the casting is arranged, as shown at *a*; and similarly, for planing the slots, these are recessed back as shown at *c c*, in which respects this design resembles that depicted in Figs. 130 and 131. It will be noted how the pinching screwhead projects at the end; and, especially if screwed out to its full extent, how obviously inconvenient this is apt to be to anyone moving about near the machine.

Figs. 148 and 149 indicate a further variation wherein the top facing is made to project at the sides, as shown at *r r*. The weight of the dynamo is thus brought well over the side walls of the casting.

In Figs. 150 to 153 is represented a design that is distinguished by its resting on the foundations only at the two ends and the middle, as at *c*, *d*, and *e*; and there is no provision for planing the sides of the slots, *m m*. These latter are thus presumably cored out to the finished size, and made clean as much as may be necessary to receive the square necks of the dynamo holding-down bolts by a little chipping and filing. Facing strips, *n n*, are added, which, as well as the feet *c*, *d*, and *e*, may be planed in the usual manner. The pinching screw has a small hexagonal head to work with a spanner, but has also tommy holes put through as shown (Figs. 150 and 153). This type of rail offers some approximation to a design by the India Rubber,

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Gutta Percha, and Telegraph Works Company, Limited, Silvertown.

(To be continued.)

THE LOCAL DISTRIBUTION OF ELECTRIC POWER IN WORKSHOPS, ETC.

BY ERNEST KILBURN SCOTT.

PART I.

(Continued from page 362.)

In carrying out an installation it is well to bear in mind that the workmen may be prejudiced against changes, and therefore they may not behave fairly by the new machinery, unless the arrangements for starting, stopping, etc., are simplified as much as possible. This can be partly attained by enclosing the working parts of switches, etc., and also by making all the details, especially the handles, amply strong.

With regard to the question of *resistances*, their form and size will depend on the work for which they are intended. Only where exact regulation of speed is required or, in case of series-wound motors and transformers, etc., is it necessary to have the resistance wire large enough to carry all the current for long periods of time. Resistance coils which are only connected up to regulate the shunt winding of a motor have only to carry a very small current; but when they are employed as a starting resistance as well, as is often arranged, then they may have to carry the full current for short intervals of time. In this latter case the wire must be larger, care being also taken to have the starting switch so designed that it cannot be left in an intermediate position. In other words, when not held in the hand, it must either be "fully on" or "fully off." In these cases the wire is usually of such diameter as to carry the full current without overheating for, say, 10 minutes.

In order to get the same fall of potential between each pair of points of a regulating switch, the resistances must be arranged in gradually increasing increments; and the sizes of wire used in any one resistance frame may therefore vary considerably. At one end there will be platinoid or manganin wire of small gauge, say, No. 18 B.W.G.; at the other, galvanised-iron wire up to $\frac{3}{16}$in. in diameter. Owing to its liability to sag when hot, the supports of the fine wire coils should not be more than 6in. or 8in. apart, the distance increasing as the wire gets larger to 24in. for the $\frac{3}{16}$in. wire. The iron wire must be very well galvanised or the zinc will flake off whilst the wire is being bent into a spiral. In many cases it is advisable to galvanise the larger-diameter wire spirals after they are coiled. Messrs. Siemens make their regulating resistances of wire coils placed in iron tubes and filled up with fine sand. This makes a very solid job, and it is found that the sand is a sufficiently good insulator of electricity, and at the same time conductor of heat to give ample radiating surface.

Water rheostats form a very cheap form of resistance so far as first cost is concerned, but it should be remembered that the contacts get eaten away and require renewing; that gases are given off, and also that the water-and-salt solution requires renewal at more or less frequent intervals. A film of oil on the liquid will help to prevent evaporation. The advantages are that there is no sparking at contacts, and very exact regulations in resistance can be made. The non-sparking makes them especially useful in explosive factories, flour mills, etc.

The fundamental basis of comparison, when comparing *two different systems* or processes, is, of course, that of costs (first cost and cost of maintenance); there are, however, other considerations which enter into this question of electrical power, such as convenience and adaptability, etc., which cannot very well be expressed as a money value. Considerations like these are bound to have great weight, irrespective of running and first cost, and in very many cases they rise to such prominence that they of themselves warrant a complete change from the old system to the newer one. With regard to the costs, very few are available, but such as there are have conclusively shown that when electricity has had a fair trial, there has been a considerable saving and an increase in production. This latter feature is of greater importance than the saving in running cost, because, after all, the cost for power in a factory only forms a small percentage of the total establishment charge. If increased output can be secured by greater convenience and promptness in starting and stopping, as well as by regulating the speed, etc., this in itself is well worth consideration. With self-contained tools a workman can take complete control of the operations of the motors without hindering his own work, and when conditions are favourable he may by temporarily increasing the speed save considerable time in completing any piece of work he is engaged upon.

With regard to the question of *efficiency* at low loads, Table No. VIII., compiled by M. Felix Mélotte, is interesting, as it gives a comparison between the efficiencies (obtained on a varying load) of electrical and mechanical transmission of power. An inspection of the figures will show that the two systems of transmission, which at first appear to be equivalent, become very different as the load diminishes. Thus, when only one-fifth of the power is developed, electrical transmission still yields 47·2 per cent., whilst mechanical transmission has had all its power absorbed in the constant frictional loss of 206 h.p. This is a calculated table, but there is no reason to doubt that the figures are being very generally borne out in practice.

TABLE VIII.

	Horse-Powers.					
Electrical Transmission:						
Load on the engine	1,000	750	500	333	250	200
Constant frictional loss	50	50	50	50	50	50
Variable electrical loss	50	27	11	4·5	2·2	1·2
Total loss in dynamo	100	77	61	54·5	52·2	51·2
Available power of dynamo	900	673	429	278·5	197·8	148·8
Efficiency, per cent.	90	89·7	87·8	83·5	79·1	74·4
Loss in conductors	18	10	4	1·7	0·8	0·5
Energy available at motor terminals	882	663	435	276·8	197	148·3
Of which 6 per cent. frictional loss	53	53	53	53	53	53
4 per cent. variable	35	20	8 5	3·4	1·7	1
Total loss in motor	88	73	61·5	56·4	54·7	54
Power available	794	590	373·5	220·4	142·3	94·5
Final efficiency, per cent.	79·4	78·7	74·7	66·2	57	47·2
Mechanical Transmission:						
Load on engine	1,000	750	500	333	250	200
Loss in shafting, etc.	206	206	206	206	206	206
Useful effect	794	544	294	127	44	0
Final efficiency, per cent.	79·4	72·5	58·8	38·1	17 6	0

This would be a convenient place to refer to the most important tests which Messrs. Siemens carried out at their extensive works in 1894. At the electric central station which they have put down there are five boilers working at a pressure of 130lb. per square inch, and supplying steam to four compound condensing high-speed engines. Three of these are of the Willans single-acting type, the fourth being a Belliss double-acting engine, and each is coupled to a two-pole dynamo capable of giving 1,500 amperes at 120 volts The total length of cable between the engine-room, switch-board, and the various departments is over 18,000ft., distributing boards with switches and fuses being placed at convenient intervals. Further details of the way the tests were carried out, etc., will be found in the *Proceedings* of the North of England Institute of Mining and Mechanical Engineers for December, 1894; but the following Table No. IX. gives a summary of the results obtained. It will be seen that the power delivered at the main switchboard cost ·59d. per Board of Trade unit for the Willans engines and ·64 for the Belliss engine; but Mr. Alexander Siemens has since stated that better results have been obtained from this latter engine. As the average loss in the cables is not more than 3 per cent., and the average efficiency of the motors 89 per cent., the net cost per brake horse-power on the motor comes out a little over (·52d.) ½d. per hour, and this was with a load-factor during the six months whilst the tests were in progress of 28·5 per cent. Messrs. Siemens have also stated that the first cost of the electrical plant per brake horse-power was 30 per cent. lower than the steam-engine plants, etc., which it has replaced. As will be seen from the items of cost in the table everything has been included, and the half-penny per brake horse-power hour is a thoroughly reliable figure. Although the most efficient plant was employed there is nothing exceptional about it, and machinery might be

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purchased any day from at least half a dozen firms which would show equal, if not better, results.

TABLE IX.—Tests for Six Months ending October 31, 1894, of Electric Power Installation at Messrs. Siemens's Works. Engines of 300 i.h.p coupled to $^{24}/_{36}$ dynamos, giving 120 volts 1,500 amperes at 350 revolutions per minute.

Item of cost.	Per Board of Trade unit.	
	Willans engine.	Belliss engine.
	Pence.	Pence.
Coal (including cost of delivery and removal of ash), 17s. 5d. per ton: Willans 3·4lb., Belliss 3·95lb. per Board of Trade unit	0·3180	0·3680
Water (7½d. per 1,000 gallons)	0·0228	0·0264
Stores: oil, waste, boiler fluid, etc. (taken from last six months' consumption)	0·0416	0·0416
Wages: stokers, trimmers, drivers, labourers, electrical assistant (half time) and switchboard boy	0 0977	0 0977
Steam for auxiliary pumps, feed (only 0·7 taken), air, and circulating, water 0·003d., coal 0·026d.	0·0290	0·0290
Repair to central-station plant and motors	0·0802	0 0802.
Total cost per Board of Trade unit	0·5893	0·6429
Total cost per electric horse-power per hour	0·440	0·480

(To be continued.)

ON THE CONSTRUCTION AND CALCULATION OF RHEOSTATS.*

BY P. M. HELDT.

The resistance material of rheostats for the regulation of current or potential in electrical circuits may be metallic wire, carbon or graphite, or acidulated water. In the present article rheostats in which the first-named material is employed will only be considered.

The different conductor materials used in the construction of commercial rheostats are iron, German silver, and copper. Each of these materials has advantages in particular cases. The advantages of iron are cheapness and the ability to withstand high temperatures. German silver has a high resistivity or specific resistance and a low temperature coefficient. Copper is only used where large currents have to be carried, as, for instance, in electroplating work, where one dynamo supplies several tanks requiring different voltages, and regulation is effected by inserting resistance into the circuits requiring the lower pressure. In this case, copper, by virtue of its higher conductivity, makes it possible to use smaller conductors, thus facilitating the construction of the rheostat.

The following table gives the carrying capacity of tinned iron wire under different conditions. The last column gives the length of wire having a resistance of one ohm:

Size of wire, B & S.	Safe current in wood frame.	Safe current in iron frame	Safe current for one minute.	Feet per ohm.
8	17·4	20·3	43 6	250
9	14 6	17·1	36 6	173
10	12·3	14·3	30 8	137
11	10·3	12·0	25·8	108
12	8·7	10·1	21 7	86·4
13	7·3	8·5	18·3	68·5
14	6·1	7·1	15 3	54·3
15	5·1	6·0	12·9	43·1
16	4·3	5·0	10·8	34·1
17	3·6	4·2	9 1	27·1
18	3·00	3·5	7·6	24·3
19	2·52	2·9	6·3	16·5
20	2·17	2·5	5·4	13·5
21	1·82	2·1	4·5	10·7
22	1·53	1·77	3 8	8·49
23	1·28	1·49	3·2	6·73
24	1·08	1·20	2 3	5·34

In designing motor-starting rheostats, the values given under the heading "Safe current for one minute" should be used, while the carrying capacities given in the other two columns apply to dynamo field rheostats, motor regulators, and such other rheostats as have to carry current continuously. No definite resistivity and carrying capacity can be assigned to German silver, as it is an alloy, and different makers use different proportions of the elements. In the tables given by Matthiesen the resistivity of German silver is given as 2·2 times that of iron. For the same rise of temperature a German-silver wire would, therefore, carry about two-thirds the current of an iron wire of the same size. Most commercial German silver has, however, a specific resistance higher than that indicated by the above ratio.

The wires of rheostats are mounted in a number of different ways. They may be embedded in enamel or some other refractory insulating material; they may be wound on a plate of slate; they may be wound on a framework of iron rods insulated with asbestos, or on insulated metallic spools with layers of asbestos between the layers of wire. Finally, the wire may be wound into coils which are stretched between insulators on an iron frame or in a frame of insulating material. When the wires are embedded in enamel, they are placed on the surface of and in close proximity to a cast-iron base-plate which assists in radiating the heat. Slate is also quite a good conductor of heat, and plates of slate are often used for smaller rheostats. Spool-wound coils of wire sometimes present an advantage where the rheostat is only used for a short period at a time; as, for instance, in motor-starting rheostats, as this method of winding permits of getting a large amount of wire into a small space, and the capacity of the rheostat under such conditions depends more on its capacity for taking up heat than on the radiation. When spiral coils are employed, they are generally placed in a case with openings to facilitate the circulation of air.

The diameter to which spiral coils of wire are wound varies with the size of the wire. If for a given size of wire the diameter is taken too large, the coils must be stretched considerably to obtain the necessary stiffness. No. 24 (B. & S.) iron wire may be wound into coils of ½in. diameter, while No. 16 may be wound into coils of from ¾in. to ⅝in. diameter, and other sizes proportionally. The wires are wound close on a mandril in a lathe, and are stretched as they are put in position. For the larger sizes of wire a stretching of 20 per cent. is sufficient, while coils of No. 24 of 6in. or more in length must be stretched to about double their length. Some manufacturers place asbestos tubes inside coils of smaller wire, which, as they stiffen the coils, permit coils of larger diameter and reduce the stretching required.

Dynamo Field Rheostats.—Shunt and compound wound generators are generally regulated by means of a rheostat in the shunt field circuit. In Fig. 1 is shown a dynamo field rheostat, which is of fireproof construction. The form shown is adaptable to any size of dynamos.

In the factory it is generally easy to experimentally determine the resistance required to cut down the voltage of a machine to the desired lower limit. Cases may, however, arise where this is not handy, and the resistance can then be calculated, provided the excitation-voltage curve of the dynamo and the resistance of its field are known. The calculation may be illustrated by a practical example. The main curve in Fig. 2 is the excitation-voltage curve of a 1·5-kw. 55-volt generator.

The machine is run at such a speed that, without any load and without any extra resistance in the field circuit, it generates 65 volts. A rheostat is required which will cut down the voltage to 40. The field resistance is 36·4 ohms.

From the curve we see that at 65 volts the exciting ampere-turns are 6,200, while at 40 volts they are only 2,300. The ampere-turns are proportional to the voltage applied to the shunt. When 65 volts are being generated the voltage at the terminals of the shunt is 65. At 40 volts it must, therefore, be $65 \times \frac{23}{61} = 24{\cdot}15$. The rest of the E.M.F. ($40 - 24{\cdot}15 = 15{\cdot}85$ volts) must be compensated for by the drop in the rheostat. As the same current goes through field coil and rheostat, their resistance must be to each other as the drop of potential in them. Thus we get for the resistance of the rheostat $36{\cdot}4 \times \frac{15{\cdot}85}{24{\cdot}15} = 24$ ohms.

* From the *American Electrician*.

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The largest current that any part of the rheostat ever has to carry is a little less than $\frac{65}{36{\cdot}4} = 1{\cdot}78$ amperes, and the smallest current $\frac{40}{36{\cdot}4 + 24} = {\cdot}65$ ampere. After finding a few intermediate points in the same manner as we found the smallest current, we can draw a curve showing the field current for the different voltages. This curve is also shown in Fig. 2. For small rheostats, like the one under consideration, but one size of wire is generally used. In the present case an iron wire No. 22, or a German-silver wire No. 20, would have the required current-carrying capacity. The

FIG. 1.—Dynamo Field Rheostat.

total length of wire required would be for iron 204ft., for German silver of the resistivity given above, 148ft. In all large rheostats, however, the size of wire decreases from the "out" terminal to the "in" terminal. The calculation of the different portions may be illustrated by the present example. Supposing that 25 steps of about one volt each are desired. From the field-current curve and the table of

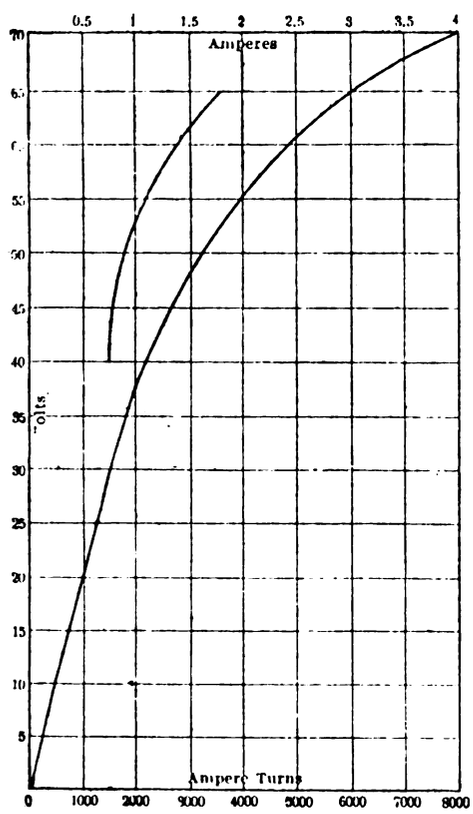

FIG. 2.—Excitation Curve of 1·5 kw. 55 volt Dynamo.

iron wire we see that the largest wire that would be used is No. 22. Of this we must make the first three sections of the rheostat. When the fourth section is inserted the field current is reduced so much that No. 23 will carry it. The resistance of these three sections is to be calculated in the same manner as the total resistance of the rheostat was calculated above. We then calculate the sections requiring No. 23, No. 24, etc., successively.

In some lines of work it is desirable to be able to change the E.M.F. of a generator very gradually—that is, by very small steps. This requires a large number of contact points, and as a rheostat with a large number of contacts as generally made (Fig. 1) is quite expensive to manufacture, several types have lately been brought out in which an attempt is made to simplify the construction. One of

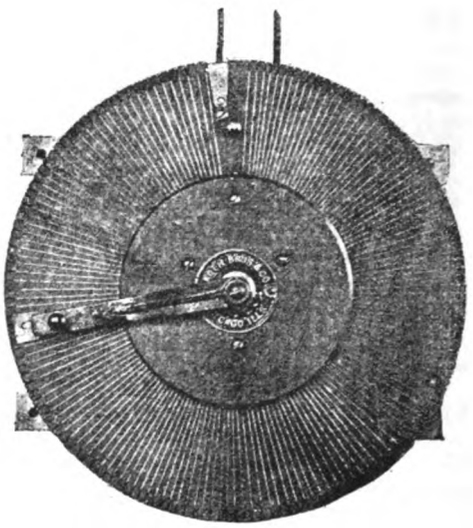

FIG. 3.—Multiple-Contact Rheostat.

these is illustrated in Fig. 3. It consists of a plate of slate in the form of a concentric ring, the inside and outside edges of which are grooved to receive the resistance wire. The wire is wound on the plate in a continuous winding nearly all around the ring, as seen in the illustration. The plate carrying the wire is clamped between two other plates of slate. The front plate carries the contact lever, while to the back plate are fastened two strips of brass, by means of which the rheostat is fastened to the switchboard. The sliding contact piece bears directly on the wire. The rheostat illustrated has 180 steps.

Fig. 4 shows diagrammatically a rheostat in which the number of steps is equal to twice the number of contacts less one. It consists of an ordinary rheostat with a slightly different contact arrangement. The contact lever carries,

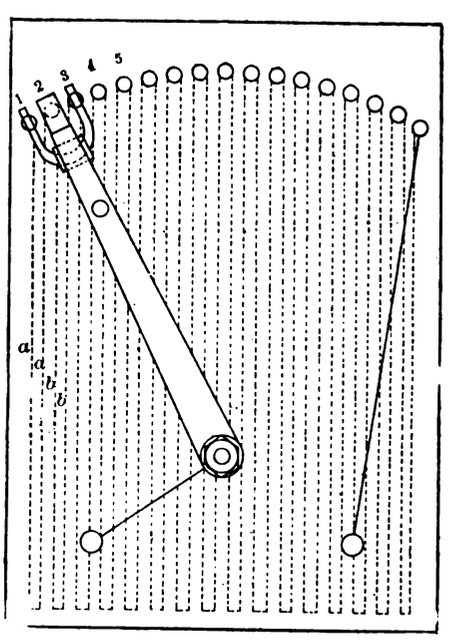

FIG. 4.—Multiple-Contact Rheostat.

in addition to the regular contact piece, another double contact piece, which is, however, insulated from it. The main contact piece is wider than the distance between two neighbouring contact points, while the two prongs of the double contact piece are narrower than this distance. Suppose that the current enters through the contact lever. It will then pass from Contact 2 to Contact 3 through the sections a_1 a and b_1 b, in parallel, and from 3 through the

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rest of the sections in series. The resistance of two sections in parallel is, of course, equal to one-half the resistance of a single section. When the lever is turned to the right the main contact piece comes in contact with 3, and the prongs of the extra contact piece are between Contacts 1 and 2 and 2 and 3 respectively. The parallel resistance is then cut out. This type was suggested by Vedovelli.

Motor-Starting Rheostats.—When a shunt motor is started up, a resistance must be placed in its armature circuit to prevent an abnormal rush of current. This resistance is cut out stepwise as the motor gains speed. Motor starters have generally but one size of wire all through of sufficient cross-section to carry the full-load current for one minute (see table). The resistance of the rheostat should be such that when it is connected across the mains a current equal to the full-load current of the motor will pass. From this condition the resistances of starting rheostats for motors of different outputs and voltages, compiled in the following table, have been calculated (10 per cent. is allowed for armature and friction loss in the motor).

RESISTANCE IN OHMS OF MOTOR-STARTING RHEOSTATS.

H P. ...	1	3	5	7	10	15	20	30	40	50
110 v. ..	15	5	3	2 1	1·5	1	·75	·5	·37	·3
220.....	60	20	12	8·4	6	4	3	2	1·5	1·2
500.....	300	100	60	42	30	20	15	10	7 5	6

Motor-starting rheostats are nearly always automatic—that is, they have an electromagnetic attachment, by means of which the armature is automatically cut out of circuit whenever the main current fails for any reason. This protects the motor from injury when the current in the mains is established again.

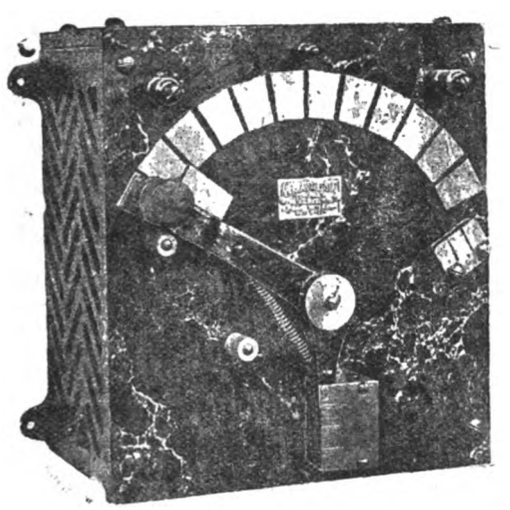

FIG. 5.—Automatic Starting Switch.

The rheostat of Fig. 5 has two levers turning on the same stud and connected by a spring, as seen in the illustration. One of these levers is the contact lever, while the other one serves as armature to an electromagnet, and also as a switch arm. In the illustration the contact lever is on the "off" button. In order to start the motor, the contact lever is slowly turned to the right. When the current fails the contact lever remains in position, but the magnet lets go its armature, and the circuit is opened at the switch on the magnet. When the motor is to be started again, the contact lever is first turned to the left. This closes the lower switch, and the magnet takes hold of its armature. Then the contact lever is turned to the right, and the motor starts.

Motor-Regulating Rheostats.—The speed of motors may be regulated by means of a rheostat in the armature circuit. For the special case of a constant torque on the motor the speed is proportional to the counter E.M.F., and the current remains constant, both for shunt and series motors. The resistance necessary to reduce the speed to a certain fraction of its original value may be found by the following rule:

Multiply the E.M.F. of the mains minus the drop in armature (and field in case of series motors) by the difference of unity and the given fraction, and divide the product by the current. The quotient obtained is equal to the required resistance in ohms.

Motor-regulating rheostats are now made, in which the contact lever is automatically held in any position and automatically released in case of overload or when the main current is interrupted. Fig. 6 shows a front view of such a rheostat. Two levers are rotatable on a stud fastened to the base plate. One of these, the contact lever, A, has an elbow-shaped side projection, L, with a number of notches on its outer edge corresponding to the contact points. The other lever, B B, is of iron, and is two-armed. The lower arm serves as armature to the electromagnet, M. The other arm has pivoted to it at its extremity a third lever, C, provided with a catch, *c*.

The two arms of lever C are of unequal moment, and one of the arms rests continuously against a stud, *s*, fastened to the base plate. A helical spring (not seen in diagram), coiled around the hub of lever A holds the lever against the stop, S, when the rheostat is not in use. When the lever A is turned to the right, lever B also turns on account of the friction between the two levers, and is thus brought near the poles of the magnet, M. The catch, *c*, engages into the notch corresponding to the contact point, on which the contact lever is left. The catch is locked by the electromagnet through the armature, B. The magnet, M, is wound differentially, one winding being in the field and one in the armature circuit of the motor. The turns of the windings are so proportioned that under ordinary conditions the effect of the field current predominates. When the current in the armature circuit rises above a certain value, the magnet is so much weakened that it cannot resist the action of the spring on the hub of lever A. It leaves go its armature, B, the catch, *c*, disengages, and lever A returns to the "off" button. The same happens if the main or the field circuit should be opened. This construction is due to Mr. Charles Roth.

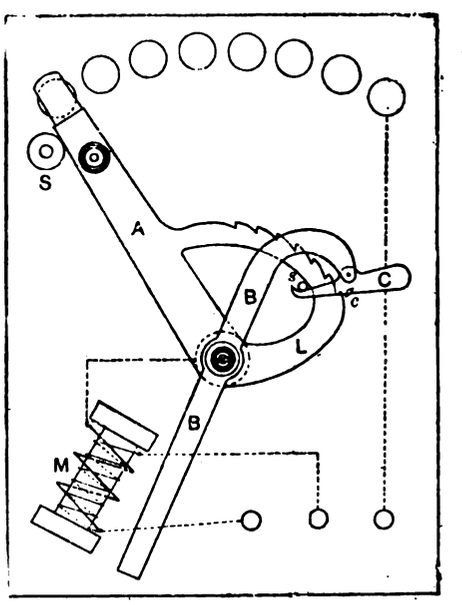

FIG. 6.—Motor Regulating Rheostat.

FORTHCOMING EVENTS.

The following are some of the announcements for the forthcoming week:

WEDNESDAY, APRIL 21.—Meteorological Society ("Cold Periods and Anticyclonic Conditions in Winter," by Mr. W. H. Dines; "Sunspot Influence on the Weather," by Mr. A. B. MacDowall; "Kites for Meteorological Records in the Upper Air," by Mr. A. Lawrence Rotch), at the Civil Engineers, 7.30 p.m.—Crystal Palace Lecture (Parliament).

THURSDAY, APRIL 22.—The Institution of Electrical Engineers (discussion on Mr. Baylor's paper, and afterwards paper on "The Generation of Electrical Energy for Tramways," by Mr. J. Raworth), at the Institution of Civil Engineers, Great George-street, S.W., 8 p.m.—Also at Dundee, meeting of the Dundee Institute, 8 p.m.

FRIDAY, APRIL 23.—Ingenieurs Civils de France, at Paris.

SATURDAY, APRIL 24.—Institution of Electrical Engineers Students' visit to the City and South London Railway Works.

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THE FLATTENING OF THE GARNESDON LOAD CURVE.

BY J. H. C. B.

When a public undertaking is completed there is joy spread about in several camps; eulogies are indulged in, and sometimes criticisms are let loose, not to mention the technical and untechnical papers' articles upon the undertaking, replete with manufacturers' facts, figures, and adjectives concerning the machinery: its capabilities and its beauty of design.

The general rule in these matters is that those who know least about the undertakings are they who say the most, and inversely, though it is as well to mention that this rule is affected by the *reductum ad absurdam* clause. For though it is those people who have most to do with the innermost details of an undertaking who best know its peculiar virtues and shortcomings, yet it is not they who supply public information or opinions upon the subject so much as the men who more generally superintend the undertaking. And, as a rule, the weak points and back-street work connected with public undertakings, though of more use and interest to the profession, are never known to outsiders for very obvious reasons indeed.

This is right, and as it should be, because there are prematurely grey heads enough in the land; and a flaw in a casting, a bald spot on a cable, and a stripped bolt have been known to hang together quite long enough for all practical purposes, thanks to the high factor of safety decreed for them. And what is a factor of safety used for if not to cover this kind of thing? Such, at least, are the thoughts of the dealers with details when occasion demands, and superintending engineers are generally only human in the limits of their capacities for observation, whatever manner of beings they may occasionally imagine themselves.

Sometimes these should-be-unknown happenings leak out, and sometimes they do not. For instance, there will probably never be fully published some of the behind-the-scenes and beneath-the-streets transactions that retarded or helped the progress of the electric lighting of the first city in the world. It is here proposed to bring into the light of day some doings in connection with an extension of mains in Garnesdon, the facts of which have hitherto been covered with the tape of silent secrecy and braided over all with the fear of justice.

As several electrical people already know, the town of Garnesdon is lighted by a company upon the alternate-current transformer sub-station system, it being one of the pioneer towns thus supplied. It is an agricultural centre rather than a manufacturing community, and the gas interest is strong therein, the directors of the Gas Company being connected with most of the prominent undertakings and public offices in the county. This fact has proved very inconvenient to the Electricity Supply Company, as may be imagined, and its progress has occasionally been retarded on this account.

Nothing short of a previously-dated provisional order can daunt a properly-constituted supply company, however; and despite occasional pulls-up, the Garnesdon Electricity Supply Company did good work, and steadily increased the number of its tee-joints. And its secretary dreamed vain things of Stock Exchange quotations and of buying up by the Municipality at 100 per cent. per capital expenditure within the decade.

The principal working officials, as may be seen in the Blue-book of that period, were the engineer, who was also manager; the electrician, who assumed the *rôle* of mains superintendent when occasion demanded; and the secretary aforesaid; and the three men worked harmoniously together, taking such an interest in the general working that they might have interchanged places without affecting the regularity of the supply or the accuracy of the accounts and transactions.

It was, indeed, a peacefully desirable central station to have anything to do with, barring the cruel load curve in winter and the almost complete absence of this during the summer months, and but for the Gas Company and its peculiar ways, the Garnesdon Electricity Supply Company, Limited, might have always remained in that state of oblivion which is said to be the reward of happy nations without a history.

The load curve just mentioned had not the usual bad effect upon the economics of the station, since turbines were responsible for the motive power, and so there were no open-mouthed boilers to feed without return during the light-load period. Nevertheless, the engineer and his *confrères* continually searched their minds for a means of flattening the curve, if only sufficiently to balance the interest on capital and depreciation items.

Therefore, it appeared to these individuals in the light of a heavenly intervention and reward for a virtuous past when an enquiry was received from the Artificial Silk Weaving Company, Limited, regarding the terms at which electricity could be supplied during the day for motive power and electrolytic operations. About 100 h.p. would be the maximum required, which was just about the capacity of the station without spares.

The three officials held a consultation, and decided to offer to supply at 3d. per B.T.U., hardly expecting to have this price accepted, but with a firm belief in the Oriental method of asking for twice as much as one expects to receive. The Silk Company accepted the rate, however, and with such alacrity, that tears of remorse came to the eyes of the tenderers because they had not asked 3½d.

A letter of explanation followed the acceptance, and stated that the company had acquired land at an exceptionally low figure near Garnesdon from the lord of the manor, on the understanding that all the factory hands should be natives of the town, and that no steam or other engine should be allowed to pollute the air or besmirch the scenery. So that it was well worth the company's while to purchase its power from outside.

It was decided to run a high-tension concentric to the new factory and transform there to a low-tension continuous current, so that sections of shafting might be worked separately and started without trouble, and principally, of course, for electrolytic work. It was arranged that the Silk Company should stand the racket for the feeder and transforming apparatus, and should also entrust the wiring of the factory to the Electricity Company at a profit of 15 per cent. upon the cost. Surely nothing more delightful ever fell into the net of a supply company; for the silk people, having implicit faith in the success of their process, did not spare love nor money to put the factory in good working order. The Supply Company entered into the matter with spirit, and contracted for two gorgeous sets of transformer converters, all green and gold, with lacquered brasswork and a guaranteed full-load efficiency of 94 per cent., not to mention "best this," "latest design" that, and "specially strengthened" the other vital part. And the concentric cable was to be of $^{5000}/_{2500}$ megohm rubber, doubly braided, lead-covered, and braided, while the factory wire was 1,000 megohms, with *vulcanised* joints. This elaboracy had been rendered necessary by the Silk Company stipulating that the current should not be discontinued between 8 a.m. and 5 p.m. in summer and 9 a.m. to 4 p.m. in winter, under penalty of £20 per day of omission. It desired to penalise the Supply Company thus for every momentary stoppage, but the engineer would not agree to this, knowing the accidents that will happen to the best-regulated machines, be one ever so careful. A very important point, however, had been taken too much for granted, and it was not until the cable had been actually got on the ground that the fact of having to cross the railway line to reach the new factory appeared likely to be an obstacle. The Supply Company had powers to lay mains anywhere in the township except in or upon the ground owned by the Garnesdon and Storton Railway Company, and, so far, this had not been necessary. To the eyes of faith there seemed to be nothing against this proceeding, except that two of the Gas Company's directors were also on the Board of the Railway Company.

This may have been a coincidence, and the Railway Company may have had good and just grounds for their decision, but it is upon record that the Supply Company's application to lay mains under the permanent way was refused, and the secretary's attention was drawn to a copy of the Act of Parliament on the ownership of land, with the clause relating to the centre of the earth underlined.

The receipt of this letter filled the Supply Company with wrathful consternation, which is all very well in its private capacity, but of small value against railway companies with prejudiced boards. At a council of war, held in the engineer's den, the opinions were various and heated. The secretary was for appeals to the Courts, to the District Council, and to the newspapers; the engineer suggested tunnelling under the track by night and hauling the cable through; but the electrician's proposal to cut the cable and carry a couple of bare wires over the lines on poles as high as possible was considered most feasible, as the land on the one side belonged to the factory and on the other side to a large shareholder in the Supply Company. The only alternative was to take the cable along the roads, a three-sides-of-a-square run of about six miles, so the risk of the railway company noticing or objecting to the overhead span was agreed upon.

In due time the factory was built, the machines for producing from wood-pulp the imitation silken threads were in course of erection, the electrical fittings were being installed, and the work of connecting the central-station switchboard to the switchboard in the factory was commenced.

The first half mile lay along the main street, where an enlightened Municipality had erected a glass arcade over one of the pavements. Under the apex of this roofing the space had been utilised for the stowing of electric light, telegraph and telephone cables, with proper precautions against inductive effects, and to the great saving of the street surfaces, not to mention the increased facilities offered for jointing and testing. The cables, perforce, ran under the roads at crossings. So popular had this innovation become that it was intended to erect arcades on one side, at least, of every street in the town; and while the arcades cheapened the cost of laying cables and connections, so that the Supply Company was putting up mains as fast as the arcades were erected, the umbrella and macintosh dealers of Garnesdon were either leaving the town or becoming electrical engineers in sheer despair.

To continue, the factory feeder branched off from the main

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street down a lane and on to the land of the obliging holder of the Supply Company's shares before mentioned, and terminated in a joint-box at the base of a 40ft. pole, from which ran phosphor-bronze wires to an arm at the top, and, supported by oil insulators, they stretched across the railway track to a similar erection on the other side, and then went underground to the machine-house of the factory.

The line had been completed just a week, and everything had gone on satisfactorily. The usual applications for compensation had been received from that class of unfortunates whose mission in life is to fall in mains' excavations early and often, or to discover differences in level in footpath reinstatement for the purpose of tripping over, in those streets that had had to be opened up. The secretary was congratulating himself upon having settled these people's claims at the low average price of £5 a-piece, when a communication was received from the Garnesdon and Storton Railway Company to the effect that if the wires over their track were not taken down within 48 hours they would be removed forcibly.

The secretary swore in plain English, and the engineer, having been in the B.I. service in his salad days, expressed his feelings in time-worn Hindustani; but the electrician, being a pessimist, had foreseen the likelihood of such a proceeding, and therefore only laughed.

"Let them do it if they can," he said. "I fancy it will take them longer than they expect, and in the meantime we will make other arrangements for the transmission."

"What other arrangements can we make?" growled the engineer; "if we are not allowed to put any cable through this side of hell. Hadn't we better negotiate for leave to go past, and pay the beggars something to keep them quiet?"

"We can try," answered the electrician; "but I don't think we shall clear much on the job after satisfying *them*."

And it went at that; the upshot being another conclave a few days later, at which the secretary announced that the Railway Company would require £1,000 for the right of way, and £1,000 per annum as rent.

"What do you estimate our profit at?" enquired the engineer.

"About £1,200 a year," answered the secretary; "which means working five years for nothing, and after that for one-sixth of our rightful income."

"I met the Silk Company's manager to-day," observed the electrician," and he tells me that he has been offered a plot of ground by the railway people where they could put down as many engines as they liked. Of course, they wanted a good lot for it, and the Silk Company did not see any saving in the suggestion, even when the railway bounders suggested using gas from the Gas Company's mains for the motive power."

"That explains things more clearly," said the engineer; "but it licks me how we are going to do anything very brilliant with the business if those wires come down."

"I have an idea," said the electrician, "by which we can frustrate this gazo-railway alliance in that event."

To be brief, the electrician's idea was to make a pretence of tunnelling under the track, but to run the cable secretly to the banks of the canal, which was also owned by the gas and railway clique, and lay it as a submarine cable, passing under the railway bridge and landing at a convenient spot on the Silk Company's land. He estimated that this method, after defraying the cost of the extra cable required, would save £700 on the initial £1,000 demanded, and £1,000 a year for ever afterwards. There was only one thing needed to ensure success, and that was utter secrecy.

The engineer wanted to know what the submarine cable was to cost, and was hardly pacified by the assurance that a well-made indiarubber cable, lead covered and braided, such as was in use on the rest of the circuit, would suffice for the work. The canal was deep enough for safety, but not so deep as to breed teredos; so the secretary was instructed to ask the cable manufacturers to have ready another half-mile for instant delivery, in case of need, of the $^{7}/_{14}$ concentric with an extra braiding over the lead.

A week afterwards a final notice came from the Railway Company, advising that the obnoxious lines of wire be removed within 24 hours. No notice was taken of this in the hopes that the affair might blow over.

Late on the evening that the 24 hours elapsed, the engineer and electrician, while surveying the land in the neighbourhood of the canal, observed an engine strolling down the line, and men in tall hats were mingled with the crew. It stopped underneath the twin wires of phosphor bronze, and a succession of chimney-sweeping rods were built up in the air with a file on the end. When the file reached the wires it tried to cut them, but the apparatus was too supple for the purpose, and after half-an-hour's entertainment this method was abandoned and the engine went back to its yard, reappearing shortly afterwards with some coils of rope on the tender.

The engineer had by this time commissioned some farm labourers to pull in the wires in the event of their being severed, and now philosophically awaited events.

A missile, with string attached, was flung over the wires from the engine people, and gradually a rope was drawn over them and both ends of the rope attached to the engine's rear coupling. Then the engine moved forward, snapping the oil insulators on the pole-arms first, and then dragging the ends of the wires out of the boxes where they joined the concentric cables on either side. The wires dropped on the metals, and were promptly filed asunder by the gang on the engine and left on the embankments. Then, with derisive laughter, the party returned whence they came.

"Perhaps it's as well," mused the electrician, as the men hauled back the wires, "there is usually trouble with bare wires carrying high-tension currents, and especially when both wires are on the same pole-arm."

"Why the deuce did you put them on the same arm?" queried the engineer.

"For the sake of symmetry and for the look of the thing. Has it never struck you that that is the god of most engineering jobs, as it is of the sign-painters?—I mean the instinctive sacrifice of inartistic utility in design to better please the eye of the man in the street, who as a rule notices nothing," said the electrician, who wrote poetry and studied human nature in weaker moments.

"I have noticed that, sometimes," assented the engineer. "I had to do with a blacksmith once who did jobbing work of the roughest kind, and that man would *not* work to a drawing unless he was threatened with the sack. His idea was to make the job look '*all* right,' and let accuracy go to."

"I think organ-builders are the worst culprits, with their multiplicity of dumb-pipes to fill up; but switchboard makers run them hard." And then the conversation turned to the best method of laying the new circuit. It was arranged to put gangs at work on both sides of the line, excavating as if for a tunnel to mislead the Railway Company; also to order the cable and to lay it during the first dark night.

The next day the Silk Company's manager called at the electricity works. He came to tell them of a communication which he had received from the Gas Company announcing that the "electricity wires" over the railway track had been severed by the Railway Company, who had decided not to allow them to pass across their property on any consideration; that therefore it would be impossible for the silk factory to be supplied by the Electricity Company, and that they (the Gas Company) would be happy to do so, either for lighting or motive power, at an advance of 10 per cent. upon their original estimate.

"And I want to know," concluded the silk man, whose name was Coyne, "if this is correct, and if my only course is to accept their offer?"

"I was going to see you about the matter to-day," said the engineer. "It is quite true as regards the cutting of the circuit, but with your kind help and secrecy we still hope to be able to supply you."

Then he explained the submarine scheme.

"Well," said Mr. Coyne, rather dubiously, "I sincerely hope all this will work out as you expect. I can promise absolute secrecy and can let you have a couple of men to help you with the work who are human sphinxes."

"Thank you," interpolated the staff, with one voice.

"But I must protect myself, and the Gas Company have offered to lay a pipe line to supply my workmen's houses, which in case of need could also supply gas-engines, erected on the Railway Company's land, to work the factory. This last I hope will be unnecessary, but I shall allow them to bring their pipes on to my land in case you are compelled to disconnect."

"There is no fear of that," said the electrician, "but by all means let them lay their gas-pipes, which I suppose will have to cross our shareholder's land."

"We can soon put a stop to that," exclaimed the secretary impulsively.

"If you take my advice, you will not," said the electrician, "and I'll you why afterwards."

"We shall have our plant in running order next week," said Mr. Coyne. "Shall you be ready then?"

"It depends upon the moon," answered the electrician. "Where's that 'Whittaker'? Ah! yes. Last quarter to-night. The cable should be here to-morrow, and if you can lend us an empty barge from your wharf we will have it laid by next morning."

Mr. Coyne was willing, and arranged for the barge and the men to be handy for the enterprise.

On thinking it over aloud with his *confrères*, the electrician admitted that there was a handsome risk of detection in pursuing the course decided on, but it seemed the only one open, and the risk was certainly worth taking. The prospects of the ideal load curve alone was sufficient to spur most engineers-in-charge on to equal deeds of derring-do, not to mention the pecuniary result, which is sometimes lost sight of by professors and progessists in their lust for the ideal.

The cable arrived in due course (880 yards on one huge drum) by cart from the nearest railway station on another line. The drum was disguised, according to instructions, into the semblance of a crate of machinery, and was taken to the silk factory after

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dark, to which its truck was also brought and the drum mounted thereon.

At midnight there assembled at the factory, in clothes of various stages of use but not ornament, a party consisting of the engineer, the electrician, and the secretary, with a couple of trustworthy hands; the shareholder, whose land was being put to such practical use, and a friend of his, sworn to secrecy; Mr. Coyne and his "sphinxes," and the London agent of the Silk Company, who was visiting the factory; altogether about a dozen. All the outsiders had been given shares in the Electricity Company, so that it should be to their advantage to keep silence.

A brick shed had been erected over a portion of the already interred cable (which had been connected to the late lamented overhead construction), and a hole had been dug inside, sufficiently large to admit of the cable being cut and jointed to the new length. The drum was brought here, and, with a plough in front turning up a furrow, the procession started for the canal with the drum paying out cable into the furrow as it went. (The horses and plough had been lent by the ever-obliging shareholder, who was like a happy providence to the scheme.)

The furrow was carefully covered in again by the party behind, but many halts had to be made, the night being too dark for speed and accuracy combined, and it was important that no traces should be left. No lights or even smoking was allowed, and it was ridiculous to see how gingerly everyone moved about; as if the Railway Company had posted sentinels of the Mayne Reid order.

The canal was reached at last, the plough and drum-truck wheeled aboard the lugger, and the amateur smugglers busied themselves in hiding all traces of the cable's entry into the water, the towing path being on the other side. This being done, the barge was towed out into mid-stream and the cable paid out over the stern. The excitement ran high as the railway bridge loomed in sight out of the darkness. Once it was past, and the horse's hoofs and splash of the cable woke no more echoes, the feelings of the gang could scarcely be suppressed; and, aided by past experience, the landing on the shareholders' ground and laying of the cable were so expeditiously done that it was barely 4 a.m. when the procession arrived at the junction shed.

There were about 50 yards of cable left on the drum, so it was cut, and the drum put out of sight, and after returning over the cable run to make sure of its being all right, the party adjourned to the shareholder's house and feasted and made merry until worktime.

There are few things more sickening than being made a mock of. "Kick me vigorously," said the French philosopher in effect, "but do not laugh at me." Ridicule is hard enough to bear when one is a humble individual and deserves it, but for a dignified railway company to be flouted and jeered at successfully, when trying to enforce Its undoubted rights, is galling in the extreme to Its staff, from the Right Hon. the Chairman of Its Board to the newest doorbanger on the line. And when this flouting is the premeditated act of a thing like an Electricity Supply Company, Limited, the pressure of humiliation is as crushing as a hydraulic riveter. For the dictation of a railway company in ordinary everyday life is obeyed as if it were a stipendiary or the law of average. So that it was something new to the Garnesdon and Storton Railway Company, Limited, after telling another company that it must not cross the railway track with vulgar wire between the highest heavens on the one side and the centre of the earth on the other, to find that this presumptuous company, aided and abetted by a silk manufacturing concern (of which better things were once expected), had seemingly tunnelled from their own ground underneath the sacred track in an incredibly short space of time, and had pushed an electrical cable through this hole, which cable now supplied the silk factory with light and power which should have been generated by a respectable and deserving gas company. That this was so they had the word of one who had been told in confidence and for the promise of many drinks by one of the Electrical Company's men; and, moreover, these tidings had become well known in the neighbourhood. It was true that the Electricity Company denied it, but then electrical people were such liars (especially in their comparisons between gas and electricity and the respective costs); and again, why had they endeavoured to keep it a secret at first by erecting hoardings so that the operations could not be seen from the railway embankment? and what was their reason for telling their workmen that they were boring for water on either side? Conscientious people do not bore for water in the horizontal plane, neither do they fill up the boreholes with screwed lengths of gas-piping with electric cable inside, when they think the workmen have gone home. Well, this Electricity Company may think itself deep and of abundant cunning, but it must please observe what will happen to that cable when the Railway Company unearths it.

Thus communed the officials of the Railway Company among themselves, and the fruit of their councils took the shape of gangs of men, who dug a trench along the foot of the embankment in a position calculated to intercept the cable in its course. Ten feet they went down, but no cable in sight, and 5ft. more with equal non-success. It was necessary to work in a 4ft. trench, the soil was so crumbly, and to plank up the sides and stay them. The absurdity of the work increased with its cost, as still no signs of cable or piping appeared, while the Electricity Company's officials would occasionally climb upon the hoarding and shout words of earnest encouragement to the workers, which had an opposite effect.

In the meantime the joints had been made on the new length of cable, and some misleading work performed for the benefit of the Railway Company, as has been noted; for the boring was of an illusory character and had not penetrated 10 yards, while spare lengths of cable had been connected to the dead ends of the main cable and threaded through some gas-piping, which were driven a short distance into the borings on each side to aid the illusion of a complete perforation. Thus it was that the Railway Company's trench, while it extended 50 yards on each side of the boring and went down to a depth of 15ft., was of no use, except as a source of employment for the local out-of-works and a theme of much hilarity to about a dozen individuals. The Railway Company, from a sense of mortification, descended to frantic wrath. Their solicitors had advised them that nothing could be done legally in the absence of conclusive proof that the line went underneath, though it was plain that *when* the cable was discovered it could be cut and the owners proceeded against for trespass.

This was poor consolation, and an ordinary railway company would have filled in the trench and put down the expense of the proceedings to experience gained. But this combination with the gas interest had its effect upon the Railway Company as a kind of bovine instinct, when the red flag of electricity was waved in its face. Down went the trench, and down, and down. Men got hurt every day by falls of earth from unshored portions of the sides, and when the made ground was past, the geologists of the neighbourhood found ample food for controversy in the sections of strata brought to light.

There is no knowing to what depth the Railway Company would have gone in their blind search for the cable that was not there had not an unfortunate accident occurred to one of the factory hands, who while swimming in the canal was so careless as to swallow his false teeth, and then sank like a sphere of platinum. Whereupon the horrified spectators shouted and got grappling poles from the nearest barges, and in due course hooked the bight of the cable, which they brought to the surface and straightway forgot about the original object of their search.

That evening the engineer and electrician had just finished their tea when the secretary burst in with despair written on every feature of his face.

"The game is up!" he gasped. "Some blasted idiots have grappled the cable! Come and switch off the circuit before anything happens."

The electrician was off, like a high-voltage switch, to the station next door, where he partly closed down the turbine valve and then switched off the factory circuit from the 'bus bars. It was after working hours, and only a few lights were being supplied to the factory, but the electrician had his own ideas about governors.

The other two came after him, breathing blasphemy at every pore, which, while tending to distract their minds, did not alter the seriousness of the situation.

"Oh! shut up," said the electrician, "talk less and think more. Swearing won't do any good."

"Well, I can't see what's to be done," almost wailed the secretary. "There's a crowd of people around the cable, and they've pulled it up to where it runs under the factory field. The railway folk will know to-morrow, and then it's all up with that blessed load curve of yours."

The engineer was in a similarly helpless state, so it behoved the electrician to do the thinking for the occasion. He had, however, planned beforehand the course he should take in case of anything happening of this nature, and now he hurriedly thought out the details and decided upon the best course of action.

"We must get the cable out of the way before it is hurt. Was the crowd maltreating it?" he enquired of the secretary.

"No; I told them what it was, and they dropped it like hot bricks."

So they got a few men together, and, as the drum and truck had not been returned, they ran them over the cable route unearthing and picking it up as they proceeded, and reeled it all back again on the drum.

"What is the next part in the programme?" asked the engineer, recovering somewhat as the work on. "Sell everything off second-hand? or keep them in case we have any more transmission to do?"

"Sell your grandmamma!" observed the electrician; "that gas-main that has been laid to the factory is what we must make use of. It is nearly completed now, and we can get our cable in before the gas is turned on."

"Oh! you stark, staring, mad idiot!" almost yelled the engineer; "you'll have us all in jail yet with your confounded

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notions. How are we going to draw cable into a mile of gas-pipe along a public road without being dropped on?"

"There are more things in 'the City" and Clerkenwell, Horatio, than e'er were known by local authority," soliloquised the electrician, recalling some moonlight happenings with picks and shovels, pipes and street boxes, "and the earth is the great 'fence' that covers all. We do not need to draw in more than a couple of hundred yards—from where the gas-main crosses our shareholder's field to where it enters the Silk Company's land."

"Oh! I see," said the engineer, and was consoled.

They ran across Mr. Coyne that evening, and endeavoured to calm his soul by a revelation of their latest plans. He accepted their assurances of success with a grim smile of disbelief, but offered his services again for the attempt.

It was now about a month after the last midnight essay, during which time the factory had been supplied with current for the space of fortnight, and the daily fine of £20 for non-supply had therefore mounted to the goodly sum of about £300. The Railway Company had entered a suit against the Electricity Company for trespass in their canal and for instigating an assault upon certain of their officials who had endeavoured to prevent the cable being taken away by the engineer's gang. Thus a feeling of discontent was becoming general among the holders of local Electrical Supply shares, not to mention the inconvenience caused to the Silk Company by the stoppage of their plant, so that in their "off-colour" moments the Electrical Company's staff felt it were better if day loads had never been pricked, and that squared sheets were but exciters to emulative sinfulness. All immediately concerned were therefore well pleased when the word was passed around one evening that they should meet at the witching hour in the shareholder's house, for the perpetration of illegalities against gas corporations are deeds of virtue when the market value of electrical scrip is at stake.

About midnight a start was made in a corner of the field across which the gas-main had been laid from the road. A place had been marked during the day, and the gang dug down to the pipe and broke out with cold chisels a 4ft. length, planks and a felt roof being put over the hole to deaden the sound of hammering. This operation was also performed on the main at the other side of the line. Then a cord was passed through by means of a rat and ferret, and a 3½in. rope was pulled through afterwards. The cable drum had been mounted above the hole in the shareholder's field, and the cable eye threaded through a Y-piece and attached to the rope, and, aided by a couple of horses, the party in the factory field drew the cable through and threaded it through another Y-piece, with enough end to lay along a new furrow from the gas-main to the junction-box shed. This was then covered up and resodded, and the Y-piece permanently fitted into the pipe run in the usual way with lead, and the branch outlet stopped up as a gland around the cable. At the other end of the pipe the Y-piece was similarly secured and the cable-truck run backwards along a furrow to the box; and leaving the two unmade joints in the sheds for daylight, the party once again visited the house of the providentially directed shareholder to celebrate the business.

A couple of days afterwards the factory recommenced work, much to the astonishment of the Railway and Gas Companies, who had the canal dragged and offered rewards for information regarding the mysterious transmission. The fields were well watched, however, and as time went on sheds and outbuildings arose over the buried cables and effectually prevented injudicious investigation.

So the Railway Company refrained from casting any more money away on fruitless excavations for the benefit of its friend the Gas Company, and assumed a Micawber-like attitude, being content with the finding of the law courts for £500 damages for the previous trespass in the canal.

This, then, is the history of how the Garnesdon Company's load curve became the envy of the profession.

It may be considered an unfortunate omission that no one was electrocuted in course of the proceedings, if only for the sake of incident.

And it certainly is strange that no womenkind should have meddled in the business to complicate it with a love affair. There may be those who will doubt the truth of this narrative on this account alone, but it must be remembered that disreputable happenings have been sometimes known to occur without the slightest association with the softer sex.

PHYSICAL SOCIETY, April 9.

Mr. SHELFORD BIDWELL in the chair.

Mr. T. A. Garrett read a paper on **"A Nickel Stress Telephone."** In conjunction with Mr. W. Lucas the author has experimented upon telephones with nickel magnets. A magnetised nickel rod is wound with insulated wires, and is then fixed vertically by a clamp at its lower end. A wooden diaphragm is rigidly attached to the top of the rod in a horizontal plane. The rod just passes through the middle of the diaphragm, where it is fixed with sealing-wax. The diaphragm is entirely supported by the nickel rod. On speaking against the top of the diaphragm, variations of longitudinal pressure, and consequently of magnetisation, are produced in the nickel, and corresponding undulatory currents are induced in the surrounding coil. The nickel wire is sometimes magnetised by stroking it with a magnet, and sometimes by passing a current through the coil. A diaphragm of pine wood gives better results than a metallic plate. The instrument does not work well as a "receiver"; an ordinary telephone is used for this latter purpose. The results obtained with a weakly-magnetised nickel rod are much better than those with a strongly-magnetised steel rod, indicating that the undulatory currents are due rather to magnetic variations arising from changes of stress than to the relative motions of the magnet and coil.

Dr. Silvanus P. Thompson said that some years ago he had worked with a somewhat similar apparatus, using it as a "receiver," with wires of nickel, cobalt, and iron. Cobalt gave the best results; the metallic strips in his experiments dipped into the solenoids without contact with them. This arrangement did not work well as a "transmitter," even when a battery was included in the circuit. In some cases the rods were cut into short lengths, separated by brass.

Mr. Boys asked how the nickel "stress" instrument compared in clearness and loudness with an ordinary telephone?

Mr. Shelford Bidwell had tried a nickel telephone with a mica diaphragm, depending not upon mechanical stress but magnetic strain. It did not work well.

Dr. Chree thought the "stress" telephone might possibly be improved by choosing the right strength of magnetic field.

Mr. Appleyard said the arrangement was interesting historically, because it was mechanically almost identical with the original instrument used by Philip Reis as a "receiver." The authors had succeeded in getting it to work as a "transmitter." Their success was probably due to the rapidity with which the magnetisation of nickel responded to very small changes of stress or current. The Post Office electricians had tried to introduce nickel cores into relays on account of its magnetic sensitiveness. The results, he believed, had not been very satisfactory.

Mr. T. A. Garrett, in replying, said the "stress" telephone gave better articulation than an ordinary "watch" telephone, but the sounds were feebler. There seemed to be a field-strength proper to the instrument. He had noticed that the articulation was clearer with three cells than with six.

Mr. W. A. Price then read a paper on **"Alternating Currents in Concentric Conductors."** This was a mathematical investigation of a proposed new form of submarine cable. The case was considered of two concentric conductors interrupted alternately at different points throughout the whole length. In the mathematical treatment the cable is supposed to be laid in a circular path, and successive charges of electricity are supposed to be applied at some point at the extremity of a diameter of the circle. Expressions are given for the amplitude of the periodic charges arriving at a point diametrically opposite to the first, and for the reduction in amplitude throughout the whole length of the cable of an applied E.M.F. The theory indicates that under no circumstances can the "speed" of a cable of the proposed form be greater than the "speed" of a cable of ordinary type. The author has experimented upon an artificial cable connected up to represent the proposed form. The "definition" of signals is considerably better than that obtained through an artificial cable of analogous "weight" and "length" connected up in the ordinary way. Within certain limits the "definition" continues to improve as the number of sections or sub-divisions of the cable is increased.

Mr. Blakesley said he was sorry the result did not indicate a successful type of cable. He would have been inclined to predict that the amplitude would have decreased with the number of sections. If a number of condensers were joined in series, and one end was subjected to a periodic E.M.F., the amplitude would fall off inversely as the square of the distance.

Mr. Price then exhibited a galvanometer support. The instrument was suspended from two indiarubber cords attached at the top and bottom to cross-bars of metal, thus forming a rectangle. The cross-bars were provided with knife-edges in such a way as to compensate for unequal stretching of the indiarubber. Weights could be added, if necessary, to the support, so as to increase its inertia.

Mr. H Garrett read a paper communicated by **Prof. W. B. Morton** on **"The Effect of Capacity on Stationary Electrical Waves in Wires."** The author investigates the effect produced when a condenser is inserted at a point in the secondary circuit of the apparatus used by Blondlot for obtaining stationary electrical waves in wires. The positions of successive nodes are determined in the usual way, by a bridge, with a vacuum-tube indicator. When two opposite points of the parallel secondary wires are joined to the plates of a small air-condenser, the nodes approach the condenser on either side. The amount of the displacement of the nodes—that is to say, the extent of the shortening of the apparent half wave-length—depends upon the position of the capacity along the wires. The effect is nil when the condenser is at a node, and a maximum when it is midway between two nodes. The state of affairs at a point of the circuit is obtained by summation of a series of separate disturbances due to the different direct and reflected trains. In obtaining a formula for the conditions of resonance with which to compare the observations, the author adopts a method from Heaviside. It connects the frequency of oscillation with the position and capacity of the condenser.

After a vote of thanks to all the authors the meeting was adjourned until May 14.

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THE GREAT METER CASE.

Our readers will remember the action tried in the beginning of March by which the plaintiffs, Messrs. Chamberlain and Hookham, wished to restrain Messrs. Johnson and Phillips from manufacturing and selling the Perry meter. We reported the case somewhat fully, and also illustrated the various meters, etc., brought into court. Mr. Justice Wills delivered his judgment last Saturday. We reproduce the full text of the judgment elsewhere, as it is of great interest to all patentees and inventors. The decision that Messrs. Hookham's patent is valid, and that all the claims except the sixth have been infringed by the defendants, is one that, as Mr. Justice Wills points out, involves great hardship on Prof. Perry. Echoing the words of the judgment, "it is a strange thing that one of the two men who laid down the correct theory, and indicated the lines upon which to work, should be thus hoist with his own petard." The whole matter was most carefully gone into in the court, and from the evidence of expert witnesses the judge decided that the Ayrton and Perry 1882 patent did not give sufficient practical detail to invalidate subsequent patents using the same principles. In fact, his Lordship ruled that an intelligent workman could not, from this 1882 patent, make a meter that would work. Now, in the Hookham patent practical details were given; in fact, the drawings were almost working drawings. The plea of Mr. Bousfield, that the ample description of one type of motor being claimed prevented the wider application of the claim to other types, was not upheld by the judge. On the contrary, he decided that in many places Mr. Hookham described novelties invented by himself, and that the combination of them made a valid patent which covered the defendants' type of meter. The sixth claim of the above patent was for grooved pole-pieces, the object of the grooving being to increase the braking power. Now, in the Perry meter the grooves, *per se*, do not increase the braking power. The view taken was rather that the grooves were gaps between adjacent pole-pieces, the gaps being backed with metal for mechanical reasons. Hence the ruling that this claim has not been infringed. This led to a reduction of the costs to be borne by the defendants, who may appeal any time within the next fortnight.

Amongst the list of details of construction which Mr. Hookham is now ruled to be the inventor, the following may be specially mentioned: The use of permanent and powerful magnets in electricity meters with proportions as described to give permanence. The use of any form of electromotor known in 1887 in combination with a magnetic brake for an electricity meter. The proportioning of the forces in the meter so that the frictional loss forms a very small proportion of the driving or braking force. This last principle, although used of old for other purposes, was first applied by the plaintiff to electricity meters. The frictionless bearings used were also held to be novel. The fact that various details are claimed in combination, also gives a broad range to the patent. This judgment therefore gives Messrs. Chamberlain and Hookham the

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right to claim that theirs is a master patent for motor meters. The decision will press hardly on the defendants, who appeared to have had good grounds to contest the action; and we can only regret that the result could not be arrived at by less expensive procedure.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

BRUSSELS INTERNATIONAL EXHIBITION, 1897.

SIR,—In August last you rendered great assistance to the British Section of the Brussel Exhibition by publishing a letter in which I called the attention of our manufacturers to the importance it then appeared probable the exhibition would assume, and asked them to consider carefully whether it would not be of sufficient interest for them to participate. I venture to trouble you with a second letter now that I am in a position to state positively what are the actual prospects of the British Section, to the success of which your co-operation last summer has materially assisted. Commencing with a court of 30,000 square feet, the applications from manufacturers have rendered it necessary on several occasions to obtain more space from the exhibition authorities, until to-day the commercial courts of the British Section occupy no less than 70,000 square feet, besides some thousands of feet in the machinery hall, and a series of fine arts courts, which it is confidently anticipated will be in all respects worthily representative of British contemporary art. It may therefore now be stated that, as regards its extent, the British Section at the Brussels Exhibition will leave little to be desired. It will be much smaller than the French Section, which has had the advantage of a very large Government grant; on the other hand, it will be far more extensive than that of any other foreign country. I cannot claim for the industrial courts that they will contain exhibits of a very novel or monumental character; but they will be filled with contributions from exhibitors of high standing and distinctly representative in their various branches of industry, Therefore, as regards quality of exhibits, as well as extent of space occupied, this country will be well represented. It is evident that this result could not have been obtained without united and continuous efforts on the part of the British Commission, and its president, Sir Albert Kaye Rollit, and especially of the Executive Committee; while the undoubted success of the Fine Arts Section is due to Sir Edward Poynter and the members of his sub-committee, who have laboured under very difficult and discouraging conditions.

In my capacity of executive commissioner to the British section, I would like to take this opportunity of thanking all our numerous exhibitors for their universal consideration and thoughtful co-operation with me, and to bear witness to the admirable spirit of friendliness and accord that animates them, and will continue, I doubt not, to do so till the end.—Yours, etc., JAMES DREDGE.

AS OTHERS SEE US.

BY BERNARD A. BEHREND.

The Continental electrical engineer gets many strange impressions when paying his first visit to Great Britain. Thus, although the theoretical development of alternate-current machinery came from England, and is due to the many prominent electrical engineers there, I saw comparatively few alternate-current stations compared with the large number of continuous-current stations. Again, polyphase machinery has not yet made much headway in England, and personally I do not see reasons for believing that three-phase current motors will soon be employed in preference to continuous-current ones. This impression arises from the feeling against the system I found in conversation with electrical engineers, and showed the general conservative tendencies against new departures. Thus the fact that three wires, instead of two, were required was said to be a great objection, although in my opinion this is very small compared with the many advantages to be gained by the use of multiphase plants.

As is well known, the great impetus to the polyphase working in Germany was due to the success of the Lauffen-Frankfort transmission in 1891, power being transmitted over a distance of 110 miles. I may state here that the water power available on the Continent has done much to aid the development of three-phase current machines, and that the lack of water power in England undeniably tends to retard the organisation of large power transmission schemes. The English engineers have specially applied themselves to the improvement of continuous-current motors and dynamos, and my impression is that their two-pole machines are very well designed both as regards efficiency and non-sparking. In fact, the efficiency is higher than that of Continental machines of equal output. In England one very seldom sees a multipolar dynamo, nearly all the machines being two-pole. One reason for this will be obvious if one remembers that the average revolutions of large dynamos in England is three to four times greater than from machines of similar output made on the Continent. These high speeds are largely due to the Willans single-acting engine, which was to be found giving satisfaction in nearly all the stations I visited. The high speeds of these engines work in with small-diameter armatures, which again tends to a two-pole design. The two-pole type also finds favour because it economises labour charges. It, of course, necessitates more weight of iron and copper; but where iron is cheap and wages high, advantage may possibly be gained by the use of two poles instead of four. It is not true, however, that multipolar machines cannot be made sparkless, as is often stated in England. If the design of the field is carefully attended to and sufficient copper used in the exciting coils, then multipolars can be made as sparkless as two-pole dynamos. To make a continuous-current machine sparkless is exclusively a question of the amount of copper put into the field coils, and this fact is well known in England—you only want to see the heavy magnet coils of the continuous-current two-pole machines of Siemens Bros., Crompton and Co., the Brush Company, etc., to understand why they run so sparklessly.

As regards alternate-current stations I was privileged to see in England, I would refer first to the Deptford station of the London Electric Supply Company. In these works there are three huge machines working at a pressure of 10,000 volts. The armatures revolve with the enormous centrifugal speed of 12,000ft. per minute, and I was assured that this speed had not caused any trouble. This is a credit to the designers of these alternators.

The design of continuous-current machines in England is very different from the design of these machines on the Continent, as I have stated before, and this is still more the case with the alternators. The leading types of alternate-current generators are almost all machines without iron in the armature; the armature may be at rest, as in the Mordey machine, or the moving part, as in the Ferranti and Siemens machines. But the construction of all these ironless core armatures require great experience and skill on the part of the workman, as the least carelessness may cause a disaster. If I should speak from the customers' point of view, I should not be inclined to buy machines of this kind, although they have, at any rate, an efficiency 2 or 3 per cent. higher than the ordinary alternators with iron cores in their armatures. The flying into pieces of such a coreless armature is not impossible; on the contrary, it is very likely, and represents a great danger to the life of the attendants. Besides, every repair of these armatures wants a specially-trained workman. All these circumstances are a great counterweight for the 2 or 3 per cent. gained by avoiding the hysteresis in the armature.

The points mentioned above have led to the construction of machines without any moving windings at all, and I believe that these machines are a great improvement; mechanically they are perfect. Even Mr. Wm. Mordey, who has done so much for the improvement and perfection of the ironless core machine, has begun to put on the market machines without moving windings, and this is, at any rate, a very remarkable fact.

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The transmission of power in factories and the electric street railways have not yet been developed in England as they have on the Continent. Electrically-driven tools, etc., have first come into general use in Switzerland and Germany since the three-phase current system has been brought to the present perfection; and it might be that the introduction of three-phase motors and generators also in England might have a similar effect. The owner would see that his electrically-driven machine tools are better both from the economical and mechanical point of view than belt-driven ones. But my impressions were that the conservative character of the English people is against the adoption of three-phase machinery, but I am sure that after having acknowledged the great advantages of this system, they will throw off their prejudice against three-phase currents.

SHEFFIELD.

REPORT ON TRAMWAY TRACTION.

(Continued from page 399.)

BUDAPEST.—Population, 506,000.

In Budapest the deputation had interviews with H.M. Consul-General, and the directors and engineers of the tramway companies, also with the contractor who constructed the lines. At Budapest there is the most important example of electric conduit traction in Europe; in fact, in no other town have the tramways been extensively and successfully worked on this system. The deputation therefore regarded this inspection as one of the most important.

The streets generally are of extraordinary width and are mostly flat, but there are a few steep gradients (the steepest being 1 in 18), and the radius of the sharpest curve is 75ft. The view herewith shows one of the streets in Budapest where conduit lines are laid. The tramlines, as a rule, run near the kerbs, leaving the centre of the roadway free for ordinary traffic. The paving is generally of granite, but asphalte also is used, costing about 9s. or 10s. per square yard, without foundation. The old rails (some of which the deputation saw in process of removal) were in bad condition and without concrete. The rails used for the conduit system are of a special section (as will be seen from the diagram accompanying the Berlin report), each rail being practically a double girder. Similar rails are mostly used for the overhead electric lines, and the weight is about 170lb. per yard. The rails in the underground tunnel weigh 100lb. per yard. When the conversion of the horse lines in Budapest is completed, the mileage of the the tramways will be as follows:

Electric underground railway	$2\frac{3}{10}$ miles	($4\frac{7}{10}$ miles of track).	
„ conduit	„ $14\frac{1}{2}$	„ (30	„ „).
„ overhead	„ $26\frac{3}{4}$	„ (54	„ „).

making a total of nearly 44 miles. All the lines have a gauge of 4ft. 8½in. There are two tramway companies in Budapest: one the horse lines (the Budapest Street Tramways Company); the other the town lines (the Budapest Electrical Town Line Company, Limited), founded by Messrs. Siemens and Halske. As the city increased it was necessary to lay down more tramlines, and the horse company were not willing to do this without a subvention. Messrs. Siemens and Halske then stepped in, and agreed to do what was necessary without any subvention if electric traction was allowed. They also undertook to bear the cost if the result was not satisfactory. A company was accordingly formed, and Messrs. Siemens and Halske laid the first line in 1887. The horse company are now arranging to adopt electricity both underground and overhead on all their lines. The two companies have running powers over each other's lines. The Government would not allow any lines either overhead or underground in Count Andrassy-street (which is one of the finest streets in Europe), and an omnibus company was formed to meet the want. The two tramway companies, however, agreed to join in the construction of an underground railway, which has seriously reduced the value of the shares of the omnibus company.

There are four systems in use: (1) horse; (2) electric underground railway (mentioned above); (3) electric conduit system; (4) electric overhead system. Accumulator cars have also been tried, but were not a success, and had ceased running. A photo of one of the accumulator cars (which is similar to the cars used in other Continental cities where accumulators have been tried) is given herewith.

As regards the Town Line Company (duration 50 years—till 1940), for the first five years they pay nothing; for the next 10 years they pay 2 per cent. of gross receipts; for the next 10 years, 3 per cent.; for the next 10 years, 4 per cent.; and for the next 15 years, 5 per cent. This is for the use of the roads only, and is practically a mileage rent, payable to the Municipality. They also pay 16 per cent. of the net profits for the concession from the commencement of the term, and about one-quarter kreutzer on each ticket sold—*i.e.*, $\frac{1}{16}$d. The other company's concession is on similar but rather heavier terms, and lasts until 1949. It was previously to expire in 1917, but was prolonged 32 years in consideration of electric traction being adopted, the Municipality desiring the change.

There is not much to be said about the horse tramways. While the deputation were in Budapest they inspected some of the horse lines, which were being converted to conduit electricity. This work is in the hands of Messrs. Siemens and Halske, and all the lines are to be converted within the next four years. During the conversion the traffic is worked on one of the lines only, crossing places being provided; and the streets are so very wide that the interference with the traffic is very slight. It would, however, be much more serious in streets that are narrow.

The conduit lines were, as above indicated, built by Messrs. Siemens and Halske, of Berlin. There are two double rails, one pair (over the conduit) forming the slot. The slot varies in width from about 1½in. on the straight to 2in. at curve. Beneath the slot rail, at one side of the track, is the conduit, about 22in. deep. Inside the conduit are two conductors, carefully insulated, one supplying the current, the other for the return. At intervals of from 66 to 130 yards there are manholes which give access for cleansing and repairs, and midway between the manholes are hand-holes. The collector is attached to the car and passes through the slot, touching both the supply and the return conductors. There is no return by the rails. Some particulars of the cost were given to the deputation by the representative of the Town Line Company as follows:

	Per kilometre of track.
Pavement	£131 5 10
Construction of conduit, including excavation, but no materials	546 5 0
Rails, nuts, bolts	1,038 16 8
Yokes, insulators, wires	953 1 3
Labour on laying down rails, nuts, etc.	137 0 10
Manholes	46 1 11
	£2,852 11 6

This is equal to a cost of about £4,600 per mile, and includes no cost of engineering or superintendence. Labourers here receive about 2d. per hour and rail-layers 3d. to 3½d. The deputation were further told that this could only be taken as an estimate, the cost per mile having ranged from a minimum of £4,587 to a maximum of £6,944. It was stated that one kilometre (·621 of a mile) of conduit tramway could be laid in about a month, or, working three gangs, in a fortnight.

Against this the cost of the overhead was placed at about £2,900 per mile with the return current by rail. The cost seems to have been an element in the construction of the overhead electric tramways, as the poles and general overhead arrangements are very plain, and there is not much attempt at ornamentation. Similar apparatus will be used for changing from overhead to conduit and *vice versâ*, as in Berlin.

The power for both the lines of the Town Line Company and the underground tunnel is supplied from one station. The following are the particulars of the machinery: A maximum voltage of 500 is allowed, and the current is

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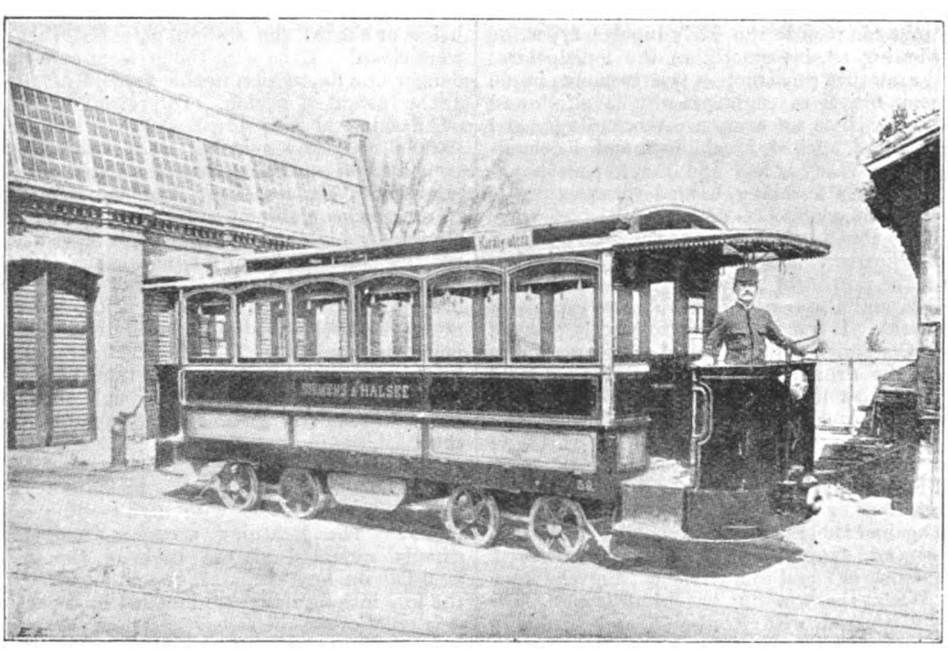
direct. There are three engines of 100 h.p. each, four engines of 200 h.p. each, and three engines of 600 h.p. each (total horse-power 2,900), producing 7,750 amperes at 300 volts. No power is supplied for public or private lighting from this station except for the station itself. Two separate companies supply current for general lighting. The power station for the Street Tramways Company has two 300-h.p. engines and two 600-h.p. engines, producing

Budapest—View of Conduit Electric Tramways (Siemens and Halske), showing Double-Slot Rails.

3,600 amperes at 400 volts. The cars hold 50 passengers, inside and outside. Some of the cars have one motor, and some two motors, of 20 h.p. each. The weight is for two-motor car 8⅓ tons empty, one-motor car 6¾ tons empty, and that of the summer car is 5½ tons empty. Each car travels about 186 miles per day, and there is only one class. The fares vary from 1½d. to 3d. Stopping-places are provided. It is stated that there have been no accidents, and up to now no interruptions through breakdown to machinery. The conduit lines have, however, on exceptional occasions been blocked by snowstorms for as much as a day together. The maximum speed allowed is about 15 miles per hour, but this varies with the traffic in the streets. The service is 12 to 18 cars per hour. Under the Town Line Company the men work 11 hours per day, and there is a relief man for every two men. The drivers receive about £1 to £1. 2s. per week, and the conductors 15s. 6d. to £1, also a free uniform (costing about £4. 4s.), consisting of overcoat, trousers, cape, and cap. This is renewed when necessary, but if a man wears out his uniform too quickly he is dismissed. There are different suits for summer and winter. Under the horse lines company the men work 11 to 12 hours per day. Their drivers and conductors get from 13s. 6d. (horse coachmen) up to about 18s., with gratuities in addition. The uniform is given as required, and the men have one day holiday per week.

The deputation were informed by the engineer of the company who laid the underground system that he would prefer overhead as the cheapest to construct and maintain. The insulation was difficult to maintain with the underground system, the cleansing was very costly, and there were also accidents to horses in bad weather. It was said that, as a rule, snow did not stop the car traffic, but if fine snow fell and drove into the conduit they might have to stand a day, and then horses had to be reverted to. The current, however, was not injured. It appeared that the overhead electric lines had also suffered through the snow, but not so much as the conduit, and the injuries were less costly to remedy. The wear on the rails is unequal, the rail over the conduit wearing rather more



Budapest Tramways—View of Siemens and Halske Accumulator Car.

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rapidly than the other. The manager of the horse company informed the deputation that the overhead tramways only cost one-third as much as conduit, and were much preferable from a practical point of view. His opinion was that electricity was a cheaper form of traction than horses, though his company had not much actual experience as yet. The conduit only seems to have been adopted because the overhead is objected to in the centre of the city. Its advantage is solely that the overhead apparatus, the appearance of which in some quarters is considered objectionable, is done away with and its disadvantages are many. The liability of wheels of carriages, etc., to get into the slot is one of the worst features of the conduit system here.

The deputation came to the conclusion that if the engineers and managers of the various companies were permitted by the Municipality to exercise a free option, they would all prefer to have the electric overhead form of traction as being the cheapest and easiest to maintain, and, therefore, more beneficial from a commercial standpoint.

(To be continued.)

INSTITUTION OF ELECTRICAL ENGINEERS, April 8.

Sir HENRY MANCE (president) in the chair.

SOME RECENT DEVELOPMENTS IN ELECTRIC TRACTION APPLIANCES.

BY A. K. BAYLOR.

(Continued from page 468.)

The temperature which will be developed in the conductors or any other part of the machine in a given number of hours' running at a given output, and the sparking limit, are too often omitted. There is certainly no reason why dynamos should not be as specifically rated as the engines which are to drive them. A standard should be adopted covering sparking and temperature limits, so that all dynamos would of necessity be rated on the same basis, and the rating indicate accurately the capacity of a machine for service. The absence of such a standard puts a premium upon over-rating, as selling prices are based on rated output.

In the economy of a plant much depends upon the stability of the generator armatures, and the development of this feature of modern machines has been most interesting. Compared with the drum windings common in the early bipolar types, or the ordinary ring winding used formerly in the multipolars, the present standard armature construction is extremely simple and durable. The main object of engineers who have followed this work has been to produce an armature mechanically and electrically strong to guard against breakdown, and mechanically simple to permit of ready access and easy repair should an accident occur. Properly speaking, a modern armature is not wound, but built. The conductors do not consist of wire, but solid bars formed to shape before they are put in position. The greatest cause of burn-outs and grounds in the old wire-wound armatures was the shifting of the windings due to twisting and centrifugal strains, and this sort of trouble was especially common on smooth cores. It was impossible to readily provide proper radiation for the inner coils on such armatures, more particularly those of the drum type, and the indiscriminate crossing at the ends of conductors of considerable potential difference was another source of trouble. Breakdowns from these causes are now pretty much done away with. Shifting of the conductors is impossible, as they are embedded in slots in the core and bound firmly in place; and in the latest construction all the end connections or wires outside the slots, instead of being bent down against the core, are extended straight out parallel with the shaft, and supported by cylindrical extensions from the spider at a diameter equal to a circle cutting the base of the core slots. When the winding has been properly disposed, it is carefully covered with insulation and bound in place with binding wires across the core face and out over the cylindrical end supports. The leads to the commutator are taken off at the extreme edge, leaving the conductors proper a compact cylinder like the rim of a pulley wheel, and nearly as substantial, presenting on the outside a smooth surface upon which dust and grit cannot collect, and protected fully on the inside by the core and the spider extensions. The task of replacing a damaged coil in such an armature is comparatively simple, and rupture of the insulation seldom occurs, as the coverings have little tendency to deteriorate when the conductors cannot shift or vibrate, and when wires of great difference of potential are kept well apart. Destruction by heating is guarded against by ample use of copper in the conductors, and by ventilating ducts through the core. The latera extension of the end connections as described provides also excellent means of radiation, and this arrangement of conductors reduces the length of wire at the ends to a minimum, effecting an economy in copper and an increase in efficiency. A practical advantage of much importance gained by this method of armature construction is that it effectually guards against damage due to careless workmanship. In constructing an ordinary wire-wound armature a careless winder may so abrade the covering of the wire that its insulation will be ruined. With the construction described, on the contrary, each coil or section is made up, formed, and insulated separately, and carefully tested for any imperfection. The separate sections being shaped by die before being placed on the core, assembly is a simple matter, and is attended with little or no danger to the insulation.

In commutators the chief development has been towards better mechanical construction. On the best machines the commutators are built in sections, so that separate parts may be removed and renewed without disturbing the balance of the commutator—a matter of great convenience on a large machine.

SWITCHBOARDS.

In modern practice the panel system is almost universally used in dealing with the switching and controlling gear of the station. The panels are usually slabs of polished slate or marble (wood being no longer sanctioned), upon which the necessary instruments are mounted so that each panel, whether for the control of a generator or a line feeder section, is complete in itself. By following fixed dimensions, and a regular arrangement of instruments and switches, any number of these panels may be mounted side by side, forming when interconnected a complete and simple switchboard. This practice is largely the result of the constant additions that have been necessary in almost all electric traction plants, and the desirability of increasing the capacity of a station by the addition of new machines and controlling gear without disturbing the instruments already installed, preserving at the same time the appearance and uniformity of the switchboard as a whole.

In the principle of switchboard arrangement there has been little or no change, except as to the main switches. Formerly it was the usual practice to mount the positive, negative, and neutral switches on a common yoke, and throw them in and out of circuit simultaneously by a single handle. It was then necessary, in putting a generator on the line in parallel with other machines, already running, to build up its field with the shunt excitation only, to a point something below the station voltage, so that when the positive, negative, and equalising switches were closed the additional field due to the series coil coming into action would bring the machine up to station pressure. It required some care on the part of the operator to determine how far to carry the shunt excitation so as not to fall below or exceed the station potential when the main switches were closed. Even with the greatest care there was always the danger of a fluctuation in the voltage of the running machines at the instant of closing. To prevent any tendency to motoring or flashing at the brushes, when throwing machines into parallel, the main switches were separated, so that each could be closed or opened independently, and this arrangement is now followed in practice. With separate switches it is possible to run the generator up to full voltage before throwing it into circuit by building up the shunt field and then closing the positive and equalising switches, thus putting the series coil into parallel with the series coils of the running machines. In order to connect with the line it is only necessary to close the negative switch, and the load will divide smoothly, the voltage being already balanced. A further practical advantage is gained by this arrangement in that less time is required to build up, due to separate excitation through the series coil. It also prevents the fields coming up at opposite polarity to those on the machines in operation.

The general arrangement of instruments on generator and feeder panels of a switchboard includes a "station" or "total current" panel fitted with high-reading ammeter and watt-meter. The lightning arresters and field rheostats are usually mounted at the back of the generator panels. It is usual on any extended system of electric traction to divide the line into insulated sections fed by separate feeders. Where it is practicable, the separate feeders are carried back from each individual section to the station, so that any part of the line may be thrown in or out of circuit at the main switchboard. As a rule, automatic circuit-breakers are placed in the feeder circuits as well as on the station mains, thus doubly protecting the generators. In early practice a fusible cut-out was thought sufficient to protect the dynamo from any excessive drafts of current, but it was found that a fuse small enough to properly protect the machine was subject to such frequent replacement as to prove an inconvenience. Automatic circuit-breakers were then adopted, mounted upon the switchboard of each generator; separate feeder circuits, when they were used, being fitted with fuses. This arrangement is sometimes followed still, but the free use of automatic circuit-breakers in central stations is

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becoming more and more universal, and now, as a rule, they are placed on all the separate feeder circuits as well as the station mains.

Overhead Line.

As a means of conveying current to the car the overhead trolley system must still be considered the standard, and where maximum efficiency is to be combined with minimum cost for installation there is little probability of its being superseded. Aside from the objection that may be raised to overhead trolley construction on the score of appearance, everything is in its favour, and there is no doubt that most of the prejudice against it is based on ignorance as to the character of a well-constructed line. There are certain districts, of course, where an overhead trolley wire could never be sanctioned, but for general purposes it has much to recommend it. Its general popularity in America has come gradually. The idea that overhead wires can be erected promiscuously in American cities is distinctly erroneous, and the opposition met with when the first trolley systems were installed there was in every way as vigorous as it has been in England or on the Continent.

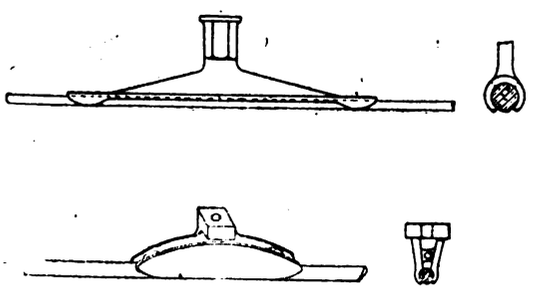

Fig. 4.

In dealing with high-speed service with the ordinary overhead trolley construction some difficulty was at first encountered in the method of supporting the wire. The form of support ordinarily used, such as shown in Fig. 4, by partially surrounding the wire, destroys the smoothness of the surface against which the wheel makes contact. Even at limited speeds of eight to twelve miles an hour the trolley wheel strikes a perceptible blow on passing such a support, but when the speed is increased to 20 and 30 miles an hour or more, as it often is on inter-urban service, this blow throws the wheel away from the wire, and

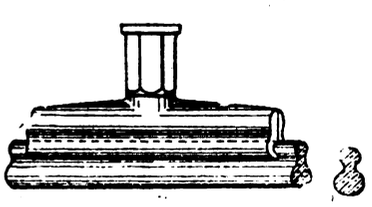

Fig. 5.

causes serious arcing. To overcome this difficulty a so-called "figure 8" section of wire has been used to some extent. Fig. 5 shows the section and method of support. It will be seen that this provides a continuous and regular under surface. The use of this wire has been limited, however, on account of its tendency to kink badly in handling. The form of support shown in Fig. 6 provides a perfectly smooth run-way for the wheel, and permits the use of standard round-section wire. In

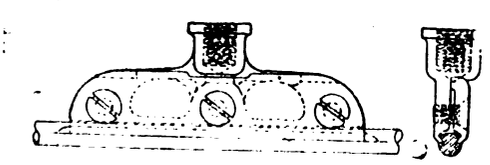

Fig. .

putting up a line with this method, the wire is milled at the points of support, as the work proceeds, by a special portable tool.

Ground Returns.

On a single-trolley line the question of track bonding is one of vital importance. The resistance of the rail joints must, of course, be kept at a minimum to secure best efficiency; but this is by no means the most serious consideration in applying electric traction to English conditions. Under the Board of Trade regulations limiting the drop in the ground return to a maximum of seven volts, methods of bonding that are practicable in American practice, where such a limit is not fixed, are entirely inadequate here. On an extended system in England it is, as a rule, the conductivity of the earth circuit that governs the design of the plant. It determines the necessary number of points of distribution, and the choice between direct and alternating current machinery in the generating station.

Fig. 7 shows various bonding devices that have been adopted from time to time, and which provide ample conductivity when first installed, but very few of them possess the virtue of main-

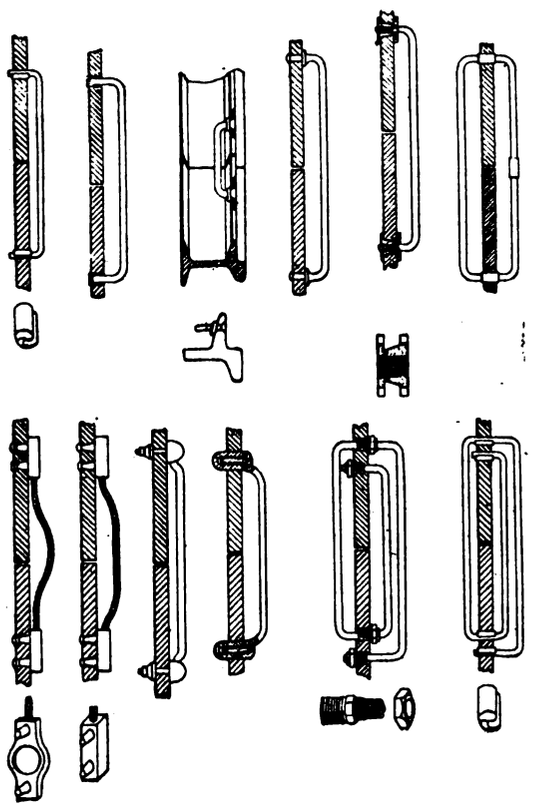

Fig. 7.

taining their contact in service. The bonding problem is a mechanical one. A serious difficulty in the development of electric traction has been to find means of rigidly supporting the rail ends, and the weakness of all metal bonds making contact by means of studs through the web of the rail is their liability of being worked loose by the up and down motion of the rails at the joint. The best way of making contact by means of a stud through the web is by spreading the metal in the stud out against the rail. The most effectual means of applying such a bond is that shown in Fig. 8, which is the arrangement most commonly used at present in practice. The stud is hollowed out by drilling, and is driven into a hole in the rail, which it fits tightly. A steel pin is then forced into the cavity in the stud, and, being slightly larger than the hole, it spreads the copper, bringing it into excellent contact with the rails. With this arrangement the hole in the rail may be made purposely irregular, and the copper in spreading will fill every crevice, increasing the maximum area of contact, and at the same time providing good mechanical means of preventing the stud from twisting or working loose. The projecting end of the stud may be turned back over the pin to prevent its backing out. Other methods have been adopted for making a contact of this kind,

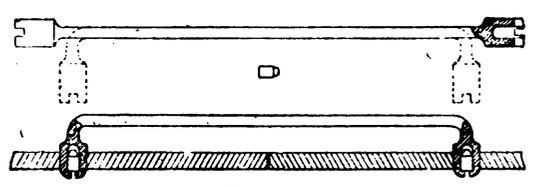

Fig. 8.

the stud being made solid, and spread by pressure applied at the end, but it is much more difficult in this way to ensure perfect contact over the entire inner surface of the rail hole. With weak rail joints no bond of the stud type can be relied upon to maintain permanent contact in service, no matter how firmly it may be set to begin with. Various arrangements of spring washers and gravity nuts have been tried to provide adjustment and absorb vibration, but without success.

A so-called plastic bond has been recently introduced which has shown good results in test. It provides a means of utilising the conductivity of the fishplates, no other solid conductors being introduced. Fig. 9 shows the method usually followed in applying this bond. A section of elastic cork, of convenient shape, with a hole in the centre, is placed vertically against the side of the rail; the hole is then filled with a plastic amalgam, and the fishplates bolted in place. The cork washer yields to

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the pressure of the fishplates, allowing the amalgam to spread somewhat on the surface of the rail web and the inner side of the fishplate, thus establishing the electrical connection. It is claimed for this material that it maintains its plastic condition and provides a permanent amalgamation of the metal surfaces.

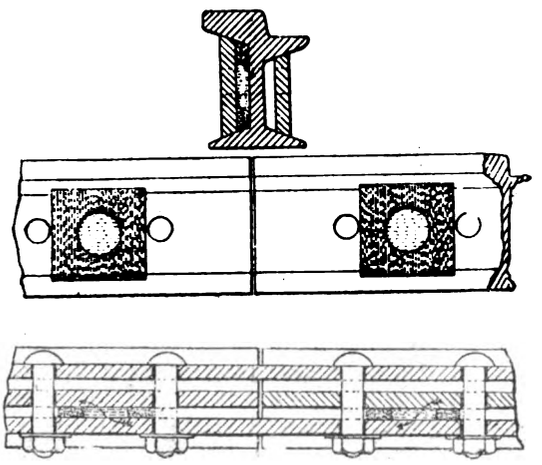

FIG 9.

If this is so, it is clear that any ordinary vibration and motion at the joint will not affect the contact. Fig. 10 shows another means of making contact. A hole is drilled down from the top of the rail into the fishplate, or from the base of the fishplate into the base of the rail, the cavity being in either

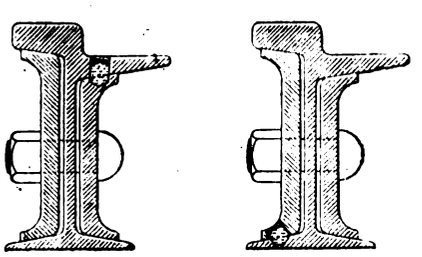

FIG. 10.

case filled with plastic material and covered with a small soft-iron plug.

Fig. 11 shows still another method, which has somewhat the characteristics of a mercury-cup connection. Holes are drilled into the abutting rails near the ends at the angle formed by the base of the web. These cavities are filled with the plastic amalgam, and receive the ends of a copper yoke, which spans the joint. No other means of contact is provided, and the yoke is held upright in position by the fishplate. A joint of this kind will, it seems, allow a great deal of motion between the rails without disturbing the connection.

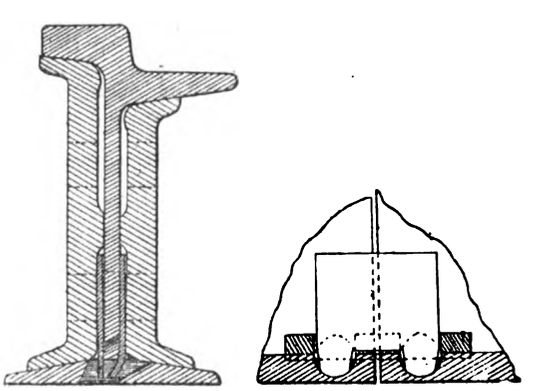

FIG. 11.

It must be remembered, however, that there are other considerations beside bonding which demand that movement at the rail joint should be prevented. With loose joints the whole car equipment is strained in service, and the cost of maintenance on the car body, the truck, and the motors is seriously increased. In this connection the experiments with electrical and cast welded rail joints are worthy of attention. The idea of forming by these methods a continuous rail arose first from mechanical considerations and the great difficulty of maintaining rigid joints. During the past two or three years a great deal of experience has been gained with solid joints under various climatic conditions, and the results indicate that this practice will have an important bearing on permanent-way construction, especially for electric traction when the rails form the return circuit. In making cast welded joints the rail ends are first cleaned, and then a mould is clamped around them and filled with molten iron, which forms, when it has set, a strong mechanical bond which has been found in service to withstand admirably great extremes in temperature without fracture. It often occurs, however, that the casting makes no union with the rail, and when this is the case it has little value as an electrical connection. When the joints are made with the rails at a comparatively low temperature (as they usually are, in order to secure the greatest possible contraction before joining, and therefore less liability of breakage in cold weather), the iron poured into the mould is apt to be chilled against the surface of the rail, preventing adhesion. Furthermore, the rail may expand slightly under the heat, contracting again when the mass has set, leaving the casting practically a shell around the joint, although supporting it rigidly. Mechanically, this may be considered an advantage, as it allows slight contraction and expansion with changes of temperature, without undue strain; and in some cases the rails are painted with a compound before the iron is poured around the joint, for the purpose of preventing any union of the metals. When the rail ends are left perfectly clean it frequently happens that a good union is effected, especially at the base of the rail, where the casting is thickest, and in such cases the joint has a very low electrical resistance. Until the process can be made to ensure adhesion of the metals, however, cast joints should, as a rule, be supplemented by the usual bond connections. When this is done no saving is effected in the first cost of bonding, but the solid joint will materially decrease the expense of maintaining the connections, doing away, as it does, with vibration and movement at the rail ends. When cast joints are used, frequent cross-bonding may be sufficient guard against bad electrical contact if the ground return is not worked to its utmost capacity, and in such cases the cost of bonding is reduced. There are several long sections of line in America with cast welded joints that are being operated without auxiliary bonding, and with apparently perfect satisfaction and freedom from electrolysis; but it is doubtful whether some of these sections would come within the existing Board of Trade limitations in England as to drop in the ground return.

Electric welding of the joints, on the other hand, secures perfect electric continuity, and reduces the joint resistance to that of any other part of the rail. It has been found difficult, however, in practice to secure the requisite mechanical strength by this means. Electric rail welding was formerly accomplished by placing two U-shaped yokes against the rail, one on each side, forming a link around the joint, and the weld proper was made between the ends of these yokes and the webs, 3in. or 4in. back from the rail ends. It was found, with this process, although perfect union was made with the web, that the weld, in cooling, introduced very severe strains on the surrounding metal, and frequently after short service the links broke loose, taking out a disc of each web still in perfect union with the yokes. The process was consequently abandoned, and rails are now welded by abutting the ends together and welding them under pressure. This gives greater mechanical strength, which is the principal consideration, and as such a joint has the full conductivity of the rail no auxiliary bonding is necessary. If these welds prove in practice to be as mechanically strong as cast joints, they will of course be preferable for electric traction, but if not, casting will be more economical although electrically imperfect. There seems to be no doubt that the principle of a continuous rail is mechanically sound, and that, when joints are made with the rails at a low average temperature, they are fully capable of withstanding strains of service and temperature, especially in climates with moderate extremes of heat and cold.

THREE-WIRE SYSTEM.

In dealing with long lines extending beyond the economical limits of 500-volt direct-current transmission, the three-wire system has been proposed, and applied to a limited extent in practice. This plan cannot be recommended in laying out a new plant for high-tension distribution, and is by no means as flexible as alternating-current transmission through sub-stations either with static transformers or rotary converters, but it may be considered in connection with existing systems that have outgrown their original capacity, and where it is desirable to increase the service with the existing plant without heavy expense for line copper and danger of exceeding a safe drop in the ground return. Theoretically, for a given amount of copper, the potential being double, only one-half the current should be required in operating a given number of cars if a perfect balance was maintained, the load being equal on each branch. By thus doubling the potential and halving the current the total line loss, with a given amount of copper, should be one-fourth that of the two-wire system. If such a balance could be maintained, reducing the track current to practically zero, danger of electrolytic trouble would be entirely removed. As a perfect balance is practically out of the question, however, the track must carry current and be bonded as with the ordinary two-wire system, and the net average saving in copper can only be taken

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as about 60 per cent. Various arrangements have been adopted for balancing the load. On an ordinary double-track line, with a fairly equal distribution of cars, it is only necessary to make one trolley wire positive and the other negative. The track in all cases with this system being neutral, those cars going in one direction balance with those going in the other, and the cross-bonding between the rails represents practically the only line drop outside of the trolley wires. With a single line an equal division is not so easily made. The positive and negative trolley wires may be erected side by side over the track, the cars going in one direction using one trolley wire, and those returning using the other; but it is not desirable to bring the two wires, between which there is a difference of potential of 1,000 volts, very near together, on account of danger of leakage and risk to linemen. Another arrangement is to divide the trolley into longitudinal sections, making such sections alternately positive and negative. This gives a better division for balancing the load than where two trolley wires are used on a single track, as in case of a blockade the cars congested at a point are apt to be going in the same direction, and would therefore on the double-trolley wire arrangement be on one side of the system, unless the trolleys on some of the cars were temporarily changed from one wire to the other. On double-track systems having branching single lines, the balauce may be made by dividing the branches equally as to load between the positive and negative mains, but this has the objection of requiring the current to flow over a considerable length of track, with attendant danger of electrolysis.

Another means of dividing the load is to have every car balance itself, by running two trolley wires over each track,

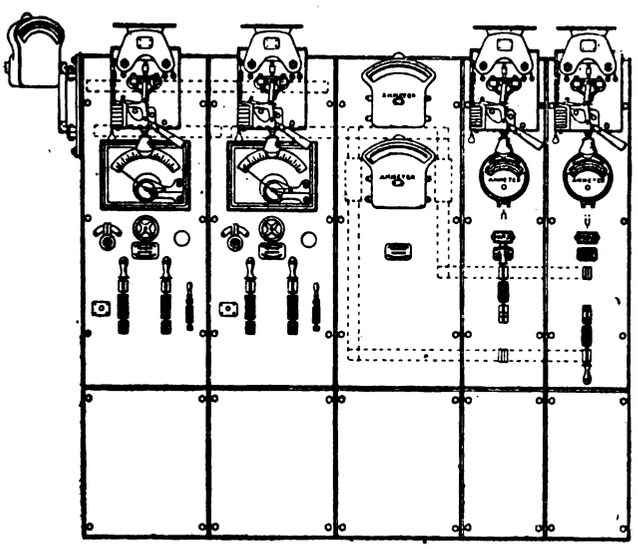

FIG. 12.

and mounting two trolley poles on the car, with two separate circuits between the trolley and the ground. This arrangement, however, is only to be considered with a four-motor equipment, as otherwise series-parallel controllers could not be used. A four-motor equipment may be divided into two circuits of two motors each, handled by the series-parallel method like two independent equipments, the controllers, consisting of two separate cylinders in one casing, geared together so as to act in unison. If this plan of balancing were followed with a double-motor equipment, each motor would have to be controlled separately by a rheostat—an inefficient arrangement as compared with series-parallel control.

Fig. 12 shows a specially arranged switchboard for the three-wire system, with the feeder switches arranged so that they may be thrown from one side to the other as desired, for balancing purposes. In using this system it is of course necessary to divide the station into units of two generators each. If, however, it is desirable on light loads to run only one machine, all the feeders may be thrown on one side, and the line run as an ordinary 500-volt two-wire system. As the number of cars running at such times would of a necessity be small, there would be no serious line loss.

MOTORS.

The improvements in street car motors have been along lines parallel to those followed in the development of generators. The adoption of steel has made possible the construction of much lighter, much stronger, and much more compact motors. The two-pole types have become practically obsolete, and multipolars have taken their place. The open frames necessary when machines are built of forged pieces have given way to entirely closed frames, which go far toward increasing the life of the motor and reducing expense of maintenance. Formerly the interior of the motor was open to the attacks of dust and grit in dry weather, and mud and water in wet weather, which caused rapid wearing away of the commutator and brushes and serious deterioration of the insulation. With the modern construction the armature, commutator, and brushes are completely enclosed between two bowl-shaped castings, excluding all grit and moisture. In the older forms the gearing was also exposed, and naturally cut rapidly away in service. All gearing is now enclosed in oil-tight casing, which increases its life and adds to the efficiency of the machine. The modern steel motor is, for a given output, only about one-half as heavy as the old wrought-iron bipolar type. This is clearly of the greatest importance as affecting the total weight of the car, reducing wear and tear on the permanent way, and economising power. The principle of armature construction already spoken of in connection with generators is now followed in all the best modern street car motors. Here it is of even greater importance than in the generator, as the motor armature is much more subject to overloads and consequent danger of burn-outs. The use of alternating-current motors for traction work has made little headway. With the exception of the line at Lugano, Italy, practically nothing has been done in practice with such apparatus. In spite of the many apparent advantages of such a system, it does not adapt itself economically to traction work. When current has to be widely distributed the use of three-phase motors will, of course, do away with the necessity of sub-stations, which is an advantage, and the absence of commutators is a large factor of economy. It is also a great convenience to be able at any given point on the line, where the conditions are severe, to place s special transformer delivering more than the normal voltage to the line, thus increasing the maximum torque of the motors for the time; or a special booster may be placed on the car and thrown into circuit whenever an increased torque is desirable. On the other hand, as the torque of this type of motor at a given voltage is limited, it is at a disadvantage for ordinary traction purposes as compared with a direct-current machine, having an indefinite maximum torque under similar conditions.

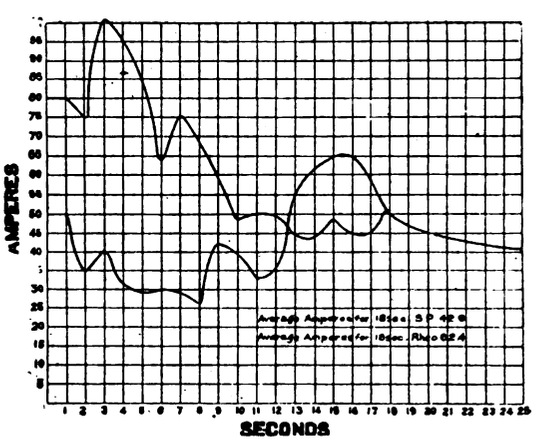

FIG. 13.

It is evident that for a given service a multiphase motor must be larger than a direct-current motor. When direct currents are used, the motor may be designed for more nearly the average work; and when severe conditions are met with, as in mounting a gradient or rounding a curve, the motor will exert sufficient torque to overcome the difficulty. The triphase equipment designed for the average work would be stalled under similar conditions. Consequently, three-phase traction motors must be designed for the maximum effort which they may have to exert. Another serious drawback in the triphase equipment, as compared with direct-current apparatus, is the fact that series-parallel control cannot be economically employed. The use of two trolley poles is also a disadvantage, although not necessarily a serious one. Experience so far has gone to show that the use of three-phase motors for traction work must be confined to special conditions, and that for ordinary service direct-current motors are much better adapted.

CONTROLLERS.

The series-parallel method of control is now used exclusively in standard practice wherever the car equipment consists of two motors. The economical advantages of this method of control are, of course, obvious, and some of the very earliest experimental equipments embodied controllers of this type. At that time it was customary to use an independent switch for passing from series to parallel, on account of the severe arcing that would otherwise occur at the instant of change. This arrangement was so inconvenient in practice that the idea was abandoned, and for some years the motors were controlled by commutation of the fields or by the use of graduated resistance. Now, however, that the old arcing difficulties have been overcome, series-parallel control has supplanted all other methods for double-motor equipments. The superimposed curves shown in Fig. 13 represent the comparative power consumption in starting

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a double-motor equipment with rheostatic and series-parallel controllers. It follows that the more congested the service, and the more frequently the car is stopped and started, the greater is the economy to be gained by the use of series-parallel controllers, and high-speed lines, or lines upon which fewest stops are made, gain least in total power consumption by their use. As the maximum possible draft, however—that is, should every car start at the same instant—on the power-house of any system using series-parallel control is approximately half as much as with rheostatic control, the maximum load is brought down nearer to the average load, with a corresponding saving in the necessary generators and engine power to be provided.

When modern series-parallel controllers were first produced, many large American systems found it to their advantage to install them on all their cars in service, and to throw away all other types of controller, the expense of the change being many times offset by the increased service of cars possible without additional power-house capacity or line feeders. If on a system using this method of control one-half the station capacity should be disabled, all the cars could still be operated by being run in series, and therefore at half speed, which would inconvenience the public much less than taking half the cars out of service and running the remainder at full speed. This plan also has the commercial advantage that just as many passengers can be carried, although the car mileage for the time being is reduced. The mechanical features of the modern controller have been carefully developed, and every precaution has been taken to prevent careless or unskilful motormen from injuring the apparatus. It is usual to so interlock the power and reversing cylinders by means of gearing that it is impossible to move the power handle unless the reversing switch is fully thrown either forward or backward, and impossible to move the reversing switch unless all power is cut off from the motors.

(To be continued.)

ELECTRIC LIGHTING AT CARLISLE.

We are indebted to the *Carlisle Journal* for the following abstract of Prof. A. B. W. Kennedy's report on the electric lighting of the city of Carlisle:

Prof. Alexander B. W. Kennedy, who was instructed to report to the General Purposes Committee of Carlisle Town Council upon the electric lighting of this city, has completed his report, which has now been printed for circulation among the members of the Town Council. He states with confidence, on the basis of actual experience in connection with municipal enterprises of the kind, that "a well-conducted municipal electric lighting undertaking is now certain of success, not only technically but also from a financial point of view;" and he sees no reason why Carlisle should be an exception to the rule, especially as the Corporation have at Tullie House a nucleus of lamps using a very considerable quantity of energy.

By their provisional order the Corporation are only bound to supply light at first within a very limited area in the centre of the city; but Prof. Kennedy says he thinks it is seldom advisable in starting an enterprise of the kind that the city should confine itself to the smallest allowable area. As a matter of policy and also of cost he thinks it is better to extend somewhat at first, so as to enable the Corporation to increase the number of consumers as rapidly as possible. "No enterprise of this kind," he says, "can pay with a minimum load; up to a certain point the larger the load over which the fixed charges can be distributed, the better the undertaking will pay. To the area shown in your map and forming Schedule 2 of your order, I therefore advise that you add the following streets: Botchergate, as far as Tait-street; The Crescent; Lowther-street, from The Crescent to East Tower street (of which only a small portion is included in your schedule), one side only; East Tower-street, Market-street, and Long-lane, as a means of connecting up the northern ends of your mains. In the estimate which follows I have allowed for all these extensions. Beyond the streets covered by your second schedule, the Act provides that you shall supply on demand to any consumer within 50 yards of any point on your distributing mains, with right to charge, however, for mains more than 20 yards long. Consumers at a greater distance than 50 yards from your mains you are not bound to supply unless they are prepared to guarantee you, for three years, an income for current used equivalent to not more than 20 per cent. on any special outlay which you have to incur on their account." Beyond the extensions mentioned, Prof. Kennedy also advises as to the cost of carrying the mains into the eastern or residential part of the city and into the south-western part or works district. As to the policy of carrying out these extensions, he says that practically in other places where he has carried out electric lighting work for a municipality extensions have been called for almost before the first part of the work was fairly completed. This has been notably the case in Chester, where he has now received instructions which practically involve the doubling of the plant at the station end of the mains. These extensions are rendered absolutely necessary by the requirements of would-be consumers. He thinks, therefore, as a matter of policy it would really be advisable to carry out the work, at least as regards the laying of mains, as fully as possible from the first. The rapid extension of demand for electric lighting as soon as it is available in a city is not now merely a matter of guess or of individual opinion; it has occurred so often and in so many different places that, at least in a city like Carlisle, it may be taken as quite certain.

As to the system of electric supply to be adopted, Prof. Kennedy advises the adoption of a continuous-current three-wire system with lamps running at about 200 volts. This is a system adopted in Chester; it is also the system upon which Edinburgh, Aberdeen, Oldham, and many other places for which he has schemed the electric lighting will be running in the course of the present summer. As to the site for the generating station, he recommends the vacant ground in James-street known as Brockbank's yard. It is large enough, if the station be laid out with reasonable care, for carrying plant sufficient for supplying more lamps than will be in use in Carlisle for many years to come. It is excellently situated as regards coal supply, having a siding already laid in front of it, and it would enable use to be made of the water of the river for condensing purposes. It is also very centrally placed from the point of view of electric supply to the city as a whole.

As to the probable demand for light, he thinks that in the scheduled area, together with the additions which he has advised in Botchergate, etc., and including Tullie House, they may expect soon to have something like 7,000 lamps wired, and of these to have something like 4,000 lamps alight at one time as a maximum demand. By laying an additional feeder into the residential district, and putting down about 2,200 yards of distributing main along Henry-street and in the quarters immediately north and south of it, as far to the east as Howard-place. they might gain something like 2,400 additional lamps (eight candle), of which 800 might be alight at once as a maximum. For supplying the works district, a feeder would be laid across the viaduct and along Denton-street. About 1,000 yards of distributing main laid here would provide for 4,000 to 5 000 lamps wired, if the works in that neighbourhood adopted the light. Of this number the mains would provide for 2,800 alight at once.

"The actual cost in the station of supplying the plant necessary for the central demand, including boilers, engines, dynamos, switchboard, battery, etc., erected complete and ready for work, would," Prof. Kennedy says, "be about £9,000. To this is to be added, say, £4,000 to £4,500 for excavation, buildings, and for a chimney stack large enough for a much extended station. The mains and their connections will cost about £2,700, and an addition of, say, £1,000 should be made for meters and house services, making a total of £17,200. This includes all the cost except cost of land, engineering fees, and expenses incurred by your own staff in connection with the work. If the scheme is gone on with on this basis it would probably be advisable that you should take power to borrow £20,000, of which of course you would actually borrow only so much as you found it necessary to expend. If you extended into the two outlying districts named, it will probably cost about £2,500 more for plant, and £2,300 more for mains, or, say in all, approximately £5,000 additional. This would make your probable expenditure about £22,000, for which it might be advisable to have power to borrow £25,000."

The Corporation have power to charge 8d. per unit, but practically all corporations, although they have the same powers as to maximum charge, have fixed upon 6d. as their rate, and in many cases this figure is being reduced as the demand for light increases. Assuming that Carlisle Corporation charge a maximum of 6d. per unit, the income from the first 7,000 lamps wired in the central district, each of which will use on the average about 15 units per annum, will be about £2,625. The total expenses in the generation of this amount of electric energy, including an allowance of 5 per cent. (for interest and sinking fund) on £20 000 will be about £2,200, leaving a net profit of over £400 per annum after paying all capital charges, when they have got 7,000 lamps wired. The additional income derived from the lamps in residential and works districts, with the amount of mains described above, would be about £1,825; the additional costs for the supply of this extra current, including capital charges on the further capital expenditure, would not exceed £600. The total income, therefore, from the whole scheme, when the Corporation have about 14,000 lamps wired, would be about £4,450, and the total expenditure, including all capital charges, about £2,800, leaving a net profit of £1,650. "This would not, of course, be reached in a first year of working," says Prof. Kennedy, "but I should not be at all surprised if it were reached at the end of a second. In Aberdeen, for instance, after a couple of years there were 16,000 lamps on circuit; in Oldham about 12,000; and in other similar places the number of lamps had been about the same. In Chester it seems as if this figure would be considerably exceeded. I think I ought to point out to your Corporation that the figures I have just given are not mere engineers' estimates, but are really figures based on the actual working of a number of stations in the hands of corporations, worked on lines very similar to those which I advise you to adopt."

The report concludes as follows: "I understood your committee to say that they did not wish to consider the question of street-lighting, at any rate at present, and under these circumstances I have not made any estimate in connection with the street-lighting, but I should like just to say that in other places it has been found that the somewhat brilliant lighting of, at any rate, a few of the principal streets, was not only very popular with the citizens, especially with the poorer classes, to whom the streets in fine weather are a popular promenade, but also had a very distinct effect in increasing the demand for brilliant lighting in the interior of shops and other premises. I have not said anything special as to the lighting of your markets. There

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is not only no difficulty in lighting the markets very effectively by electricity, but in many places this has been found to be a very popular movement. I understood, however, when in Carlisle that your markets were used so little in the evening that there would be no considerable amount of light required for them. I have therefore not taken them specially into account in my estimate of probable income."

The General Purposes Committee held a special meeting last week, Mr. Scott in the chair, when it was agreed that the report of Prof. Kennedy with his suggestions as to an extended area be adopted, and that he be asked to prepare plans and specifications upon which tenders may be obtained.

LEGAL INTELLIGENCE.

CHAMBERLAIN AND HOOKHAM v. JOHNSON AND PHILLIPS.

(Concluded from page 346.)

A report of this case will be found in our previous issues. The judgment was given on Saturday last.

Mr. Justice Wills: I do not think it necessary to go elaborately through the body of the specification in order to ascertain—which is the first step to be taken—the meaning of the first claim, which seems to me to be abundantly clear.

In the first place, the drawings are, in my opinion, referred to not to confine the claim to one form of apparatus, which they graphically describe, but to give a perfectly definite description of that one form of apparatus, and to illustrate at once the principle and method of combining electromotor and brake both in a constant and powerful field, and preferably both using the same field. It is emphatically a combination claim in which all the elements described in the specification, and illustrated in the drawings, are to be found together. These seem to include (1) an armature of any known type with a constant field, (2) the use of a powerful field for the electromotor, and also for an electric, or, perhaps, it would be more proper to say, a magnetic brake; (3) the application of a permanent magnet in the form of a ring as nearly complete as possible only interrupted by the narrowest practicable interval, with large pole-pieces on each side of the interval, so as to afford ample facilities for passages of the lines of magnetic force, and to reduce to a practical zero the lines of magnetic force during the passage of the magnetic flux through the air, the pole-pieces being so arranged that each revolution of the armature shall involve its passage into and out of the magnetic field so as to give rise to Foucault currents, whose action constitutes the braking power by magnetising them when in position. I have purposely, for the sake of simplicity, missed one or two contemplated variations. For instance, the one constant field may be replaced by two, and the permanent magnet by an electromagnet, but these matters do not affect anything I have to say at present, and for the sake of simplicity may for the moment be left out of my statement. Further, there is a clockwork arrangement for registering the number of revolutions of the armature; but as, except in one small matter forming the subject of a subordinate claim, it is a well-known type, I do not propose at present to say anything about it. The first claim makes no reference to it, and it is with the first claim only that I proceed to deal.

Most of the above elements of the invention appear so clearly on the face of the specification that I need only state them. The necessity for a magnetic field, I think, appears clearly enough also, though it is not so specifically stated as one perhaps might expect. The work done by the motor and the resistance offered by the magnetic brake are in direct proportion to the speed of rotation. Friction in being reduced as low as possible varies nearly as the square of the speed of rotation, hence it will be a seriously disturbing element unless it can be made negligible. This can only be done by exaggerating the other forces as compared to it. Hence the necessity for a powerful field. If it be so powerful that friction may for practical purposes be overlooked, the speed of rotation will then, and then only, be directly proportional to the armature current. I gather all this from the specification, and without any evidence except that friction varies at a higher speed than the speed of rotation, and I point particularly to p. 1, lines 13 to 15, lines 28 and 29; p. 2, lines 11 to 14; p. 4, line 12; p. 5, lines 5 to 7; and lines 26 and 27 of the specification.

To my mind, and whatever the consequences with regard to novelty or to sufficiency of specification, the application of this combination to all ordinary forms of electromotors is clearly within the claim. In the "description" we have, the electromotor may be of any of the ordinary forms in use. One form of electromotor well known at the date of the patent had the cup armature, and the cup armature form is therefore included in the claim. I emphasise this because the alleged infringement has a cup armature, and the first objection that has been taken to the specification is that it contains no specific directions which could enable a workman to make a meter adapted to a cup armature. I have never had to deal with a patent case in which it has been more difficult to prevent one branch of the enquiry running into another, and I cannot, therefore, hope to make my judgment a model of arrangement. But I think I cannot adopt a more convenient course than by dealing at once with this question. I am afraid I need hardly say that conflicting opinions on this subject are entertained by the expert witnesses. But I think I can offer some intelligible reasons for the conclusion I have arrived at.

The apparatus described in the patent is shown bodily in the exhibit G.H. 1. Nothing turned upon the details of the electromotor. Notwithstanding that the specification describes them elaborately, I do not gather from the patent that any particular stress is laid upon them, inasmuch as any inference of that kind is qualified by the general statement that "the electromotor may be of any of the ordinary forms now in use," which implies that any known type of armature will do. Now the cup armature involves a total departure in externals from the form given in the drawings, and the real question to my mind is whether the workman who had the drawings on G.H. 1 could without experiment adapt them to an apparatus of the type of J.J. 1, the alleged infringement, which will do perfectly well to illustrate what I am going to say. It seems to me that the skilled workman could not help seeing that he had to arrange his permanent magnets so that one group of them should end in a pole-piece or pole-pieces coming up inside, and the other group with the corresponding pole-piece or pole-pieces coming up outside the cup. I do not see how he could do this except by placing them at some little distance apart from one another, the one group forming a bundle in the middle, and the other forming a ring outside the cup, the pole-pieces respectively inside and outside the cup being brought as near to the inside and outside of the cup as they could be brought without impeding the rotation of the armature. It seems to me that thus the very necessities of the case would suggest all that was absolutely necessary. Let us suppose that the north ends of the interior group of magnets and the south ends of the exterior group are those which rest on the floor of the cylinder, which must include them all. The slight mechanical arrangement by which the south ends of the exterior group would have to be connected with the north ends of the interior group, and by which the south ends of the interior group should be brought to a magnetic focus, so to speak, in the south pole-piece of the interior group, and by which the north pole-piece outside the cup should be made the magnetic focus at this end of the exterior circle of bar magnets seems, as it seems to me, to be perfectly within the grasp of a mechanical engineer skilled in this kind of work. The necessity for keeping friction low would prevent him from making the cup too large. The necessity for strong braking action would prevent him from making it too small, and I cannot, in spite of my respect for the witnesses who have expressed opinions to the contrary, bring myself to entertain serious doubt that notwithstanding the great and manifest differences to the eye in the two sets of apparatus, there would have been no great difficulty in constructing a working machine of the J.J. 1 type by a skilled workman who had before him G.H. 1, or the drawing which very fully and accurately described that apparatus.

I think it also impossible to doubt that such a skilled workman would have known that his pole-pieces must neither of them be continuous all round the circle of which they must necessarily form part, as he would know that if they were continuous, there would be no braking action at all, and that, subject to allowing a sufficient space of discontinuity if he used more than one of them, should give as large aggregate areas as possible. I think I see where I and the defendants' witnesses upon this point diverge. I think they have been speaking with the apparatus J.J. 1 in their minds just as it stands; and I have no doubt that with respect to many matters of nice adjustment and proportion so as to get the best result, they are right enough. I still retain my opinion that a skilled workman would have adapted G.H. 1 to the cup armature, and made without experiment a working machine, though probably not so good a one as J.J. 1. This objection therefore fails.

Other objections have been taken to the sufficiency of the specification, but so much light will be thrown upon them by a discussion of the important question as to the novelty of the invention, that I propose now to address myself to that question. In doing so it must be borne in mind that I consider this to be a patent simply for the combination described. It is urged on behalf of the defendants that there is nothing in the combination that is new, and specifically an anticipation by a patent of Messrs. Ayrton and Perry in 1882 is alleged.

A patentee is not bound in a combination claim to distinguish between new and old parts in the combination, and he has not so. But in dealing with the question of novelty it is very necessary to consider how much is new and how much is old, and I shall address myself at once to this enquiry.

The electromotor part of the apparatus it is conceded is no novelty. The idea of using the Foucault currents for producing braking action is clearly not new, nor is the idea, in a general way at least, of applying this braking action to an electricity meter. I think it quite impossible to doubt that it is described in definite terms by Ayrton and Perry (Specification, p. 4, lines 43 and 47). Where the revolution of magnets in front of a disc is undistinguishable in principle from the revolution of a disc in front of the magnets. Mr. Moulton laid great stress upon the arrangement of the permanent magnets so as to secure at once a powerful and a constant electric field. I think it clear that strength of field is pointed out as essential in order to dwarf the force of friction in comparison, and it is also clear that an arrangement is indicated by which when permanent magnets are used constancy may be obtained as well as strength—namely, by taking care that the pole-pieces shall be very large as compared with their distance apart. (See also on this point Mr. Swinburne's evidence, Shorthand Notes, p. 99, question 1,444. Some further details are given in lines 19 to 26, but they are concerned only with giving an advantageous, not a necessary, proportion between the area of the pole-pieces and their distance apart—proportions which, I think, are not put higher than as illustrations, and which, from the nature of the case, are hardly attainable when a cup armature is used. As

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to electromagnets, there is nothing new in the method of making them either strong or constant; strength and constancy will be secured so long as the electric current is adequate and constant. But of course the need for strength and constancy is the same with regard to them as with regard to the permanent magnets. The evidence as to whether the means adopted of securing strength and constancy in permanent magnets was new or not is as usual, not all one way. But I think it comes substantially to this: that although it was known long ago that a closed circuit in a permanent magnet would give strength, and that a circuit with only a very narrow slit interrupting its continuity had very much the same effect in this respect as a closed circuit, and although it was also known that large pole-pieces contributed to the same end, yet that there had been practical difficulties in the way of preserving constancy which, until Mr. Hookham made his investigations and experiments, had led to the practical abandonment of permanent magnets for the purposes for which constancy was required. (See Mr. Swinburne's evidence, Shorthand Notes, p. 55, 62, and 69, and Mr. Boys's, p. 122. It seems to me established that he did invent a form of permanent magnet with great splayed ends where the continuity was broken, which did effectually secure constancy, and that it was really this which made his invention, where permanent magnets were used, a success. He described the conditions of his successful magnet only, it is true, in the way to which I have called attention, but he did effectually claim it as described as an element of his combination, and he certainly applied his combination whether in the case of electromagnets or permanent magnets for the first time practically to the purpose of producing an electrical meter. There is also, as I think, novelty proved in the arrangement by which the residual friction which cannot be got rid of is made a negligible quantity. The bare idea of having one thing so small in comparison with another that it need not be taken into account beside it is, of course, as old as the hills; it is the fundamental notion involved in a good many applications at least of the integral calculus as, for instance, in the measurement of the area of a closed curve, and it cannot, I think, be foreign to either mathematician or mechanician, but the method or purpose of its application to electricity meters is, I think, shown to be once new and ingenious.

There is, therefore, in my opinion, abundance of novelty to support the claim for the combination.

Has it been anticipated by the patent of Ayrton and Perry of 1882? Their patent, it is hardly disputed, outlined in theory most that has been done since 1882. Mr. Hookham, I am satisfied, knew nothing of their patent, and was an independent discoverer and inventor, but the theory of the process adopted by Mr. Hookham (except, I think, as to the use of a field constant, and so powerful as to throw friction into the shade) was given by them. Their specification, however, is very scanty in practical directions. They allowed their patent to lapse, not caring to pay the last fees to the Crown. There was, I am satisfied, at that time (in 1884 I think it was) no real demand for meters. Messrs. Ayrton and Perry made under the portion of their patent which alone can be put forward as anticipating the present apparatus, four energy meters, but, I think, did not sell any, so that there is no case of anticipation by user. The evidence is to a certain extent contradictory as to whether from their specification alone an electrical engineer could have given directions to a properly skilled workman which would have enabled him to make, without further experiment, a working apparatus (which is the proper test of anticipation)—I mean a meter that would work. I think, however, that the weight of the evidence is upon this point entirely in favour of the plaintiffs. Probably the evidence of Prof. Silvanus Thompson is the most important for the defendants upon this point, but it seems to me, after carefully re-reading all he has said about it, as it did when I heard him, that he is by no means confident that it could have been done. Handford's patent of 1883 is also said to be an anticipation. I am not quite sure that I understand why Handford adopted the cup armature motor and put his brake on the same spindle with the armature. But he depended for his brake upon vanes, which were to revolve in fluid, and which, except at low speeds, would give a resistance varying more nearly as the square of the force than directly with it. This is clear upon the evidence. I was shown an experiment in which the resistance of a fluid in apparently one of Handford's brakes varied directly as the speed of rotation, but it was an experiment which had nothing to do with Handford's apparatus, for all the vanes had been taken away, and the fluid used was oil, which, it turns out, must be kept by elaborate precautions at a uniform temperature (for which Handford gives no directions) in order, even with the bare spindle, to produce the result shown. Handford's was not, in my opinion, a practical meter of any sort, and it appears to me to be from any point of view a very long way off Mr. Hookham's.

It has been strongly urged that the directions given as to the proportions between the size of pole-pieces and the breadth of the brake in the continuity of the ring which gives the complete magnetic circuit are not sufficiently specific to make good working directions by which the apparatus can be made. I am of opinion, however, that the descriptions and drawings give ample information to enable a workman to construct an apparatus of that type, and no satisfactory evidence has been offered to rebut the evidence for the plaintiff that a skilled workman would easily adapt the arrangements to another type. I have already dealt with this matter as regards the cup armature, and this is the only form as to which serious exception has been taken upon this ground.

There remains the very important question of infringement of the claim now under consideration. It follows almost as a matter of course from the view I take as to the sufficiency of the specification as applied to the cup armature, that with all the improvements and apparent difference introduced into the defendants' apparatus that I must think it an infringement, unless there be something to qualify the real similarity (despite the different look) which I have pointed out. In my opinion there is not. It is true that the plaintiffs' apparatus as figured has a commutator as a necessary part of the motor, and that the defendants' apparatus has none—but the cup armature necessarily involved the absence of a commutator. But it is said the pole-pieces are different in the two arrangements. The proportions given in lines 20 to 26 on p. 5 of the specification between the two ratios there specified are considerably departed from in the defendants' apparatus, and there is a great difference in appearance. The proportions given, however, are clearly not of the essence of the specification. They are introduced by "preferably." I assume that the patentee has satisfied himself that this was the best proportion between the two ratios when obtainable as it is with the disc armature. But the only thing that is insisted upon as essential is that the pole-pieces should have their surface very large compared with their distance apart. The confined space into which the cup armature of the interior pole-piece or pole-pieces must be contracted prevents their being of a size or a shape anything like the splayed pole-pieces shown in the drawings. The cup armature must be kept small in order to keep down weight and friction. Relatively to the cup the total area of the pole-pieces as shown in exhibit G.H.[4] is very large, and in the aggregate they constitute a large surface. It must have been obvious to any intelligent reader of the specification that when the invention was applied to a cup armature the size of the pole-pieces must be diminished, and must become more or less of a compromise. Mr. Swinburne says they are smaller in section than those shown in the drawings, but not so small as they look, and he adds that though the proportion between the two ratios mentioned in p. 5, lines 20 to 22, did not come in the defendants' meter within what is given as the preferential proportion, "they are somewhat near it." (Shorthand notes, p. 101.) It seems to me that the differences are apparent and not real, and that the arrangement of pole-pieces in "G.H.[4]" which is only the portion now under discussion of the defendants' apparatus) is in truth that described in the words and drawings in Hookham's specification, with nothing more than the inevitable modifications necessary when the cup armature is used. If the defendants had collected together into one segment the areas of the three pole-pieces, they would have one pole-piece occupying about one-third of the circle. They would have had a worse brake, but one in which the pole piece would have looked more like that of "G.H.[1]," and yet would have had no more pole-piece area than that given by the present arrangement.

I have therefore come to the conclusion that the plaintiffs' witnesses are right in saying that there is substantial identity, notwithstanding that which looks like dissimilarity in the apparatus of the specification and that of the defendant—in other words, that the case of infringement of the first claim is made out.

I proceed to the case of the alleged infringement of the sixth claim. Here I entertain a very clear opinion that, notwithstanding an appearance of obvious similarity, there is no real identity, and that no infringement has been committed. The sixth claim is for "making grooves in the pole-piece of the magnet of an electricity meter for the purpose of increasing the action of the brake as described and illustrated, etc." The defendants' so-called grooves are in the periphery of what would otherwise be a solid cylindrical pole-piece. But a solid cylindrical pole-piece never could be used for the purpose of a brake. It would defeat its own end—as the Foucault currents which give the braking power depend upon having some part or parts of the solid cylinder cut away. Mr. Hookham therefore must have contemplated the use with the use of a cup armature, of a non-continuous pole-piece—which is necessary to create braking power at all—and what he claims is such grooves as would increase the power of the brake. It is not a breach of this claim to create a brake by means of a non-continuous pole-piece, though it would be when you had got it to put grooves into it to increase its power. You might make a very bad instrument with small braking power by throwing the pole-pieces of "G.H.[4]" into one sector. You surely might duplicate that sector in order to get more braking power, or triplicate it, in which case you would be obliged to reduce the size of each sector, or you would get back to continuity of substance, or something very like it. When you triplicated the sector you would get just the arrangement which the defendants have, except that for what I am satisfied are merely structural reasons they have made their triplicate pole-pieces with parallel sides instead of giving them the strict form of sector of circles. Not one of these gaps increases any Foucault action belonging to any one of the separate and intermediate pole-pieces. They are necessary in order to enable the intermediate magnetised metal to act as a brake at all, and this is equally true of the so-called grooving both inside and outside of the armature. Grooves in the separate pole-pieces of "G.H.[4]" would have been infringements. The gaps between the pole-pieces, however much they may give to the triple pole-piece the appearance of being grooved, are I am quite satisfied, no infringement of the sixth claim.

Objections have been made to Claims 2, 3, 5, and 8 on the score either of disconformity or want of novelty. The objection to Claim 3 is practically answered by what I have said in discussing the first claim. The evidence is conflicting, but I am of opinion that although Profs. Ayrton and Perry's specification points out very nearly all the theory of the matter, it stopped there; that there was no prior publication of any practical way of procuring a constant yield of permanent magnets, and that the patentee is entitled, although they are not mentioned in the provisional specification, to claim their use in electricity meters, has been according to Woodward *v.* Sanson 3 Patent Reports 166 in the Court of Appeal, a fair extension of the provisional specification.

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As to the fifth claim, I understand the objection to be that it is unlimited in its terms, and might apply to all uses to which such a commutator could be put. It is, in my opinion, a very copious objection. It is plain it is intended to apply only to the arrangement used in connection with electricity meters or with dynamo-electric generators and motors.

The eighth claim relates to a very small invention, but one not at all wanting in ingenuity, but in diminishing friction and subserving the general purposes of the invention, confined, like Claim 5, to use in electricity meters and dynamo-electric generators and motors, because the whole subject-matter of the specification is confined to them. It is not to be supposed for a moment that the patentee meant in these two claims, and any other not specifically limited to electricity meters, to go into the whole field of possible mechanical use for such inventions. The absence of the limiting words "electricity meters" found where the subject-matter needs such limitation is explained by the fact that dynamo-electric generators or motors are also included in the specification.

To diminish friction is important in any electricity meter, specially so in this. One idea upon which stress is laid in the specification is to make the electromotive action, and, of course, the braking action, also very large in comparison with friction, so that friction may be, in the phrase of the patentee, "negligible." The reason for this is that the motor action and the braking action are both proportional to the velocity of the armature. Friction is not so, but varies roughly as the square of the velocity. If, therefore, friction has to be taken into account, the problem to be solved is greatly complicated. Of course, under these circumstances, friction should, in the first place, be made as small as possible, and this eighth claim relates to a mechanical contrivance, clearly new, which does something towards diminishing friction, and is therefore useful. I have thus disposed of everything except the objection to the second claim, which is that there is no invention at all in it. As usual, much of the difficulty entirely disappears if the claim be carefully construed. It says, "Secondly, in electromotors, the obtaining a constant field either for the brake, or the armature, or both, by the use of electromagnets of such construction and dimensions, that they became saturated while in use in the circuits of the kind for which they are designed substantially as described."

It does not seem to me to be at all a happy specimen of drafting, but its meaning is clear enough for all that. The phrase "as described" cannot apply to the mode of construction, winding, etc., of the magnets, because no description is given. The paragraph at the bottom of p. 4 of the specification is a material one, and it treats the methods of obtaining saturation and the proportions between the size and length of wires and strength of electrical current used, and so forth, as being—what they were in 1887—common knowledge. It is therefore the method of obtaining the constant field to which the words "as described" refer, and I read the claim as equivalent to "the obtaining in electricity meters a constant field by the use of saturated electromagnets." Inasmuch as the constant field "as described" is certainly also a powerful field, I think it may even very reasonably be read as claiming the obtaining of a field at once constant and powerful by the use of these saturated electromagnets, though it is of very little consequence which reading be adopted. This constancy of field is a very important matter in Mr. Hookham's apparatus, because his is a current meter, and only indirectly and in certain circumstances an energy meter. *In electric lighting, to* take an instance, the customer pays for energy; Mr. Hookham measures current only. If the pressure is constant, as it is practically in the supply for lighting, current is proportional to energy, and energy is measured when the current is measured. Messrs. Ayrton and Perry, whose specification contains the only serious approach to anticipation, propose to measure energy whether the pressure be constant or varying. Necessary constancy of field, therefore would be as bad for Messrs. Ayrton and Perry's system as it is good for Mr Hookham's. The application, therefore, of the well-known means of obtaining a constant field to electricity meters appears to me to be one "lying so much out of the track of its former use as not naturally to suggest itself to a person turning his mind to the subject, but to require some thought and study." I use the words of Lord Chelmsford (C. in Penn *v.* Bibby, Law Reports 2, Chancery Appeals, pp. 127 to 136), and the only alteration I should make in applying them would be that I think there is in this instance a good deal of ingenuity in the novel application of an old process.

It has been urged upon me that the decision I have arrived at will involve upon Prof. Perry, one of the patentees of 1882, great hardship, inasmuch as the defendants are his licensees working under a patent of 1890 and that it is a strange thing that one of the two men who laid down the correct theory and indicated the lines upon which to work should be thus "hoist with his own petard."

I am very truly sorry if my decision does involve hardship, but I cannot help the conclusions I have arrived at. They seem to me after the most serious consideration to be the right ones, after which there is no more to be said. But it is well-known law—no intelligent patentee can be ignorant of it—that in order to give right to a monopoly the patentee must not merely set a problem and perhaps even render it not very difficult to solve, but must condescend to practical details, so that at the expiration of the patent the rest of the world may be able without further experiment to make the patented article. This condition, I think, Messrs. Ayrton and Perry did not fulfil, and, if so, they cannot complain that another should travel by the road they have discovered up to the door which they did not unlock, and, having found the key himself, should unlock the door, go in, and shut them out.

My judgment, for the reasons given, must be for the plaintiffs, with the injunction and account prayed for and delivery up of infringing articles. I certify that the validity of the letters patent No. 4 225 of 1887 granted to George Hookham came in question, and that the particulars of the breaches, excepting those relating to the grooving of pole-pieces, have been proved. I allow the printed shorthand notes, including those of the final addresses of the counsel, without which I could hardly have got on.

The enquiry has been materially lengthened by the charge of infringement of the sixth claim, and I think my order as to costs ought to be that the costs be taxed, as if the plaintiffs had succeeded upon all the matters in dispute, and the allocatur be given for three-fourths of the sum so ascertained. The costs to be taxed on the higher scale.

The taxation of costs was deferred for a fortnight while the defendants consider their position as to whether they will appeal. Mr. Justice Wills certified for their counsel.

BURNLEY AND DISTRICT TRAMWAYS COMPANY, LIMITED—MOTORCARS ON TRAMLINES.

In the Court of Chancery, before Mr. Justice Romer, the shareholders in the Burnley and District Tramways Company having by special resolution altered the Company's articles of association by including the use of motorcars on their lines for locomotion among the objects of the Company's formation, petitioned the Court for its sanction of the alteration.

Mr. Justice Romer made the order as asked.

DISPUTED ORDER OF ELECTRIC LAMPS.

In the Westminster County Court, on Tuesday, the case of Fryer *v.* Holtman was before his Honour Judge Lumley Smith, Q.C., on a judgment summons applying for the committal of the defendant for non-payment of a judgment debt in respect of electric lamps supplied.

The **Debtor** appeared and said he never ordered the goods and would never pay for them if he could help it.

His **Honour** said time would prove as to that, and made an order for payment in a month, subject to committal in default.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

The National Telephone Company, Limited, invite tenders for the purchase of quantities of obsolete stores. See advertisement.

Constantinople.—Tenders will be received on the 21st inst. by the Turkish Telegraphic Authorities for telegraph wire, insulators, sal ammoniac, etc.

Dieppe.—Tenders will be received on the 29th inst. at the Sous-Prefecture at Dieppe for furnishing and fitting the telegraph and post office. Applications should be made by the 24th inst.

Blackburn—The Corporation are prepared to receive tenders for the supply and erection of electric tramway equipment, full particulars of which appears in our advertisement columns.

Liege.—Tenders will be received by the Provincial Government of Liège on May 3 for the construction, maintenance, and working of an overhead electric tramway from Grivegnée (Bonne-Femme) to Chênée.

Aberdeen.—The Corporation are prepared to receive tenders for the supply, for one year, of electricity supply meters, house fuse boxes, and house concentric armoured service cables. See advertisement.

Bucharest.—The Roumanian Government will want tenders on August 20 for the supply of 55,000 porcelain insulators (double bell), and other porcelain telegraphic fittings. Application should be made to the Direction of Posts and Telegraphs at Bucharest.

Dresden.—Tenders are wanted on April 21 by the City Authorities for 2,100 metres of copper wire (various sizes), about three-quarter ton of copper rod, 800 metres of steel wire rope, and 500 metres of double cable insulated. Particulars at the offices (Betriebsamt der Gas Wasser und Elektricitätswerke), Dresden.

Amsterdam.—The Consul-General of the South African Republic invites tenders for the supply of (1) insulators and (2) hard-drawn copper wire. Tenders which have not been received before 24th inst., Doelenstraat No. 8, at Amsterdam, will not be regarded. Specifications (in two tenders) will be procured on demand by Mr. F. J. Belinfaute, late A. D. Schinkel, Paveljoensgracht, The Hague, at the price of 1sh. each.

Valletta.—Sealed tenders will be received at the office of the Receiver-General and Director of Contracts, Valletta, until 11 a.m. of Tuesday, May 4, for the supply of a 200 kilowatt steam alternator, a steam-engine to drive directly the 200-kilowatt alternator, and a water-tube boiler and accessories to evaporate 6,000lb. of water an hour at 150lb. of pressure from 60deg. F. For full particulars see advertisement.

Salford.—Tenders are required by the Corporation for the fittings, etc., required (including fixing) for lighting with electricity certain rooms in the town hall. Plans of the town hall may be obtained from the Borough Engineer, Town Hall, Salford. Tenders, endorsed "Electric Lighting of Town Hall," together with drawings, etc., to be sent to Mr. Samuel Brown, town clerk, Town Hall, Salford, addressed to the Chairman of the Town Halls, etc., Committee, by 19th inst.

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Blackburn.—The Corporation require tenders for the erection of a new chimney, 150ft. high, at the electricity works, Jubilee-street. The specification, form of tender, and schedule of quantities may be obtained on the payment of £2. 2s. (returnable on receipt of a bona fide tender) at the office of Mr. E. M. Lacey, consulting engineer to the Corporation, 10, Delahay-street, Westminster. Sealed tenders, endorsed "Tender for Chimney," to be delivered to Mr. Robert E. Fox, town clerk, Town Hall, Blackburn, by noon on 24th inst.

Bedford.—Tenders are required by the Electric Light Committee for the supply and erection of the following plant: two water-tube boilers, fitted with Vicar's mechanical stokers, alternating-current motor, and steam-piping. Specification, with terms and conditions of tender and contract, may be obtained at the offices of Mr. T. S. Porter, town clerk, Town Hall, Bedford, on payment of £2. 2s., which will be returned on receipt of a bona fide tender. Tenders, sealed, and marked "Electric Lighting," must be delivered to the Town Clerk by 20th inst.

London, N.W.—The St. Pancras Vestry are prepared to receive tenders for the wiring and other works in connection with electric lighting of the Whitfield-street baths and wash-houses. Copies of the specification and conditions of contract can be obtained, and a plan of the general positions of the lights inspected, at the Electricity Department Offices, 57, Pratt-street, N.W, on payment of a deposit of £1, which will be returned on receipt of a bona fide tender. Tenders to be sent to Mr. C. H. F. Barrett, vestry clerk, Vestry Hall, Pancras-road, London, N.W., endorsed "Tender for Wiring Baths and Wash-houses," by 12 noon on 27th inst.

Aberdeen.—The Corporation are prepared to receive tenders for the manufacture, delivery, and erection of an electrical storage battery, to consist of 125 cells of 400 ampere hours capacity, also for battery-regulating switches. Sealed tenders, addressed to the Town Clerk, Town House, Aberdeen, must be received by the first post on 27th inst, endorsed "Offer for Electrical Storage Battery" or "Offer for Battery-Regulating Switches," as the case may be. Specifications can be obtained, on payment of 10s., on application to Mr. Alfred Blackman, city electrical engineer, Cotton-street, Aberdeen, the amount to be refunded on receipt of a bona fide tender.

Blackpool.—The Corporation invite tenders for the work required in erection of new electric tram shed. Plans may be seen, and specification and bill of quantities may be obtained, at the Borough Surveyor's Office, Market-street, Blackpool, on deposit of £1. 1s., which will be returned on receipt of a bona fide tender. The person whose tender is accepted will be required to undertake to observe the recognised customs and conditions as to standard rates of wages and working hours which prevail in each particular trade in the borough. Sealed tenders, endorsed "Tender for New Tram Shed," and addressed to the Chairman, Electric Tramway Committee, Tramway Office, Blundell-street, Blackpool, must be delivered by 19th inst.

Egremont (Cheshire).—The Wallasey Urban District Council require tenders for supplying for 12 months, from June 30, the following among other articles, being the principal stores required for the use of their electrical works—viz., paper-insulated concentric cables, electric meters, lamp columns and lamps, main switches and cut-outs. Further particulars, with forms of tender, may be had and samples inspected on application at the Gas and Water Engineer's Office, Great Float, near Birkenhead. Sealed tenders which must be on the printed forms, properly endorsed, and addressed to the Chairman of the Gas and Water Committee, to be left at the office of Mr. W. Danger, clerk, Public Offices, Egremont, Cheshire, by 4 p.m. on 22nd inst. The contractors will be required to enter into formal contracts, and may also be required to give security, in conformity with the Public Health Act, 1875.

RESULTS OF TENDERS.

Huddersfield.—The Corporation have placed their extension order for plant for next winter with the Brush Electrical Engineering Company.

London, S.W.—The following tenders were received for electric lighting and decorative works at 14, Nevern-square, Kensington, S.W.:

Rugg and Son	£350	8	0
H. Smith and Son	343	5	0
Simmonds Bros.	321	0	0
J. Whitaker	313	0	0
F. Holdstock, Earl's Court (accepted)	299	0	0

BUSINESS NOTES.

Wakefield.—The City Council have passed the plans for a new sub-station in Westgate.

Western and Brazilian Telegraph Company.—For the past week the receipts were £2,165.

Lynton (Devon).—The Surveyor reported at the Urban District Council meeting that the electric lighting during the month had been satisfactory.

Morley.—The Town Council are applying to the Local Government Board for sanction to borrow £19,500 for the erection of electric lighting buildings, machinery, and plant.

Ipswich.—In reply to a question at the Paving and Lighting Committee meeting, the Town Clerk said the provisional order was made, but the confirming Act had not yet been passed, though it had been read a second time.

Bradford.—The Town Council have adopted a resolution determining upon the extension of the area of electric lighting supply, so as to include the whole of the borough.

Carlisle.—The Town Council have adopted Prof. Kennedy's report upon the proposed lighting of Carlisle by electricity, and also instructed him to prepare plans, etc., upon which tenders might be obtained. The cost is about £25,000.

The Diamond Jubilee.—The Edison and Swan United Electric Light Company, Limited, have issued an attractive Diamond Jubilee catalogue, containing useful particulars and illustrations of illuminated signs, including the Ediswan "Queen" star.

Address.—We have been notified that the office of the South London Electric Supply Corporation, Limited, will from this date be at 28, Victoria-street, Westminster, and that the directors have appointed Mr. Sydney H. Webster secretary of the company.

Bristol.—On Tuesday, at the Corporation electric light works, a lofty pile-driving engine fell on a gang of workmen, one of whom was killed and others injured. The engine-driver, who was beneath the structure, only escaped by leaping from the platform.

Price List.—We have received the leaflet for April from the General Electric Company, Queen Victoria-street, which contains particulars of an effective idea for illumination, besides wiremen's sundries, commutator burnishers, etc., and a new self-adjusting telephone arm-rest.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended April 11 amounted to £1,353, as compared with £1,469 in the corresponding week of the previous year, being a decrease of £116. Last year's figures represent Easter week returns.

Bristol Tramways and Carriage Company, Limited.—The traffic returns for the week ended April 9 were £2,078. 0s. 3d., compared with £2,937. 15s. 7d. for the corresponding period of last year, being a decrease of £859. 15s. 4d. Last year's figures represent Easter week returns.

City and South London Railway.—The returns for the week ended April 11 were £1,021 compared with £868 for the corresponding period of last year, being an increase of £153. The total receipts for the half-year 1897 were £15,839, compared with £14,339 last year, being an increase of £1,500.

Indo-European Telegraph Company.—The directors, after adding £10,000 to the reserve fund, recommend a dividend for the six months ended December 31, 1896, of 17s. 6d. per share, making, with the interim dividend already paid, 6 per cent., and a bonus of 20s. per share, making in all 10 per cent. for the year.

Messrs. Hall's Agents.—Messrs. J. P. Hall and Co., of Oldham, inform us that Messrs. J. P. Rushworth and Co. have ceased to act for them as Bradford agents. They will therefore feel obliged if their customers will forward all enquiries and orders direct to them at Oldham until such times as they are able to make other arrangements.

Great Northern Telegraph Company of Copenhagen.—For the past year the net receipts amount to £360,287. Deducting interest and amortisation of debentures and interim dividends already paid, there remains a balance of £222,092. It is proposed to pay a final dividend, making a total of 10 per cent. for the year, carrying forward £59,481.

Willans and Robinson, Limited.—The ordinary general meeting of this Company was held on Wednesday afternoon. The report, which was given in our last issue, was carried, and after some discussion the proposed addition of two new directors to the Board was agreed to. Owing to Easter-tide a longer report of the proceedings must be deferred to next week.

Ramsgate.—The Town Council are still somewhat undecided as to the proposed electric railway scheme. A long discussion took place at the last meeting, and eventually it was decided to adjourn the question for a fortnight, and that in the meantime the town clerk is to write to Blackpool and other places where the trams are running to get what information he can.

Hastings.—A Hastings tradesman, named Frederick Valentine Kirkham, who recently wrote to the papers complaining of the high price of electric light, was a few days ago fined £3 for fraudulently taking it for nothing. It is understood that the Town Council, sitting in committee, have decided to purchase the undertaking of the Hastings Electric Light Company.

Coventry Electric Tramways Bill.—The Bill promoted to incorporate the Coventry Electric Tramways Company, and to empower the company to make and maintain tramways, has been before the Committee of the House of Commons as an unopposed measure. The capital authorised by the Bill is £105,000. The preamble was formally proved, and the Bill was allowed to proceed.

Cambridge Electric Supply Company, Limited.—The revenue return for March quarter is as follows: Number of units sold 1897, 76,382, as compared with 65 425 last year. The revenue from electricity supply in 1897 was £2,070. 3s. and in 1896 £1,767. 10s. 9d., and the revenue from meter rents, etc., £67. 15s. 5d. and £60 19s. 1d.; total, £2,137. 18s. 5d., as against £1 828. 9s. 10d. last year.

Blaydon.—A letter was read at the District Council meeting from Mr. C. C. McColvin, Chopwell, respecting the lighting of that village, and it was decided that the clerk request the owners of Garesfield Colliery to supply information as to the conditions, together with the probable cost to the Council, upon which they would erect plant for the supplying of electric light in the Chopwell district.

Ealing.—The District Council have decided, on the recommendation of the Electric Lighting Committee, to transfer the

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insurance of the eloctric lighting station (£12,000) from the Hand-in-Hand to the Fine Art and General Office, and to increase the insurance by £3,000 in respect of the new buildings. The Surveyor reported that the number of private lamps now applied for was 10,103.

Edison and Swan United Electric Light Company, Limited.—This company have the contract for the Blackpool high-voltage lamps for the change over at Blackpool, and have received the order for the fittings for the Corporation. They have also received the contract for the Bray Corporation switchboard, and for the switchboard for the Metropolitan Asylums Board infectious diseases hospital at Park, near Tottenham.

Motherwell.—At the Commissioners' meeting last week, Bailie Findlay, convener of the Lighting Committee, reported that the provisional order granted to the burgh in June, 1895, was now in danger of lapsing, the burgh in the interval not having taken any steps to lay down plant, etc. He intimated that he would lay a full report before the Board at the next monthly meeting, and move that the scheme be proceeded with.

Acton.—At the District Council meeting, Mr. Buxton said the six months for which the question of electric lighting for the streets of Acton was deferred by the Council had now elapsed, and he would, therefore, move at the next meeting that the Council take steps to put into effect the provisional order on this head, and that, as a preliminary measures, enquiries be made as to the results attained by other public authorities using the electric light for street purposes.

Douglas.—At the meeting of the Manx Legislative Council several hours were occupied in the consideration of a Bill to authorise the Douglas-Laxey Electric Tramway Company to construct another electric tramway from Laxey to Ramsey. It was stated that the total cost of the undertaking would be about £100,000. and that the income would probably be £12,000 annually, and the expenditure 45 per cent., leaving over £6,000 profit. The question was adjourned.

Rhondda.—At the meeting of the District Council a deputation from Mardy representing a company which had recently been formed, with a capital of £2,000, for the purpose of lighting dwelling-houses and shops and other establishments belonging to the shareholders by electric light, waited upon the Council, asking for consent to erect cables across certain streets at Mardy. It was decided to postpone the matter until the whole scheme of the company was submitted to the Council.

Blackpool.—A serious fire occurred on Thursday week at the electricity works. It seems to have originated in a shed where a compound of tar and resin was being manufactured, and then to have spread to the adjoining shed and a building in the centre of the yard where the drums were stored. About 20 barrels of tar and two full drums of cable were destroyed, and the dynamos injured to the extent of about £50. It is roughly estimated that the damage will be between £200 and £300.

Stirling.—It was reported at the meeting of the Police Commissioners that Prof. Kennedy considered impracticable the proposed utilisation of the water power at Touch in connection with the electric lighting of the burgh, and the committee therefore resolved to adhere to their former resolution to proceed with the lighting of the extended area, as recommended by the engineer. This was approved of, and it was remitted to the committee to enquire as to obtaining a suitable site for the works.

British Carbide Manufacturing Company, Limited.—This Company has been registered, with a capital of £100,000 in £10 shares, to acquire and turn to account any wayleaves, water rights, to construct and maintain dams, reservoirs, turbines, aqueducts, etc ; as electricians and electrical engineers, and producers of electricity for the purposes of light, heat, or power ; to experiment with and develop the use of carbide of calcium ; to construct and maintain rail and tram roads, etc.

Electric Metal Working Syndicate, Limited.—This Company has been registered, with a capital of £40,000 in £1 shares, to enter into an agreement with G. W. de Tunzelmann to commercially develop and obtain contracts for the supply, sale, or lease or royalty of electric welding apparatus, and to carry on the business of engineers, light and power contractors, electricians, electrical manufacturers, and makers of dynamos, motors, etc. Registered office : 61 and 62, Gracechurch-street, E C.

Ayr.—At a meeting of Scottish gas managers, Mr. Smith, of Ayr, gave some facts that show how gas is affected beneficially by the electric light. In Ayr, the Corporation supplies electric light and a company the gas. Since the electric light was introduced, 142 fewer street lamps burnt gas ; but larger lights were used, and because of that, and of the growing use of gas for heating purposes, the consumption of gas increased by 7 per cent. last year. Increased light begets the desire for better illumination.

Sheffield.—At a meeting of the Parliamentary Committee of the City Council it was resolved : "That the committee, having considered the subject of purchasing the undertaking of the Sheffield Electric Light and Power Company, Limited, are of opinion that it is advisable that the City Council should put in force the powers reserved to the Corporation under Section 50 of the Electric Lighting Orders Confirmation Act (No. 4), 1892, and recommend them forthwith to give notice for the purchase of the undertaking."

Levenshulme.—In his farewell speech to the District Council, Mr. J. M. Pollett, J.P., who is retiring from the Council, said that, regarding the electric light, he was pleased that an agreement had been come to between the Council and the Manchester Corporation for the supply of electric energy on satisfactory terms. They only awaited the formalities of the Board of Trade before they had the advantages of the electric light. Much improvement had been made in the ordinary lighting of the district, especially in Stockport-road.

Great Crosby.—A communication was read at the District Council meeting from the Liverpool District Lighting Company enclosing plan and specification of the work necessary in the Council's district to provide for the supply of electricity, and a report upon the matter was submitted by Mr. Hall, the surveyor, in which he said he would require further information with regard to the specifications. The Council resolved that the surveyor's report be approved, and that he, along with the chairman, be authorised to consult Mr. Miller, electrical engineer, of Liverpool, before anything further was done.

Radcliffe.—At the meeting of the Urban District Council the minutes of the Electric Lighting Committee included a long report respecting the proposed electric lighting of Radcliffe, showing the estimated cost and annual working expenses of the installation with the use of steam and gas respectively. The estimated cost with a steam-engine plant was £14,000, and the working expenses £1,919 ; and the capital expenditure on gas-engine plant was estimated at £13,000, with £1,565 for working expenses. The annual revenue from 6,000 8-c.p lamps at 9s. each was estimated at £2 700. The report was accepted.

Waterloo.—At the District Council meeting, the minutes of the General Purposes Committee showed that a letter had been received from Mr. William Horsfall, engineer to the Liverpool District Lighting Company, Limited, enclosing a plan and specication for the laying of the electric light mains in the district under the Great Crosby and Waterloo Electric Lighting Order, 1896. The committee resolved, "That the plan as showing the streets along which the company proposes to lay mains be approved, but that the specification be referred to the surveyor (Mr. Spencer Yates) to report to the next meeting of the committee." The minutes were approved.

Huyton and Whiston.—On Tuesday, Sir Courtenay Boyle, permanent secretary of the Board of Trade, assisted by Mr. Pelham, assistant secretary Harbour Department, heard parties at the Board of Trade Offices in Whitehall on an application by the British Insulated Wire Company, Limited, Prescot. The company have asked for a provisional order enabling them to supply electric light in the districts of the Huyton and Roby Urban District Council and of the Whiston Rural District Council. It is opposed by both of these local authorties, and the question for Sir Courtenay Boyle was whether the order should be allowed to proceed without their consent. Decision is postponed.

Southport.—The Electricity Committee have resolved that where a consumer is prepared to guarantee a minimum consumption of 25,000 units per annum, and where the demand for current of the consumer would generally be at other times than at the time of maximum load at the works, they will quote special terms, having regard to the circumstances under which such consumer shall require his particular supply of electricity. Under this arrangement the sub-committee have agreed with the Winter Gardens Company to supply electricity, the charge for the first 25,000 units to be at 4d. per unit, and for any quantity consumed after that amount 2d. per unit, subject to the usual discount.

Brighton.—The Lighting Committee have resolved that in all electric street lamps which were formerly filled with 4ft. gas-burners, two electric lamps of 8 c.p. each be fitted, and that where 5ft. gas-burners were in use, two 10-c.p. lamps be fitted. The effect of this is to double the lighting power in each case at an increased cost of 5s. 2d. per post with 8 c.p., and 3s. 7d. per post with 10 c p. The electricity works make a profit of 6s. 11d. on the 8-candle and 9s. 7d. on the 10-candle lights. Mr. Arthur Wright, the electrical engineer, having been invited to read a paper in America on the Brighton system, is to have six weeks' holiday this year so that he may inspect the principal installations of electricity in the United States while there.

Bermondsey.—The General Purposes Committee reported at the Vestry meeting the receipt of a notice from the London Electric Supply Corporation, Limited, of their intention to lay trunk mains from the junction of the parish with Rotherhithe along the north side of the footway in Southwark Park-road, across Blue Anchor-lane and under the footway on the south-west side. They recommended the Vestry not to sanction the trunk main being laid under the footway in Blue Anchor-lane on the south-west side, as the Corporation has already trunk mains under the footway on the north-east side, except on condition that the trunk main on the north-east side be removed immediately the proposed new main is laid. The recommendation was adopted.

The Calm.—The *Financial Times* occasionally remarks on electrical topics when they get as far as the "company, limited" stage, and it usually manages to hit its mark. The following appeared this week : "It is nearly five months since the famous Motorcar Act came into operation, and although during that period we have heard a good deal about the movement in one way or another, the difficulty has always been to see where the motor-car came in. Public curiosity will, however, be soon gratified to some extent, for we hear that the Electric Omnibus Company, having several vehicles already completed and others in an advanced stage, has decided to put some of them on the streets next week. It is to be hoped that the progress of the 'buses will not be unduly impeded by gaping crowds. There is at least this to be said for the company—that during the period of preparation it has been quietly at work, and has refrained from shrieking of its own importance, its cast-iron and all-embracing patents and its illimitable capacity for turning out profits, like some other companies we could name."

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Colchester.—The Electric Light Works Committee reported at the Town Council meeting that they had received a letter from the engineer to the Great Eastern Railway, asking for reply to his letter of November 9 as to lighting North Station, and the town clerk was desired to reply that the question of lighting the station will depend upon whether the light will be required for the Eastern Counties Idiot Asylum buildings, and that the asylum authorities are being again communicated with. It was also resolved that the town clerk write the secretary, Eastern Counties Asylum for Idiots, enquiring whether his committee will be prepared to receive a deputation from this committee in reference to the lighting of the asylums buildings. Letters were read from the Electric Construction Company, Limited, in reference to the provision to be inserted in the contract in regard to the engines; also letter from Mr. W. H. Massey upon the same subject; and it was resolved that the decision arrived at at last meeting be adhered to, and that the town clerk prepare the draft contract in accordance therewith. The report was adopted.

Railways in the City.—The Corporation of London, on the advice of their Local Government and Taxation Committee, have decided to oppose the City and West-end Railway and Great Northern and City Railway Bills. The former of these has already been rejected by the Select Committee of the House of Commons. In regard to the Great Northern and City Railway Company's Bill, the company were authorised by their Act of 1892 to make an underground railway from Finsbury Park to Finsbury-pavement. The line was to be worked by electricity or some other mechanical means, to be constructed in two distinct tubes of iron or metal, and no goods were to be carried. By the present Bill the company proposed to use steam power, to carry goods, and to alter the construction of the line to brick. These were distinct breaches of the terms on which the Corporation consented to the line in 1892. The use of steam power and the carriage of goods totally altered the character of the line and greatly increased the risk of damage to property and of incommoding the traffic. The Corporation had therefore determined to oppose the Bill in the public interest.

The Electrical Industry in Cape Colony.—A report on the electrical and allied trades at the Cape is being prepared by Mr. A. P. Trotter in his capacity as honorary correspondent of the London Chamber of Commerce for Cape Colony, and he will allude in the report, among other matters, to the prospects of employment for electrical engineers in South Africa. In the course of a letter to the London Chamber dated Cape Town, March 24, Mr. Trotter says: "My object in writing now is to ask you to make it known as widely as possible through your journal and through the technical Press that no electrical engineers should come out to South Africa at present unless they have secured definite appointments before sailing. Electrical engineers experienced, and apparently otherwise, come to me almost as regularly as the mail, with and without introductions. I regret that I have not been able to give any assistance whatever. Engineers wanting assistants generally send home for them—a very satisfactory course for both parties. I have received letters from electrical engineers of some experience in the Transvaal stating that, owing to the stagnation of trade, staffs are being reduced, and that many competent men are out of employment."

Electric Transmission of Power in Shipbuilding Yards.—Although a variety of subjects is annually discussed by the Institution of Naval Architects, electrical subjects are rarely touched upon. This year's meeting has proved an exception, and on Friday last Herr F. von Kodolitsch, of Trieste, contributed a paper on "The Application of Electrical Transmission of Power in Marine Engineering and Shipbuilding." Although in his yards he is gradually introducing electric transmission for the heavy plant, he confined himself in his address to the various portable electric machinery which he has introduced there for boring, punching, keyway cutting, reaming, tube-expanding, sawing, and a number of other purposes. These he illustrated by means of photographs and a specimen of an electric boring machine. In a couple of years he hoped to have totally transformed the works for all the heavy plant, in connection with which he is gradually introducing electric power. Mr. von Kodolitsch stated that he could not imagine any direction in which the development of electric transmission would not of necessity add to the possibilities and economy of such power as was already possessed. In the discussion that followed the advantages to be derived from electric transmission of power in naval yards were generally insisted.

Rontgen Ray Tubes.—At the Camera Club, Mr. Wilson Noble in the chair, Mr. Campbell Swinton has been discoursing upon Röntgen rays. He also exhibited some improved forms of tubes by means of which radiations of various penetrative capacities can be produced at will. This result he attains in two ways—first, by altering the distance between the cathode and the anti-cathode; and, second, by employing cathodes of different sizes. In the first case the anti-cathode is connected to the anode terminal by a sliding steel rod, so that it can be shaken along the axis of the tube and the distance between the cathode and the anti-cathode varied from 1in. to 3in. Then the nearer the cathode to the anti-cathode the greater the penetrative power of the rays given off, other things being equal. In the second case he employs a tube with several cathodes of different sizes, and finds that the smaller the cathode in use the greater the penetration of the rays. Mr. Swinton also described a number of experiments he has carried out to elucidate various points connected with the cathode discharge. Among other things, he has tried the effect of making the anti-cathode of different metals, and has found that, while all the materials he employed give rays of much the same penetrative capacity, there is a great difference in the quantity produced, platinum and silver being far the best in this respect.

London Lighting Extensions.—The Highways Committee reported at the London County Council meeting as follows: The London Electric Supply Corporation had given notice of intention to lay trunk mains in Blue Anchor-lane, Southwark Park-road, Raymouth-road, and Rotherhithe New-road; Broadwall, Meymott-street, Collingwood-street, Blackfriars-road, Church-street, Union-place, Bear-lane, Gravel-lane, Union-street, and Southwark Bridge-road. The committee recommended that the conditional sanction of the Council be given to the work, which was adopted. It was reported that two notices, dated respectively March 22 and 25, 1897, had been given by the Notting Hill Electric Lighting Company of intention to lay mains (*a*) in Dawson-place and (*b*) in and across Holland-villas-road (two plans, 182 and 183). The proposed works are unobjectionable, and it was agreed that the sanction of the Council be given to the works referred to in the two notices (Registered Nos. 993 and 995), dated respectively March 22 and 25, 1897, from the Notting Hill Electric Lighting Company, upon the following conditions: "That the company do give two days' notice to the Council's chief engineer before commencing the works; that before any boxes be constructed the design for them be submitted to and approved by him; and that adequate means be taken to prevent the accumulation of gas in the conduits and boxes."

Montrose.—The electric lighting question has once more been resuscitated. Two or three years ago a large committee of the Burgh Commission looked into the question; deputations visited Coatbridge, Glasgow, and other places where installations had been carried out, and a report was presented. The question was, however, allowed to drop at that time. At the last meeting of the Town Council the subject was again brought forward, the following letter having been received from Edmundsons, Limited, 19, Great George-street, Westminster: "Referring to our representative's (Mr. M'Leod's) visit to Montrose I am writing to ask you to lay our offer for electric lighting before your Council. We are carrying out central-station lighting in several towns, and should be prepared to form a small local company and find the necessary capital for lighting Montrose. We should suggest that the necessary provisional order should be taken out by your Town Council, we agreeing that it should be transferred to us on behalf of the local company, and we paying all expenses of obtaining it and of the transfer. We would also agree to supply all the current required by the Council at a special rate—say, of 4d. per unit—for street-lighting, etc. We would also agree that at any time after 10 years from the date of the order the Council should have the option of purchasing the undertaking, the price being the capital expended plus 15 per cent. If your Council will entertain this offer, I should be glad to come down at once and meet a committee to explain and arrange details." A special committee, consisting of Provost Mitchell, Bailies Stone and Grieve, Dean of Guild Hall, Town Treasurer Heckford, and Messrs. Balfour and Cameron, was appointed to obtain further information and report at as early a date as possible.

Mechanical Traction in Glasgow.—The question of mechanical motors for the Corporation tramways was discussed at a special meeting of the Tramway Committee. Mr. Walter Paton, the convener, occupied the chair, and referred at some length to the reports issued by Mr. John Young, the manager, embodying his experience of the various systems of mechanical traction he had witnessed in operation while on an official visit to America. He showed that while in 1890 there were 5,400 miles of tramway worked by horse haulage, to-day there were only 1,351 miles. During the same period, he said, the overhead electric traction car mileage in America had increased from 2,523 miles to 13,200. Mr. Paton also showed that in Europe there were 91 systems worked by overhead electric traction and three on the conduit system. With regard to the expense of working the electric system, he stated that, whereas horse haulage cost 4d. per animal per car mile, giving a total of 8d. per mile, the electric motorcar on the overhead system had been run in most cases at a cost of 1d. to 2d. per car mile. Thus they had the prospect of carrying on the tramway system at a nominal cost of 1d. per mile, as against 4d. for each horse at the present time. And when it was understood by the citizens that this meant a saving of some £30,000 per annum, they would at once see that there was a very large financial question involved in the proposed change. Mr. Paton concluded by moving: (1) "That an overhead electric system of tramway traction be applied to the Springburn route, and (2) that the co-operation of the Watching and Lighting Departments be secured to have the route lit by electricity from the same source." Councillor John Ferguson seconded. Bailie Wallace proposed as an amendment "That decision be delayed for three months," as by the expiry of that period a new motor was likely to be put upon the market. The amendment was seconded by Mr. Martin. The motion was heartily supported by Councillors Kerr, King, and Dr. Colquhoun. On a vote, the motion was carried by 16 votes to 4 for the amendment. The distance of the route from Mitchell-street to Springburn is about three miles.

The Corporation Enquiry at West Ham.—Mr. Ernest Baggallay, who recently held a public enquiry into certain allegations with regard to the acceptance by the West Ham Corporation of tenders for the installation of electric lighting in West Ham, has made his report, which was presented to the Borough Council at its last meeting. The first charge was that a Mr. Paris called on the Electric Construction Company and offered to obtain the services of a member of the West Ham Council in getting the contract, for which the councillor would

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have to be paid, and Mr. Baggallay reported that there was nothing to show that Mr. Paris was acting otherwise than on his own responsibility, and that therefore the nature and object of his call on the company had no importance. The second charge was that Mr. Councillor S. T. Hunns, a member of the sub-committee for the consideration of the tenders, himself made corrupt overtures to the Electric Construction Company, and Mr. Baggallay, in relation to this, said it was not surprising that the Electric Construction Company should have looked upon this visit with suspicion, but the evidence went no further, and he did not find that any corrupt conduct was proved against Mr. Hunns. The last allegation Mr. Baggallay described as the most important. It was that the West Ham Corporation had been corruptly influenced to accept tenders which were not the most advantageous to the borough. The eight tenders accepted amounted to £23 467, and if the lowest tender in each section had been accepted the total cost would have been £15,704. The difference of £7 763 required some explanation, and Mr. Steinitz, the electrical engineer of the Corporation, upon whose advice and recommendation the sub-committee implicity relied, was examined upon the tenders at considerable length. His answers satisfied Mr. Baggallay that he had acted throughout with perfect honesty and that there was no reason whatever for supposing that he had been influenced by any corrupt or improper motive. In conclusion, Mr. Baggallay said that in the absence of evidence of any corrupt action on the part of any member of the Council, which eventually adopted Mr. Steinitz's recommendations, it was no part of his duty to discuss further the results arrived at by the Council. It was enough that he should report that in accepting the tenders the Council selected those which it honestly believed to be the most advantageous, and that the charges entirely failed.

Wolverhampton.—At the meeting of the Town Council the Lighting Committee submitted to the Council a report on the extension of the electric lighting plant, in which it is stated that the committee are pleased to be able to report that the demand for the electric light has increased to such an extent as to render it necessary to take measures to provide additional plant to deal with the anticipated demands of next winter. Having regard to the difficulty, if not the impossibility, of obtaining plant in a short time, owing to the congested state of the electrical trade, and the delay incident upon the necessary formalities for obtaining the loan, the committee deem it advisable to at once place before the Council their proposals on the matter. The total existing plant capacity is 482 kilowatts. Setting aside 140-kilowatt steam dynamo as spare, the available generating capacity is 342 kilowatts. The maximum load generated during the past winter was 238 kilowatts. There was, therefore, a balance for additional lamps of 104 kilo watts, or 3,250 8 c p. lamps, installed. The number of additional lamps installed for the year was 2,337. Assuming, therefore, a similar increase of custom for the present year, the plant will be taken up next winter to its available capacity within 900 lamps. Already to the present date over 1,000 lamps have been added this year. In view of this it will be seen that an extension of the plant is absolutely necessary, especially as the committee are of opinion from a canvass which has been made that the time has now arrived when an extension to the Chapel Ash district will prove remunerative. For this purpose an additional sub station will have to be established in Chapel Ash. It is proposed at present to extend the mains to Oakleigh-passage on the Merridale road, and to the top of Tettenhall-road. The extensions now proposed will provide an additional plant capacity of 4 000 8 c.p. lamps. The electrical engineer has submitted to the committee detailed estimates of the cost of the proposed extensions, which amounts in all to £7,830. The estimate for Chapel Ash extension does not include anything for a site for the sub-station, as it is proposed to construct it underground, near to the lamp column at the junction of Salop-street and Darlington-street. Whilst laying these recommendations before the Council, the committee ask their sanction to an application being made for a loan of £882, which has been overspent on capital account in respect of the original outlay of £30,000 authorised by the Council on December 11, 1893. The committee add that it was impossible to foresee all the contingencies that would be met with in dealing with a capital expenditure of £30,000, and the item of £882 is, the committee think, a very reasonable one for extras, being less than 3 per cent.

Edinburgh.—At the Town Council meeting Mr. Auldjo Jamieson moved the non-approval of the minutes of March 9, in so far as they provided for £4,050 being set aside for the electric lighting reserve fund. The maximum sinking fund for their debt of £250,000 was, he said, £25,000, and that sum, by the present proposal, would be reached in less than six years. From 1903 to 1915 that £25,000 would be lying invested in consols, and yielding very little. He characterised that as wasteful finance. The statutory sinking fund on an outlay of £250,000 was £8,333. In 15 years that would pay off one-half of their debt of £125 000. If they at the same time applied this contribution of £4,050 to pay off debt, it would in 15 years, with its accumulation applied in the same way, provide £96,700; so that in 15 years the debt of £250,000 would have been reduced to £28,300. If to that they added £45,000 for renewals, the debt would be under £75,000, and a sinking fund of £5 000 would pay off the whole expenditure, original and renewal, in 15 years or within the statutory 30 years applicable to their original debt. At present their debt of £250,000 cost, with interest, sinking fund, and that reserve, £19,883 a year. In 1912, if they applied that £4,050 to pay off debt, the interest and sinking fund on the whole debt, including cost of renewals, would be only £7 250; and before another renewal was needed the debt would be wholly paid off, and renewals would then be easily provided. He appealed to the Council as business men not to throw away large sums of public money by adopting a method of finance which none of them would ever think of applying to their own business. The proposed charge on the sinking fund, he pointed out, was about three times as great as any such charge in the best-managed electric light companies. They had been told that a tweedledum which was compulsory was the same as a tweedledee which was optional; that a tweedledum which was indispensable was the same as a tweedledee which was incidental; that a tweedledum which was necessary for the maintenance of works was the same as a tweedledee which was discretionary; that a tweedledum which imperatively required £45,000 was the same as a tweedledee which was imperatively restricted to £25,000. It was refreshing to find in these modern days justification for the fine old crusted story of Lord Cockburn and the Gaelic interpreter—"Ask the witness if he saw it or did not see it, if your language admits of that fine distinction." Mr. Jamieson concluded by saying that, after the vote at last meeting, when the proposal was carried by 38 to 8, he did not think it necessary to divide the Council. The motion was, however, not seconded, and it fell. On the motion of Treasurer McCrae and Mr. Mackenzie, authority was given to the treasurer of police to carry the net surplus on the electric lighting account at the close of the accounts of the current year to the credit of the burgh assessments.

Yarmouth.—A special meeting of the Town Council was held last week for the purpose of considering a revised scheme for electric tramways for the town. The Lands Committee reported that at their meeting on March 30 a letter was read from the Board of Trade enclosing a letter received from the promoters of the Yarmouth and district tramways provisional order. The town clerk read his reply thereto. The committee had before them the copy of a report of Major Marindin, which approves of all tramways other than those along Friars'-lane, King-street (except between Regent-street and Regent-road), Dean Side, Queen's-road, King's-road, Fullers'-hill, and St. Nicholas-road. Councillor F. Arnold moved, and Councillor Green seconded, "That this committee cannot recommend the Council to depart from their resolution of January 18 last, being of opinion that tramways should be in the hands of the Municipality, and that the borough surveyor be instructed to bring up his report upon the subject not later than June next." An amendment moved by Councillor A Peaton, and seconded by Councillor J. H Palmer, was carried by nine to eight, approving the revised scheme, subject to the conditions settled on January 2 by the sub-committee, and laid down in the report of the chairman of the Lands and Electric Lighting Committee of January 7, dealing with the price of current; and to the proviso that whenever the price of 6d. per unit now charged to the public is reduced by 1d. per unit, a like reduction of ½d. per unit be made to the company, and whenever the price be paid 1d. per unit a like increase of ½d. per unit shall be made to the company, but so that the prices shall not exceed those contained in the report; and that the resolution of the Council of January 18, so far as it relates to the Yarmouth and district tramways, be rescinded. The Mayor having briefly explained the reasons that had called them together, Mr. T. A Rising formally moved, and Mr. J. R. Nutman seconded, the above recommendation of the Lands Committee, the chairman of the committee having declined to move it. Councillor F. Arnold thereupon moved, as an amendment, the resolution moved in committee. He said he was surprised at the Council having the matter forced upon it again after the very decisive manner in which the last scheme was dealt with. He took it that the question was not whether there should be electric trams in the borough or not, but whether the Corporation should or should not establish them. He felt that the Carporation should retain this matter in its own hands. The present promoters alleged that they had been induced to persevere with their project by the encouragement given them in the earlier stages. All that the Council did, however, was merely to express approval of the tramways in principle. He had no fear that the electric trams would not be a success if the Corporation undertook them, and he cited, in support of his contention, the fact that the electric light, salt water, and Fish Wharf undertakings were all successful. There was no reason why they should hand over the roads, especially as they possessed the power to work the trams, which would be used by the people, and he considered that they, as representatives of the people, should have in their own hands the control of any such undertaking. The cost of working the trams by electricity was only half the cost of horse traction. To establish these trams, using electric power, would yield £500 a year profit to the electric light undertaking, and at least £2,000 a year towards the relief of the rates. He was satisfied of this from figures got out by the surveyor. The capital would be £16,000. With the trams in their own hands they could choose their own routes, adopt the most modern cars, and make the arrangements exactly as they desired. He would add to his resolution that the promoters should be relieved of the fee of 50 guineas paid to Mr. Preece, the Council's expert, with other expenses, amounting in all to about £100. Alderman B. H. Press seconded, and after discussion the amendment was carried by 16 votes to 11

PROVISIONAL PATENTS, 1897.

APRIL 5.

8693. Improvements in electric lampholders and connections. Veritys, Limited, and Morton Blencombe Cotterell, Plume Works, Aston, Warwickshire.

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8619. Improved means of supplying current to electrically-propelled railway or tramway vehicles. James Enright, 202, Holland-road, Kensington, London.

8639. An improved method of electrically hardening or converting into steel the surfaces of iron plates and other objects made from iron. Edward Travers Zobrab, St. Enoch's Hotel, Glasgow.

8663. Improvements in dynamo-electric machines or electric motors. Alfred Holmes, 47, Lincoln's inn-fields, London. (Edward Hibbert Johnson and Robert Lundell, United States.)

8674. Improvements in electric switches. Alfred Charles Brokies, 24, Southampton-buildings, Chancery-lane, London.

APRIL 6.

8696. Improvements in secondary batteries or storage cells. Arthur Pillans Laurie, 49, Beaumont-square, London.

8703. Improvements in electrical motors. Arthur Devonshire Ellis and Harry Walton Appleby, Sunbridge-chambers, Bradford.

8725. Art of and apparatus for generating and distributing music electrically. Robert Alexander Sloan, 26, Castle-street, Liverpool. (Thaddeus Cahill, United States.) (Complete specification.)

8774. Improvements relating to electric incandescent lamps. Louis Joseph Sylvain Friard, 6, Bream's-buildings, Chancery-lane, London.

8788. Improvements in phonographs. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Edward Nicoll Dickerson and Gianni Bettini, United States.) (Complete specification.)

8801. Improvements in or relating to electric traction. Llewelyn Birchall Atkinson, 1, Queen Victoria street, London.

8809 Improvements in and relating to telegraphic transmitting and receiving apparatus. John Clayton Mewburn, 55, Chancery-lane, London. (Bernhardt Hoffmann, France.) (Complete specification.)

APRIL 7.

8831. Improvements in electrical signalling apparatus for use on railway trains and the like. Alexander John Williamson, Salisbury Hall, Denbigh.

8885. Improvements in hand-fed focussing electric lamps. Joseph Edwin Barnard and Thomas Albert Brigge Carver, 28, Southampton-buildings, Chancery-lane, London. (Complete specification.)

8906. Improvements in electric couplings. William James Davy and George Thomas-Davies, 40, Chancery-lane, London.

8909. An improved electric arc lamp. Emile Prosper Léon Mors and Louis Alexis Clément Pottier, 53, Chancery-lane, London.

APRIL 8.

8936. Improved casing or conduit for concealing or isolating electric wires. Edwin Haslam, Imperial-chambers, Albert-street, Derby.

8944. Improvements in arc lamps. Henry Mostyn Darrah, 70, Market-street, Mancheeter.

8952 Improvements in the method of and means employed for connecting lamps to electric conductor wires. Frederick Palm, Penny Bank-chambers, Halifax.

8961 Improvements in electric arc lamp mechanism. Gerald Percival, 30, Old Georges-street, Cork.

8979. Improvements in electrical indicating apparatus and in couplings used in connection therewith as a system for electrical communication. Robert Stuart Hampson, 73, St. Stephen's-road, Upton Park, London.

8972. Improved electric motor. Wilfred Robert Vernet Marshall, 137, West Regent-street, Glasgow.

9006. Improvements in or connected with dynamo-electric machines. Valerè Alfred Fynn, 47, Lincoln's-inn-fields, London.

APRIL 9.

9091 Improvements in and relating to the distribution of electricity. Horace Field Parshall, 70, Chancery-lane, London. (Complete specification.)

9095. The unilever double-current telegraph key. Thomas William Andrews, 18, Old Broad-street, London.

9116. Improvements in secondary voltaic batteries. Ludwig Epstein, 28, Southampton-buildings, Chancery-lane, London.

9126. Improvements in the manufacture of filaments for incandescence lamps. Charles Henry Stearn, 47, Lincoln's-inn-fields, London.

9127. Improvements in electric meters. Evershed and Vignoles, Limited, and Sydney Evershed, Woodfield Works, Harrow-road, London.

APRIL 10.

9135. Electrical apparatus for automatically actuating ventilators, flue-dampers, throttle valves, also for controlling and regulating sources of power. Harry Edward Yerbury, Power Station, St. George, Bristol.

9166. A method of and apparatus for erecting overhead electric conductors for railways and tramways. Julius Werther and Arthur Schäffer, 4 South-street, Finsbury, London.

9173. An electro-therapeutic lamp electrode. Robert Ignatius Mayer, 40, Chancery-lane, London. (Complete specification.)

9181. Improvements in electric traction. Henry William Handcock and Alfred Herbert Dykes, 5, Victoria-street, Westminster, London.

9194. Improvements in heating by electricity. Octavius March, 40, Chancery-lane, London.

SPECIFICATIONS PUBLISHED.

1896.

6579. Telephonic apparatus. Graham.

8234 Prepayment meters for gas or other fluid or for electricity. Burchard. (Webber.)

9283. Telephonic receivers. Marr.

9832. Telephone systems of exchange. Kingsbury. (Western Electric Company.)

9964. Electric cables. Nisbett.

10906. Electrical Traction. Kingsland.

11981. Electrical indicating apparatus for ships' steering gear, guns, and the like. Lorrain. (Pfatischer, Hosmer, and Binney.)

15447. Brush-holder to be used on dynamos and motors. Francis.

21956. Electric accumulators. Julien.

23665. Telephone transmitters. Moore (Date applied for under International Convention, March 25, 1896.)

25360. Coating, covering, or amalgamating of metals with metals by the aid of electricity and apparatus therefor. Snyder.

29306. Secondary batteries. Heil.

1897.

2592. Electric fuses for mines. Linke.

3973. Arc lamps. Hegner.

4330. Incandescence electric lamp for advertising purposes. Paprian.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	9¼-9¾
Brush Company, Ordinary	3	¾ 1
—— Non. Cum., 6 per cent. Pref.	2	1½ 1⅝
—— 4½ per cent. Debenture Stock	100	104-108
—— 4½ per cent. 2nd Debenture Stock	100	95 99
Callender's Cable Company, Debentures	100	107-112
Central London Railway, Ordinary	10	9½-10
——	6	5¼-6
Charing Cross and Strand	5	10¾-11½
Chelsea Electricity Company	5	8¾ 9¼
—— 4½ per cent. Debentures	100	112-115
City of London, Ordinary	10	21-22
—— 6 per cent. Cumulative Pref.	10	16½-17½
—— 5 per cent. Debenture Stock	100	132-136
City and South London Railway, Consolidated Ordinary	100	59 61
—— 4 per cent. Debenture Stock	100	139-141
—— 5 per cent. Pref. Shares	10	15½-16
County of London and Brush Provincial Co., Ordinary	10	11½-12
—— 6 per cent. Cum. Pref.	10	14½-15
—— 4½ per cent. 2nd Debenture Stock	10	14½-14¾
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	1¾ 2¼
—— 5 per cent. Debentures	—	90 96
Edison and Swan United Ordinary	3	1¾-2¼
—— 5 per cent. Debentures	5	3-4
—— 4½ per cent. Debentures	100	105 110
Electric Construction, Limited	2	1½ 1¾
—— 7 per cent. Cumulative Pref.	2	2¼ 2½
Elmore's Copper Depositing	1	¾-1
Elmore's Wire Company	2	1¼
W. T. Henley's Telegraph Works, Ordinary	10	19 20
—— 7 per cent. Preference	10	18½-19½
—— 4½ per cent. Debentures	100	107-112
House-to-House Company, Ordinary	5	7½-7¾
—— 7 per cent. Preference	5	9½-9¾
India Rubber and Gutta Percha Works	10	20½-21½
—— 4½ per cent. Debentures	100	104-107
Kensington and Knightsbridge Ordinary	5	11½-12½
—— 6 per cent. Pref.	5	8-8½
London Electric Supply	5	1½-1¾
Metropolitan Electric Supply	10	16-17
—— 4½ per cent. First Mortgage Debenture Stock	100	120-124
National Telephone, Ordinary	5	6¼-6½
—— 6 per cent. Cum. First Pref.	10	15-17
—— 6 per cent. Cum. Second Pref.	10	15-17
—— 5 per cent. Non. Cum. Third Pref.	5	6-6½
—— 3½ per cent. Deb. Stock	100	102-105
Notting Hill Company	10	12-13
Oriental, Limited, £1 shares	1	1¼-2
—— £5 Shares	5	8½-9
—— £4½ shares	4½	7½-8
Oriental Telephone and Electric Company	1	¾-1
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	101-103
St. James's and Pall Mall, Ordinary	5	14½-15½
—— 7 per cent. Pref.	5	9½-10½
Telegraph Construction and Maintenance	12	34-37
—— 5 per cent. Bonds	100	103-106
Waterloo and City Railway, Ordinary	8	10½-11½
Westminster Electric Supply, Ordinary	5	13½-14½
Yorkshire House-to-House	5	8¼ 9

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NOTES.

Institution of Electrical Engineers.—The next meeting of the students of the Institution will be held on Wednesday, April 28, at 28, Victoria-street, S.W., when a paper will be read by Mr. F. Johnston on "Accumulators."

Electromagnetic Theory.—There is to be some sort of a prize competition to be inaugurated by the Reale Instituto Lombardo for experiments elucidating the Maxwell theory. A prize of 1,200 lire (say £60) is offered, and the competition is open to all nationalities.

Royal Institution.—The afternoon lectures start again next week on Tuesdays, Thursdays, and Saturdays (Volcanoes, Poets, and the Greek Theatre). The Friday evening discourse (April 30) is by Prof. J. J. Thomson on "Cathode Rays." The annual meeting is on Saturday, May 1, at 5 p.m.

The German Electrical Engineers.—There has been a brief notice in the *Elektrotechnische Zeitschrift* concerning this year's meeting of the Verband Deutscher Elektrotechniker. It is to take place at Eisenach on June 10 and the two following days. Papers to be read should be submitted at the latest before the middle of May.

Electrical Associations in America.—The Canadian Electrical Association have arranged to hold their next "convention" at Niagara Falls, Ontario, on June 2, 3, and 4 next, while on the part of the States the Executive Committee of the National Electric Light Association has selected Niagara Falls as the place for the next (twentieth) "convention" of the association. The meeting will be held on June 8, 9, and 10 next.

Electricity and Capillary Action.—There are two abstracts from the *Journal de Physique* published in the *Journal* of the Institute of Electrical Engineers which relate to the influence of the electrical condition of a liquid on its surface action. From one it appears that the heat of vaporisation of a liquid is to a certain extent a function of the electrical condition of the surface. The other is an electro-capillary experiment by Mr. A. Chassy with water and mercury in a tube, which is ascribed to varying surface tension. It may be noted that in the *Journal* the proportion of Röntgen radiation abstracts to the rest is still well over 25 per cent.

Torpedo Catching.—The lost torpedo is a tiresome thing, particularly when it is loaded. Apparently the proper way to go fishing for it is by electric light. "The rays of the electric light from the captive balloon on the bed of the sea off Toulon have led to the discovery, not only of the torpedo which caused the accident to the 'Jauréguiberry,' but also of torpedoes which caused two previous accidents." The sentence is a little mixed, but the meaning is plain. Seriously, however, a light vertically over the water might penetrate when the sloping rays of the sun would be reflected from the surface. But even in March the sun gets fairly high at Toulon.

An Electric Furnace.—Messrs. Küster and Dolezalek have described in the *Zeitschrift für Elektrochemie* a simple form of furnace for laboratory purposes, which can be constructed at small cost. It is made from two blocks of burnt lime. The lower block is bored out so as to fit closely the lower carbon rod, which is introduced through the hole from below. The upper block is similarly bored with a smaller hole into which fits the upper carbon. The lower carbon runs only half-way through the block, leaving the rest of the hole as a receptacle for the molten material. The upper block has a diagonal hole for the escape of the gas and one for the introduction of the material to be fused. It is advisable to fit iron hoops round the blocks so as to keep them from cracking, and when not in use they must be protected from moisture. The carbons are regulated by hand.

Roads and Paths.—The motorcart, which was to have come, seen, and conquered, has been so little in evidence of late that the most timid person has ceased to be afraid of being run down by it. But in Brussels, in connection with the exhibition, they appear to be taking elaborate precautions against mixed vehicle collisions. "The Avenue de Terveuren has been designed with a lavish regard to the various means of locomotion to which two-legged beings may have recourse. Trees are planted on either side, and the avenue itself is divided longitudinally into five sections, along which one may respectively walk, ride, drive, cycle, or fly through space in an electric tramcar, as the spirit moves one. But each section is sacred to its own particular style of locomotion, and heavy penalties would attach to the error of employing the 'voie carrossable' as a 'voie cycable,' or *vice versâ*."

Patents.—In connection with the movement for the reform of the patent laws started by the Manchester Chamber of Commerce, a deputation representing various societies and chambers of commerce has endeavoured to wait upon Mr. Ritchie, the President of the Board of Trade. The particular point enforced was the injury inflicted upon British industries by the ineffective character of Section 22 of the Patents Act, which is designed to ensure the granting of licenses to the public by patentees. The deputation showed that owing to its vagueness of language a rigid and highly lucrative monopoly was unintentionally conferred upon foreign—and in particular German—holders of British patents, at the cost of the complete suppression of certain branches of manufacture in this country. The object of patents is to encourage and reward useful inventions, and the use of the Act in this way is quite contrary to the intention of its framers. In the result the deputation were unable to get at Mr. Ritchie, that gentleman being ill, but saw Sir Courtenay Boyle.

Rotary Converters.—With time and long tramlines we are all to be converted by the (rotary) converter, 'alternating" is to go hand-in-hand with "continuous," and the lion to lie down with the lamb generally, America leading the way. According to a summary of the principles involved in the rotary converter given some time ago by Mr. Berg in the *American Electrician*, the high output and good commutation of rotary converters are due to the fact that the alternating and continuous currents to a certain extent flow in opposition to each other, and thus the heating is less than in a corresponding continuous-current machine. Moreover, the armature reaction due to the continuous current taken out of the machine is opposite to that of the alternating current put into the machine, the resultant reaction being small. In rotary converters with shunt and series excitations, the self-induction, usually objectionable in alternating-current circuits, is desirable to automatically control the voltage, and in certain cases the power factor may be very largely increased by the addition of it.

Lightning Arresters.—Some little time ago mention was made in these notes of a lightning arrester for high-tension lines, brought out by Siemens and Halske. The arc, it will be remembered, formed between two wires arranged like a couple of D's placed back to back, so that the curves nearly touch, but immediately rising is broken as the distance between the wires increases. The *Elektrotechnische Zeitschrift* has published a paper on the subject contributed by Mr. H. Görges to the Elektrotechnischer Verein, in which there

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are some rather curious photographs of the discharge between the wires. One of these shows what looks like the ordinary flame of the high-tension alternating arc, but taken through the slits of a revolving disc the picture becomes a tangle of narrow ribbons, each one obviously representing a fresh position of the arc as it travels up between the wires. In the discussion, Dr. Benischke, speaking from experience in the Tirol, suggested that a short-circuit might be started by insects getting into the air-gap in the lightning arrester. Mr. Görges mentioned a case where a sparrow had produced a short-circuit. The chief trouble with lightning arresters of the class described was to get the arc broken quick enough. On a simple alternating or three-phase system a period of two to three seconds was the maximum that could be permitted for a short-circuit, on account of the effect on the motors.

An Artist on Posts.—No one at present has considered it necessary to protest against unredeemed ugliness in the matter of telegraph posts, but it appears that a lamp-post must not only be useful but beautiful. There is an "Artist" who does not like the electric light posts in Regent-street, and who has written to the editor of the *Times* to tell him so. It was holiday time, when (newspaper) columns are not so full as usual, but still, as he gets big type, the anonymous "Artist" is probably somebody of importance. He says those who have observed the work displayed in the public standards for the lighting of Paris and other Continental cities "cannot do less than recoil in amazement at the atrocities in metal now erecting for the electric lighting of Regent-street." Artistically, there is something in the construction of the last sentence which does not please the literary taste of mere engineers—artists doubtless are different. The correspondent, however, goes for the lamp-posts artistically, with a backhander, by the way, for South Kensington, and ends up with a conundrum, "Why, I would ask, in public interests, is it that our parish authorities and contractors are permitted thus to disfigure our principal thoroughfares, to justify foreigners in their scorn of our art ignorance, and to make us thoroughly ashamed of ourselves?" Probably because "art" is not a compulsory portion of the education of a vestryman, a contractor, or a manufacturing engineer. Fortunately, everyone, whether native or foreign, does not look for beauty in lamp-posts. The writer, for instance, cannot at this moment remember what the design of the particular posts is. So the *Electrical Engineer* remains at present without an opinion on the subject.

The Civil Engineers.—The council of the Institution of Civil Engineers announce that they have arranged to afford the members of the institution an opportunity of meeting together in London this year under conditions convenient to many who are precluded from attending the weekly meetings during the session, and in such a manner as to admit of the discussion of a wider range of subjects than can be dealt with on ordinary occasions. An engineering conference has therefore been "fixed to occupy May 25, 26, and 27, the morning of each day (from 11 to 1.30) being devoted to the consideration of professional topics, and arrangements being made for inspections of engineering works in the afternoon. The public rooms of the Westminster Town Hall have been secured for the occasion, by which arrangement it is thought convenient accommodation will be afforded for the prosecution of the proposed business, without interference with preparations for the reception of the members at the institution in the evenings. The work of the conference will be carried out under the direction of the council, with the assistance of sectional committees consisting of members of the institution representative of various localities in the United Kingdom and identified with the several branches of engineering." There are seven of these, of which the last, representing electricity, consists of Prof. W. E. Ayrton, Mr. R. E. B. Crompton, Prof. J. A. Ewing, Messrs. R. K. Gray, A. Bromley Holmes, and J. H. Holmes, Dr. E. Hopkinson, Prof. Andrew Jamieson, Sir H. C. Mance, C.I.E., Mr. T. Parker, the Hon. C. A. Parsons, Mr. Alexander Siemens, Mr. C. E. P. D. Spagnoletti, and Mr. James Swinburne. The annual conversazione is fixed for May 25, and, if the numbers are excessive, on the following evening also.

Rontgen Radiations.—Two Frenchmen, Messrs. Seguy and Quenisset, are reported, "after experimenting on medical students," to have discovered that Röntgen radiations may cause dangerous palpitations of the heart. It seems unlikely, but is mentioned here merely in case anyone who works with Crookes tubes may have noticed anything of the kind. At the Paris Academy of Sciences they have had a communication from Mr. Sorel, who is a professor of natural philosophy at the Havre Lyceum, to the effect that a dead animal (cold) is less easily penetrated with the Röntgen rays than a dead animal still warm. The observation that the living animal was less opaque to the radiations than the dead one was made some time ago in Germany; but there they talked nonsense about "kritikstrahlen," not seeing that it was obviously a question of temperature and condition of the blood. Mr. Sorel also says that in some cases the radiations may induce inflammation of the lungs. With all this, the wonder is that anybody who constantly handles a Crookes tube is left alive. Mr. Crookes was at the Académie meeting and appeared to think that more care was required in observations of this sort. It is certain that most people appear unaffected. There was afterwards other talk about children, sunstroke, and the wearing of brass armour by the very ancient Greeks, all of which is completely wide of the mark. But the undoubted cases of the action of the radiations on the sub-surface and deep-seated tissues are really very curious. It is not an electrical man's business except to avoid getting skinburnt himself, and that is a simple matter; but it might be suggested to the physiologists to enquire whether the immediate action of the radiations is not on the blood corpuscles rather than directly on the tissues affected.

The Jungfrau.—In this country when anyone proposes to use his own waterfall—say, for the making of aluminium—there are usually quite a quantity of people to whom the waterfall does not belong who make a very great fuss. So much so, that if a popular body has to be consulted and permission obtained, it gets quite intimidated by the clamour. But the tendency to drive hard bargains with concessionaires is not confined to this country, as shareholders in some undertakings in Continental towns have occasionally found to their cost. One can hardly, for instance, accuse the cantonal authorities of unpatriotically giving away a Swiss mountain to German engineers in the case of the Jungfrau Railway, or of failing to insist on a quantity of troublesome conditions. Some of these are so far unique. For instance, in case the rapid ascent may be dangerous to a person suffering from organic disease, it is proposed for the benefit of delicate persons to place a medical man at the Scheidegg station for consultation. The customary objection, that the line will spoil the beauty of the mountain, is somewhat difficult to raise, as, except for a short distance, the line will be in tunnel and completely out of sight. The Act of Concession is particular to stipulate that the railway company is bound at all times to permit persons making the ascent of the Jungfrau on

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foot to have access to all parts of the mountain free of charge and without any restrictions whatsoever. On the completion of the whole or a part of the line the company are required to expend a sum of about £4,000 in erecting and equipping a permanent observatory on the summit of the mountain "for the purpose of assisting meteorological, tellural [beautiful word, tellural], and other forms of physical research," and, in addition, to contribute a monthly subscription of £40 to the expenses of it. Finally, the Government reserve to themselves the right to buy out the company after the lapse of a certain number of years, and to take over the working of the concern themselves.

Contracting in Chicago.—One of the advantages of the Constitution of the United States of America (to persons who are not Americans) is that in most matters which are of real importance each Sovereign State can do as it chooses without consulting the practice or asking the will of the rest of the country. Consequently curious experiments get tried there, from watching which the onlooker may profit. Chicago, for instance, is going to squash the undercutting contractor and reform the wicked wireman, and all by examination. (There will be the incidental advantage that no outside firm can contract.) It is to be done by city ordinance. This ordinance contains some curious provisions. The New York *Electrical Review*, which seems to approve of it, thinks it will pass, and does not appear to contemplate the courts having anything to say on it afterwards. If it does pass, then, under continuing penalties of £10 a day as a minimum (which is drastic) Section 1 makes it unlawful for any person, firm, or corporation to engage in the business of installing electrical machinery, electrical apparatus, or electrical construction work of any kind whatsoever, for the purpose of furnishing light, heat, or power by means of electricity within the city of Chicago, without first having obtained a license therefor, as specified further, and paying therefor an annual license fee of 50dol. The license is to be denominated "Electrical Contractors' License." Paragraph 2 of this section imposes a license fee of 2dol. per annum on all employés of contractors. These licenses are to be called "License for Interior Electrical Wiremen." Paragraph 3 prohibits any person from operating an electric light, heat, or power plant without a "License for Operating Electrical Machinery," and such license costs 5dol. per annum. Section 2 provides for the examination by the Board of Civil Service Commissioners of any person, firm, or corporation applying for a license under Section 1, and unless such examination is passed satisfactorily to the Board a license will not be issued. Electrical contractors must give a bond of 1,000dol. to the city to protect the latter from any expense or damage caused by defective work. Where a firm or corporation applies for a contractors' license the latter will be issued to such firm or corporation after proper examination of any one member of such firm, and in the event of the withdrawal of such member from the firm a new member must qualify. It looks as though there would be (very) junior partnerships going for young men just through the schools.

Cables and Submarine Earthquakes.—Prof. Milne has written to the *Times* on the subject of earthquakes and submarine cables. (What he wants is a "seismic survey" of the world.) What he has to say will doubtless appear when his unread communication to the Institution of Electrical Engineers is published in the *Journal*. That is not yet. Prof. Milne knows as much about earthquakes as anybody, and therefore one may abstract from his letter with the certainty that though seismology is not yet an exact science, one is in this case getting it as exact as they make it. After matters which do not concern us, it is insisted on that one feature connected with seismic disturbances in general is that their origins are more numerous beneath the sea than they are upon land, and there are undoubted cases where they have been accompanied by the interruption of submarine cables. For instance, in the Gulf of Corinth severe earthquakes have been felt and simultaneously cables have been broken. Soundings taken along these lines of rupture have shown that after the earthquake there have been considerable increases in depth. In one instance this exceeded 400 fathoms. At more than 1,000 miles distance from the scene of one of these disasters, but 11 minutes later, the unfelt movements due to the initial impulse were definitely recorded. Very many cable interruptions are apparently due to submarine landslides, and there are strong reasons for believing that in many instances these are brought about by the shaking and dislocation caused by submarine earthquakes. "The Australian Colonies have twice been isolated from the remainder of the world by the sudden failure of their cables." "Subsequently it was learned that the ruptures were the result of submarine seismic or volcanic action, a fact which in all probability would have been known at once had those colonies been provided with instruments capable of recording unfelt earthquakes." (The cables to Australia are laid through a particularly bad district from a volcanic point of view.) Lastly, Prof. Milne urges that the importance of establishing "seismographs" round many of our oceans, partly for determining when cables have been destroyed by seismic action and partly for the purpose of localising submarine *foci*, to be avoided when cables are being laid, is a matter that appeals not simply to the cable engineer but to the public. Prof. Milne's letter brought up Mr. Charles Bright, who begins by making the mistake of trying to agree with both parties—*i.e.*, with the people who say that it is the earthquake which causes the submarine slide which smashes the cable, and with the people who say it is underground water which starts the slide which produces the vibrations which get counted as a mild and unnoticed case of earthquake. (This sentence is not consciously modelled on the style of the author of the "House that Jack Built"; it came so of itself). Finally, however, he practically says "ditto" to Mr. Milne.

The Mechanism of Magnetism.—In another note there is given a brief exposition made by Lord Rayleigh of Dr. Larmor's theory of the ether. Difficult as such a conception is at first sight, its "thinkability" should be regarded rather in comparison with the mechanical conceptions of electromagnetic phenomena which have been brought forward hitherto. The best of these up to the present have mostly been modifications or developments of Maxwell's original conception of a rotating "cell" with a kind of "idle wheel" arrangement to transmit the motion to the next cell. The "cell" is sometimes the molecule or, more usually, the atom, and the transmitting mechanism the "electricity." Of such a character, for instance, is the mechanism described at very great length some time ago by Heinke in the *Elektrotechnische Zeitschrift*. Every material, whether a solid, liquid, or gas, is supposed to be made up of two fundamental elements—namely, the material particles, which are conceived as rotating, and the much smaller, spherical, electrical particles which surround them, and keep one apart from the other just as in a honeycomb the wax (the electrical particles) keeps apart the separate portions of honey (matter). Both are supposed to act on each other like friction wheels, the motion of one cell being transmitted to the others through the electrical particles. (One fails to see how to apply this to a gas.) In electrical conductors these small electrical particles on being

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subjected to an E.M.F. can wander between the material cells and then represent an electrical current, while in insulators they cannot wander. The different specific conductivity of materials is represented by the different friction coefficient between the electricity molecules and the matter molecules of each material. The magnetic properties of all materials may be represented by the direction and intensity of the material molecular rotations, and the different magnetic strengths of different materials is then represented by a different directive force. Most magnetic phenomena, such as hysteresis and the like, can also be explained by the mechanical properties of the rotating cells, and the magnetic lines of force are the direction of the axes of the cells connected together like beads on a string. The small "friction molecules" or electric particles in a dielectric cannot move or wander, but analogously to what happens in a rod under tensile strain the particles may, under the influence of E.M.F., be shifted slightly in position and return as soon as the electric pressure is removed. There is, as has been said before, nothing particularly new in this, but it is worked out to explain the main phenomena of induction, resistance, and capacity, and various problems in resonance which depend upon them. Of course, this sort of thing is a great advance on the electric fluid or fluids of the pre-historic period, which were required to do quite a quantity of unmechanical acts; but one has a sort of instinctive feeling that however it may be dodged to represent the facts, the thing as it stands is impossible, and that one is better off with the mere naked statements of what happens given by the fundamental equations. Of course, in a magnetic field there is a rotation or a twist of something. But how, and of what, is anything but clear, and the last discovery in electro-optics seems to have added to the difficulty rather than diminished it.

Ether as Specified.—In the course of his lectures on electrical vibrations, Lord Rayleigh made a long digression in the intervals of the experiments on matters of high theory, which it may be more convenient to treat at greater length separately than to have attempted to include in the summary of his lecture given last week. After explaining that the electromagnetic theory of light of Maxwell was simply that the process, whatever it is, which constituted a luminiferous "vibration" was the same as that which took place in the dielectric under a rapidly alternating charge, and the theoretical reasons for adopting it derived from the observed velocities of light, Lord Rayleigh said that the whole statement of the facts connected with the reflection of light from the surface of transparent bodies was embodied in Fresnel's famous formulæ deduced long ago with extraordinary skill from very slender foundations. If they took what was before Maxwell the favourite theory of the luminiferous medium—*i.e.*, the elastic solid conception of the ether—it was possible to obtain some approximation to the formulæ, but not without difficulty, whereas on the electromagnetic theory there was no difficulty, and the Fresnel formulæ tumbled out, so to say, at once. As to double refraction, the elastic solid ether might be said to have failed to give a successful explanation, whereas the electromagnetic theory did so at once. This theory was one of the greatest steps in pure science which had been made in our time, but it was not a step in the science of electricity, but in the science of optics. What was done was to identify certain processes in optics with known processes which occurred with electricity, and it did not in the least help to explain the cause of these. As to how one might understand the electromagnetic theory, it might be looked upon from a purely mathematical point of view. The differential equations could be written down in a small compass, and the phenomena would be derived from them. That might be satisfactory to some minds, but he could not help feeling in sympathy with those who wished to look behind the mathematics, and to form some mechanical conception of the action which took place. The difficulty was that the ether required to embody the phenomena must behave in a very peculiar way. In this connection Dr. Larmor had elaborated what was known as the rotatory theory of the ether, and had shown that it was capable of embracing nearly the whole of the field, though there were, he understood, some difficulties still to be overcome. Dr. Larmor's ether was a material thing, analogous to some extent to the elastic solid ether, but different. Its distinctive property was a resistance (elastic) to twisting which was "absolute." (Dr. Larmor has endeavoured to convey the idea by a comparison to a medium in which a quantity of magnets are embedded which are "set" by a strong field.) Of course, any part of the ordinary elastic solid resisted twisting, but that was relative only to the other parts, and was not absolute. According to this view, the magnetic force would be represented by the absolute velocity of the medium, so when they had (an electric) current along a wire they must conceive a sort of vortex or current of the medium round the wire, with a velocity falling off from within outwards. It might be that Dr. Larmor's view would be substantiated, and that it would be possible to form a consistent mental picture of the processes of the ether. But whether that were so or not, the Maxwell equations remained. These might admit of other and various interpretations, but in themselves being simply the immediate representations of the actual facts when mathematically arranged, they could hardly conceive that they could ever be displaced.

The Philadelphia Fire.—The destruction of the Philadelphia Traction Company's Mount Vernon-street generating station was noted some time ago. At that period the technical details of the disaster were not available, and except that the mischief began with the short-circuiting of a large alternator by the chain of a crane (a fairly complete way of doing the thing) and went on with the burning of an oil-soaked pine floor, little was known of what exactly happened. The *Electrical World* has since gone into the matter, and its illustrations of the machinery with the iron roof lying on the top of it after the fire was over give a pretty fair idea of the wreck. As to the cause of the disaster one need not go further than the wooden floor. (What is the use of the thermostats and other pretty little things that the Americans invent when construction of that kind is adopted?) "The floor of the engine-room was of 2in. Georgia pine, extending over a basement of 12ft. depth, in which ran the cables connecting the dynamos with the switchboard and the steam and exhaust piping. The accident which resulted in the destruction of the plant was over so quickly that accounts of its nature differ. It is believed, however, that it was due to the hand-chain of one of the travelling cranes coming in contact with the positive terminal of one of the large machines and touching the flywheel at the same time. The resulting heavy short-circuit threw sparks and drops of hot metal over and under the oil-soaked pine floor, which burst into flames in a dozen places immediately." When the men had given the fire up and run out of the building a 14in. steam-pipe under the floor tried what it could do by bursting and filling the place with steam. It did not, however, appear to make any difference, and the place was burned out. The only persons injured were in the crowd outside, and they were run over by the frightened horses. Of

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the remarks of the *Electrical World* on the disaster, the following sentence may be reproduced: "Perhaps the most prominent fact demonstrated in connection with the misfortunes of this plant is the flexibility of the trolley system. Within a few hours after the destruction of the central power station of its vast system of railways the Union Traction Company had every one of its lines in operation. There was no general stoppage of the arteries of urban transportation, impeding business and engendering protest. The fact that such recuperative powers are possessed by the electric railway (with more than one generating station) was never before so forcibly illustrated." As a matter of fact it appears that on the Union Company's system every station is connected to every other, and the burned station, occupying a central point, was the centre of the system of link cables. The only work necessary to be done to move the cars dependent upon the burned station was therefore to clear the wreckage from the switchboard, take the great copper 'bus bars, which were comparatively uninjured, and connect them with the 185 outgoing feeders and the four-link circuits bringing in the current from the other stations. "The work of making the temporary connections was begun before the fire department had finished working upon the building. By the morning following every line of railway in the city was in operation, although with a reduced number of cars." Smart work; and, as our contemporary remarks, "such an accident in a cable power-house would have meant a prolonged, entire suspension of traffic. The forethought of the engineers, who guarded against the disastrous results of such an accident with a complete system of intercommunication between power-houses, is to be highly commended. It is most unfortunate that their precautions did not include a fireproof floor in the dynamo-room of their power station."

Varieties of Rontgen Rays.—It is pretty well known that if the Röntgen radiations coming from an ordinary Crookes tube of the Jackson focus type are observed with a fluorescent screen during the process of exhaustion, the penetrative value of the rays is found to change as the exhaustion proceeds. First of all, at less than a certain degree of vacuum, no Röntgen rays are produced. Next, as the vacuum is increased, the rays begin to show themselves, but of a quality that will do little more than penetrate the backing of the screen. As the vacuum is further increased, the rays become more penetrative, and show the shadow of the bones in the hand. As exhaustion proceeds further, a point is reached when the flesh of the hand seems to be almost completely transparent, while the bones are almost entirely opaque. At higher vacua than this, the bones becoming more and more transparent, the contrast between bones and flesh becomes less and less, till at length, at the very highest vacuum at which the discharge will pass, the bones scarcely show at all, owing to their having become nearly as transparent as the flesh, while the whole hand throws but a very faint shadow on the screen. Similarly, it is found that, at any given degree of vacuum, the penetrative value of the rays is increased by increasing the power of the Ruhmkorff coil, and thereby increasing the difference of the electrical potential between the cathode and the anode portions of the tube, as measured by the length of the alternative spark in air. Again, similar results are obtained without alteration to the vacuum or to the power of the Ruhmkorff coil by varying the resistance of the tube by means of a magnetic field. In this case the gradual strengthening of the magnetic field produces a gradual decrease in the resistance of the tube and of the difference of the electrical potential between the cathode and anode, and, at the same time, causes a gradual diminution of the penetrative value of the rays. Mr. A. A. Campbell Swinton has further discovered that it is possible to vary the penetrative value of the rays produced in a focus tube by simply altering the distance between the cathode and the "anti-cathode," and has been experimenting with a new form of tube, in which the anti-cathode of aluminium, faced with platinum, is connected to the anode terminal by a sliding steel rod, so that it could be moved along the axis of the tube, and the distance between cathode and centre of the anti-cathode varied from 1in. to 3in., the anti-cathode being always outside the focus of the cathode. The results are embodied in a paper read at the Royal Society ("The Production of X-Rays of Different Penetrative Values," by A. A. C. Swinton, communicated by Lord Kelvin). Mr. Swinton has also found that the penetrative value is increased when the cathode is small. Mr. Swinton goes into the physics of the matter on the assumption that the cathode rays consist of negatively charged molecules that are repelled from the similarly electrified cathode with an initial velocity that depends upon the degree of electrical excitation of the cathode. That being so, the conditions giving high penetration are those that would conduce to a high average velocity of the molecules at the moment at which they strike upon the anti-cathode, and, at the same time, to a high average difference of potential between the travelling molecules and the anti-cathode at the moment of impact. "At high exhaustions, not only is the electrical excitation more, and the initial velocity of the molecules consequently greater, but, owing to the smaller number of collisions with the other molecules of residual gas in the tube, the average velocity of the molecules and the amount of their negative charge have suffered less diminution by the time they reach the anti-cathode than in the case of lower exhaustions. Similarly, when more electrical power is employed, the electrical excitation and the initial velocity of the molecules is increased, while the employment of a magnetic field reduces the resistance and the electrical excitation, and consequently reduces the initial velocity and negative charge of the molecules. Again, when the anti-cathode is near to the cathode, the moving molecules having a less distance to travel before they reach the anti-cathode, have by that time lost less of their initial velocity and charge by collisions than when the anti-cathode and cathode are further apart. And, lastly, not only does a small cathode become charged to a higher electrical potential than a large one, and consequently impart a higher initial velocity and charge to the molecules, but with a small cathode the travelling molecules are more compactly arranged than with a large cathode, and consequently are not likely to make so many collisions and lose so much in velocity or electrical charge during their transit." From various experiments it appears that the penetrative value, as distinct from the quantity, of the rays is independent of the material of which the anti-cathode surface is made. Under any conditions different molecules will have different initial velocities and charges imparted to them, and some will make fewer collisions than others, and consequently some molecules will thus strike the anti-cathode at higher velocities and in a more highly charged state than others, so that it may be expected that the Röntgen rays will be more or less heterogeneous under all conditions. Nevertheless, Mr. Swinton's new form of tube can hardly fail to be of service to serious investigators as apart from those who are merely playing about with the subject. Little or nothing can be done in the way of measurement until one is able to get radiations which are not mixed but all of one sort.

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THE MECHANICAL CONSTRUCTION OF ELECTRICAL MACHINERY.

BY F. M. WEYMOUTH.

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THE DYNAMO.

(Continued from page 488.)

Rails (continued).—In Figs. 154 to 156 a design of rail is shown which is somewhat similar to that shown in Fig. 144. The difference is that here the lower part is a long narrow inverted box, *a a*. This design is consequently the stiffer of the two; and for any given degree of strength will bear casting in lighter metal. A rail, for instance, of the type represented in Fig. 144, about 4ft. long, to be tolerably strong would need to be cast in metal, say, at least ⅞in. or 1in. thick. But with the box

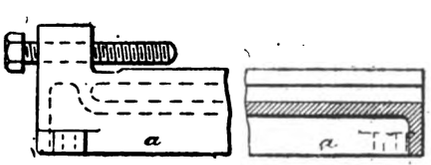

FIG. 154.

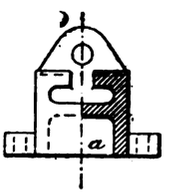

FIG. 155.

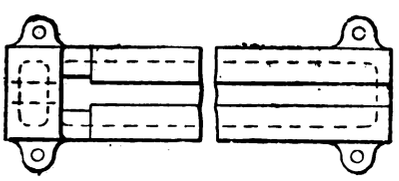

FIG. 156.

pattern now before us, having the same length, and being, say, 5in. or 6in. deep, ⅜in. or ½in. thickness of metal would be ample, especially if some extra thickening or a flange were added to the lower edges, preferably for casting purposes, on the outside. The arrangements for machining are similar to those in foregoing cases, as may be seen on inspection.

A useful combination of the last type, having a moving pedestal or bracket for the pinching screw instead of a fixed one, is illustrated in Figs. 157 to 159. Though the point is of course optional, the two rails are here shown joined across by members, *a a*, which are evident in the part plan (Fig. 159), and appear dotted in end view in

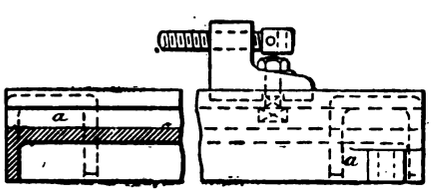

FIG. 157.

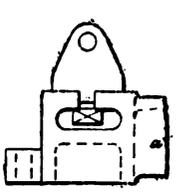

FIG. 158.

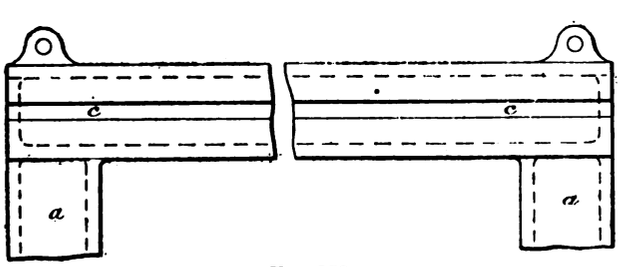

FIG. 159.

Fig. 157. It will be observed that the slot, *c c*, runs straight through from end to end. This allows a clear course for the planing cutter; and a row of rails laid end on in the planing machine may be machined in one operation. It is to be noted also that for shifting the dynamo back towards the engine again, it is easy here to pull the moving bracket off one end and put it on the other end; and also that the facings extend to the total over-all length of the rail, whereby floor space is economised, in which respect comparison may be made with Figs. 134 and 139. The design is generally simple, and is easy to cast.

Figs. 160 to 162 present enlarged views of a movable bracket, such as might be used on the rail above discussed. Fig. 160 shows a sectional elevation, and an end view, with a small section, A, on *a b*. Fig. 161 is an elevation of the cast-iron bracket only, without fittings, and Fig. 162 a plan of the same. As may be observed, this design differs from any that we have hitherto touched on, principally in the respect that it has a bush, lettered *c*, for the pinching screw. It is introduced here as in some measure representing what may be termed "first-class" work, as compared with the much cheaper expedient of simply running an ordinary V Whitworth threaded tap-bolt through the cast iron itself. The square thread in a steel bush will obviously have a longer life; and it is largely a question of "wear and tear," and of general finish in appearance. We may, however, consider some of the points in detail.

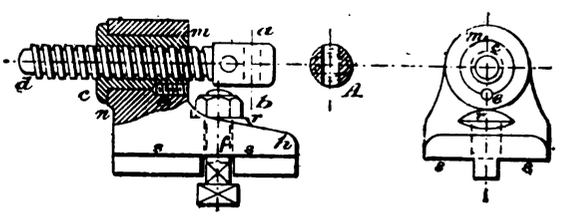

FIG. 160.

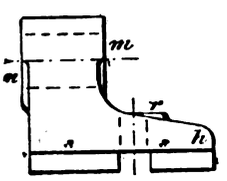

FIG. 161.

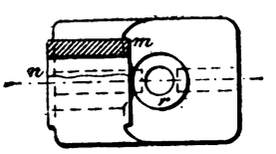

FIG. 162.

The main body of the bracket may be cast iron; but the bush, *c*, will be either of, say, gunmental or mild steel. If the former, then for the sake of getting a good thread, the bush will be cast solid, and the hole drilled out. It will in any case be turned all over. If made from mild steel it will be turned "out of the solid" from a piece of round bar of slightly largely diameter than that of the flange (at *c*). For the sake of a neat appearance facings, *n*, *m*, are put on the bracket. That at *n* will be of slightly larger diameter than the flange; but, as shown at *m*, the facing and the bush end will be flush. The finishing cut to this latter facing and the bush end must therefore be turned off not till after the bush is permanently fixed in place. To hold the bush, it will be observed that a small screwed pin, *e*, which should be of mild steel, is inserted, so as to be half in the bush and half in the body of the bracket. This prevents the bush from rotating with the pinching screw; and, being itself threading, it also prevents longitudinal motion of the bush. It is shown here with its outer end cut off flush, which will be performed when the facing *m* and the bush end are machined. Thus, when finished, and if the bush is of steel, the pin will be scarcely, if at all, discernible. A fixture thus made is permanent. But a saw-cut in the end of the small screw would enable it to be withdrawn if desired by a screwdriver—providing that the precaution is taken of oiling or greasing the pin before it is put in, so that it shall not get set fast. As, however, it would be probable that the bush, with its small amount of wear, would at least last as long as the rest of the machinery, this point would seem of small import.

The pinching screw is shown with a single square thread, which, as has been intimated, is superior to the V-thread for wear. The thread might, however, be double or triple. But the single thread will be the most powerful, though, of course, the slowest in action. The end at *d* is best rounded as shown, so that the pressure (against the bedplate) shall always come fair on the centre of the screw. A circular head is given the pinching screw, having two tommy holes through it at right angles to each other. By thus avoiding an hexagonal, or square head, the screw may be turned from a plain piece of round mild-steel bar. General snugness is attained, as the small head, allowing

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just sufficient working clearance over the top of the holding-down bolt, *f*, permits the centre line of the pinching screw to be brought down well, and so the total height is also reduced to a minimum.

The latter point will be seen to be from a mechanical point of view a distinct advantage. For it will be observed that the leverage due to the height of the point *d* above the base line, *s s*, is met, so to speak, by the leverage from the centre of the holding-down bolt at *f* to the heel of the casting at *h*. The less this height is in proportion to the length *f h*, the less will be the tensile strain on the bolt, *f*, resulting from the pressure at *d*.

The strength of the pinching screw, or, in other words, its diameter at the bottom of the threads, may bear some proportion to the pull of the belting: or, as other considerations will show, it may need to be greater. When screwed home so that the point *d* projects its maximum distance from the bush, then the screw from *c* to *d* will need at least sufficient strength as a horizontal column, or strut, to safely take the whole pull of the belt; and to this must be added a percentage of the weight of the dynamo. Of course only half this weight, roughly speaking, will come on one rail. If, for instance, a dynamo weighs 2,000lb., half of this will be 1,000lb.: and if we take the coefficient of friction of the dynamo bed-plate on the rail at ·2, then 1,000 × ·2 = 200lb., which will be the load to be reckoned on the end, *d*, in addition to the pull of the belting.

If we assume the belt to be, say, 6in. wide by $\frac{5}{16}$in. thick, then, according to Unwin's "Machine Design," we may take 100lb. per inch of belt width as the safe load, or about 300lb. as the breaking load at the laced joints. This gives 300 × 6 = 1,800lb. as the maximum load on the screw end—letting the screw be at least strong enough to break the belt—to which we add the 200lb., making 2,000 a maximum total. With the proportions shown in the sketch, Fig. 160, this will cause 2,400lb. tension in the bolt, *f*, which latter will consequently need to be not less than $\frac{3}{4}$in. in diameter, and steel at that size, and better if $\frac{7}{8}$in. The pinching screw is disproportionately strong as regards mere end pressure. But other things have to be considered. Thus usage and wear both demand size. If made much smaller than here shown (in proportion to its length) it would be apt to get bent when being worked with the "tommy," especially when the head is far back and the point *d* within the bush. Thus when sufficiently large for these latter desiderata, it will have more than ample size to take the thrust.

It will be noted that, owing to the circular form of the head, the pinching screw is easily made and kept bright all over, and with less expense than an hexagonal or square head. It will thus always have a neat appearance. The bush, it will also be observed, is inserted from the dynamo side, so that the pressure from the screw is borne by the flange, *c*, and not on the small screw, *e*. And further, the "purchase" of the pinching screw is solely from the friction, or "grip," of the under surfaces, *s s*, on the rail. Hence the bolt, *f*, is not in any way to be considered as being in shear, but only in tension. On this account, therefore, this need only be a "black" bolt, not turned; and the hole for its reception will be a clearance hole as shown. It will be noted that the facing, *r*, for the holding-down nut, is partly a raised facing, and partly recessed, which accounts for the peculiar appearance in the end view. The heel of the casting is sloped from *h* up toward *m* so as to economically dispose the metal.

In the case of a fixed pedestal the pinching screw would need to be much longer. If we thus assume it to be $\frac{3}{4}$in. in diameter at the bottom of the thread, then the 2,000lb. above mentioned would be but a safe end pressure on the screw when projecting about 10$\frac{1}{2}$in. from the pedestal, quite apart from considerations of wear and usage. These latter might therefore demand a slight increase in the diameter. Methods of calculating the strength of these screws as columns, and bolts under tension, and so forth, are somewhat outside the scope of these remarks, as they may be found in Prof. Unwin's "Machine Design," and other books.

We now approach the consideration of some other points regarding the use of slide rails. In the designs that we have hitherto considered, it will have been noted that the dynamo is guided when sliding on the rails under the action of the pinching screws, simply by its holding-down bolts, which are engaged in the slots in the rails. Figs. 163 to 166 show two arrangements wherein other means are adopted to attain this end, both of which are taken from Prof. S. P. Thompson's "Dynamo-Electric Machinery."

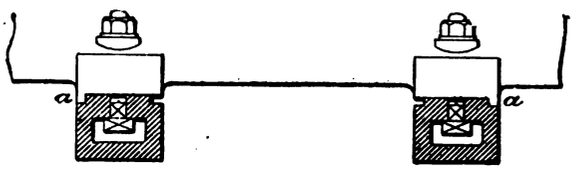

FIG. 163.

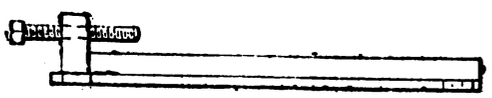

FIG. 164.

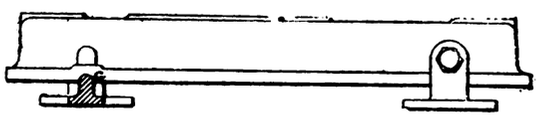

FIG. 165.

Of these the first is illustrated in the single view shown, Fig. 163, wherein it will be observed that the dynamo is guided on the rails by small fillets, *a a*, cast on the bottom of the bed-plate. But the second arrangement demands more attention. This accompanies an Edison machine. Fig. 164 is a side view of one rail, which it will be seen has a fixed head. Fig. 165 is an end view showing both rails, but with a section of one of them on *r s* in the plan, Fig. 166. It will thus be noted here that, as shown at *c* (Fig. 165), the dynamo bed-plate is grooved underneath so as to fit the rails, and is thus rendered incapable of slipping sideways. The dynamo, however, is not held down to the rails, but merely rests on them with its weight.

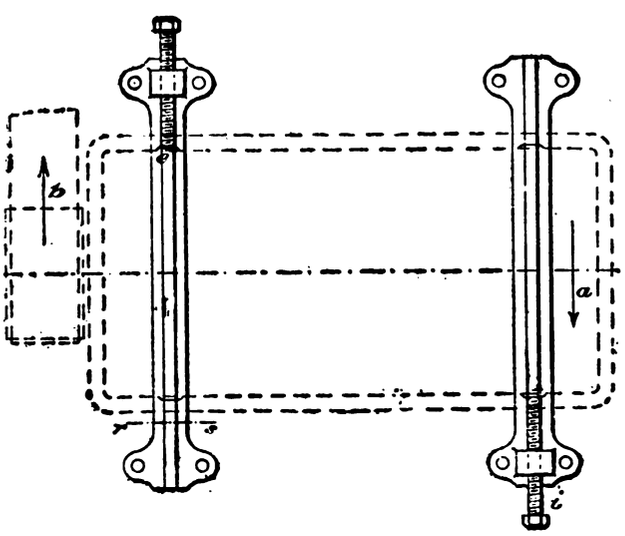

FIG. 166.

But holding-down bolts are present in the arrangement shown in Fig. 163. A further peculiarity in the Edison method is in the placing of the rails. It will be seen that the screws come on opposite sides of the bed-plate (shown dotted). For the pull of the belt, indicated by the arrow *b*, acting on the point of the screw, *e*, as a fulcrum, will tend to slew the other end of the dynamo, as indicated by the arrow *a*. The screw at *i* is hence so placed as to resist this tendency. On the other hand, general experience does not appear to commend this method. The actual strain of the belt would scarcely in most cases be able to overcome the friction of the bed-plate on the further rail; and when shifting the machine to tighten the belt, it would be more convenient to have the screw, *i*, at the opposite end of the rail to that here shown.

(To be continued.)

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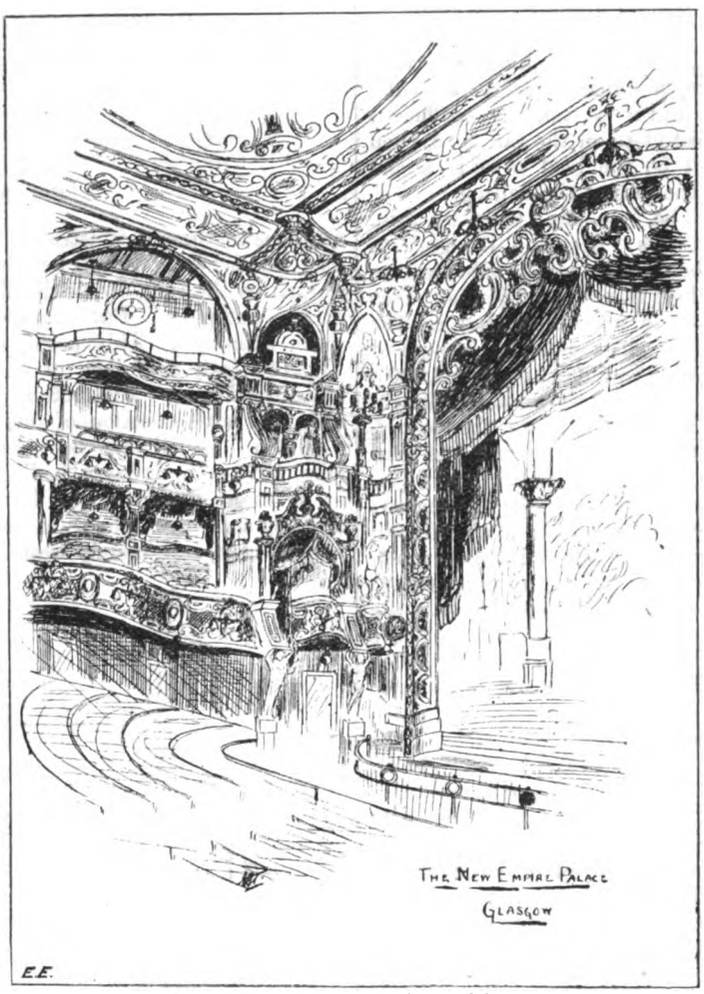
THE NEW EMPIRE PALACE, GLASGOW.

The most recent of the numerous Empire Palaces which have of late years been erected in the chief towns and cities of the kingdom was opened last week in Glasgow. The Glasgow Empire, which has risen on the site of the old Gaiety, at the corner of Sauchiehall-street and West Nile-street, will rank as one of the handsomest and most commodious of the houses of entertainment in Glasgow. Designed by the well-known theatrical architect, Mr. Frank Matcham, whose designs are carried out in a most lavish manner, the result leaves little to wish for.

The main entrance is from Sauchiehall-street, where a covered portico of artistic ironwork and glass stretches over the footway. This front is boldly designed, the entrance being surmounted by a bay window filled in with coloured glass, and flanked by pilasters, which continue on and support a curved panel bearing the words "Empire Palace Theatre." At the sides are bays finished with minarets. The centre façade is covered with a domed roof surmounted by a lurid flambeau. This entrance gives access to the stalls, dress circles, and boxes, while the entrance to the pit and gallery is from the West Nile-street façade. The building is carried out in red freestone, and is lavishly ornamented. Entering by the main doorway, the lobby is seen to be most artistically decorated; beyond this is the entrance to the stalls and the grand staircase leading up to the foyers and grand circle. Both the staircase, foyers, as well as the lobbies to the boxes and circle, are also decorated in a most tasteful manner. The auditorium is a two-gallery structure built on the cantilever principle, all supporting columns being kept well back, so that an unbroken view of the stage is obtained. The parterre is divided into six rows of stalls and a most roomy pit, while above is the first circle, with roomy promenade behind, and above again the gallery The general scheme of colour is cream picked out with pale blue, and the whole lavishly embellished with gold. On either side of the stage are niches containing life-sized groups representing "Music" and "Dancing." The elevation of the proscenium boxes is very prettily designed, and they are surmounted on either side by panels bearing the well-known composers' names, "Rossini" and "Sullivan." The hangings and general upholstery is in old-gold stamped plush, and the stalls and circle tip-up chairs are also upholstered in old-gold plush. The lower tier of proscenium boxes are each supported by two life-sized female figures, and the entrance to the stalls is formed between them.

In a building of this nature the electrical installation must always play an important part. In the present case it was entrusted to Messrs. Barclay and Son, of London, and has been carried out for them by Mr. C. V. Bretherton, who, we might mention here, has just completed the Empire Palace at Liverpool for the same proprietor. The current is obtained from the Glasgow Corporation mains at a pressure of 200 volts; after passing through the various meters, fans, and an exceptionally heavy main switch with large brakes, it goes to a distributing board, where it is subdivided into two circuits, one of which runs direct to the stage board, and the other of which runs to a distributing board placed in the box office at the main entrance. The stage board is placed on the prompt side of the stage, and from it the whole of the light not only on the stage but also in the auditorium can be controlled. The switches are so arranged that while each individual section of both stage and auditorium can be separately controlled, the whole of either side of the curtain can be switched on and off from main switches provided on the board for that purpose. The stage lighting consist of four battens of 50 32-c.p. lamps each, arranged on 12 circuits; ten wing ladders of 12 32-c.p. lamps each, each ladder on its own circuit: a float of 60 32-c.p. lamps arranged on three circuits—thus giving a total of 380 32-c.p. lamps arranged on 25 different circuits. The float and battens are arranged for three different colours—viz., white, red, or blue. The lights are all controlled by Lyon's patent liquid resistance, the resistances being placed beneath the stage and being worked by levers placed on the switchboard.



General View of the Auditorium and Stage.

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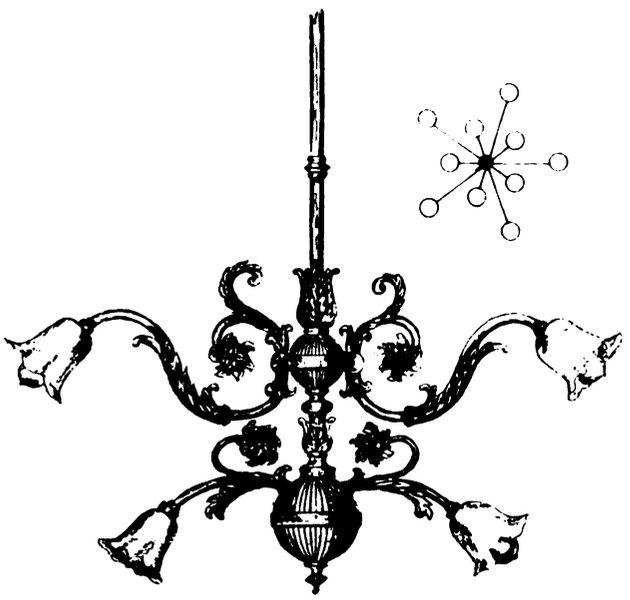
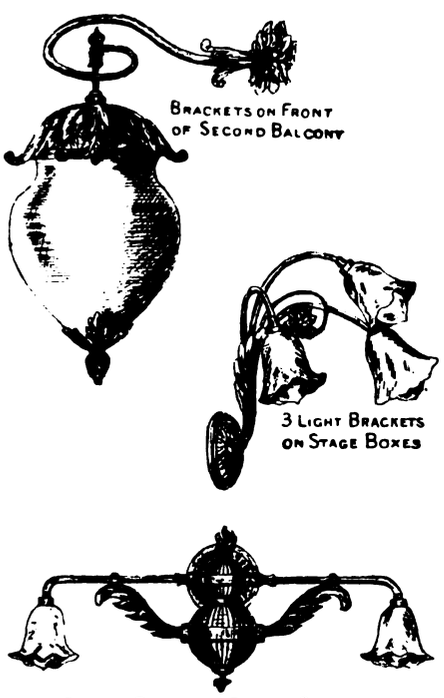
These, we might note, are, we believe, the first of Lyon's resistances to be used on a 200-volt circuit. There are also on the stage four electric stage arcs, hand-fed. There is no gas at all on the stage, with the exception of an emergency plant in case of accident.

In the auditorium proper there are 180 lamps, arranged as follows: from roof along front of proscenium, four five-light electroliers; from roof at four corners of centre, four



View of 10-Light Fitting used in the Auditorium of the Glasgow Empire.

ten-light electroliers; from roof round sunlight, eight three-light electroliers; round the first circle, nine two-light brackets; round the second circle, seven two-light brackets and four single-light lanterns; proscenium boxes, eight three-light brackets; on either side of proscenium, two three-light standards; under first circle and over pit, six single lights; under second circle, nine single lights; over gallery, two three-light clusters and five single lights.



The fittings in the auditorium are all of a tasteful design, but do not call for any special notice. The brackets on the first and second circles project at right angles from the base, and also the arms from the stem; this appears a little severe, but is rather a pleasant change from the regulation swan-neck. An effective variety is introduced by means of lanterns at the angles of the second gallery.

One noticeable feature, a description of which must not be omitted, is the method of showing the numbers of the turns. Circular projecting brackets are arranged on either side of the proscenium, into which the numbers can be mounted from the stage without the need of coming in front of the curtain. These numbers are made in the same manner as a stencil, and the open parts filled in with a transparent medium; at the back of this is placed an enamelled reflector and a 50-c.p. lamp, which serves to make the number clearly visible whether the house is illuminated or not. The various lobbies, passages, bars, foyers, etc., are lighted by some 150 lamps, all of which are controlled from the distributing board placed in the

Number-Indicating Device used in the Glasgow Empire.

box office, and upon this board all the fuses are placed. Both the main switchboards were made by the Edison-Swan Company, and the lampholders and lamps are also all of this firm's make. On the outside of the building there are 12 two-ampere "Luna" arc lamps, arranged in two sets of four each and two sets of two each; all on the 200-volt mains.

On the opening night the electrical work was far from completed, and we understand that a number of the fittings were only used temporarily. We hope that things will soon be got more shipshape, and that the lighting will prove a source of safety as well as of comfort to the numerous patrons of the palace.

THE WETHERILL MAGNETIC CONCENTRATING PROCESS.*

BY H. B. C. NITZE, E.M.

This process was first described by Mr. H. A. J. Welkens and myself, in a paper entitled "The Magnetic Separation of Non-magnetic Material," presented at the Pittsburgh meeting of the American Institute of Mining Engineers, in February, 1896, and since then published in the *Transactions* of that society.

It is a process for separating various mineral and chemical substances of such feeble magnetic permeability that they have been heretofore generally considered as non-magnetic from one another and from such accompaniments as are absolutely inert by means of powerful and specially devised electromagnets. The substances that have been found capable of being so attracted are most all of the minerals containing iron and manganese, either alone or in combination, and likewise the chemical salts of these metals, either alone or in combination. Among the minerals are hematite, limonite, siderite, chromite, menaccanite, rutile, franklinite, pyrolusite, psilomelane, tephroite, rhodonite, garnet, hornblende, and many others. None of these minerals or salts is attracted (in the ordinary sense of being lifted) by the strongest hand magnet or by electromagnets of equivalent power.

The metals iron, nickel, cobalt, and the minerals magnetite (Fe_3O_4) and pyrrhotite (Fe_7S_8), are the only substances that are magnetic in this ordinary sense, and the only ones which are capable of being separated by the

* Paper read before the Frankland Institute, January 19, 1897.

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various electromagnetic machines that have been invented prior to the Wetherill machines, such as the Edison, Wenström, Ball and Norton, Conkling, Buchanan, Payne, Chase, and other magnetic separators. It is true that separations have been made of such minerals as red hematite, limonite, siderite, and franklinite on some of the above types of machines, but it has invariably been accomplished only after a preliminary conversion of the iron component to its magnetic oxide or artificial magnetite, by means of roasting in an oxidising or reducing atmosphere. However, while these minerals and salts are not attracted by the ordinary magnetic powers sufficiently to render their separation possible, it has, nevertheless, been long known in the science of physics that all matter is affected in some way by a magnet.

Coulomb was the first physicist to announce that not only iron, nickel, and cobalt, or certain mixtures of these metals with others, were influenced by a magnet, but also that small needles and all other substances—metallic, mineral, or vegetable—oscillated under the influence of strong bar magnets like small magnetic needles. He, however, erroneously interpreted that this action was due to the universal presence of iron in quantities so small as to defy detection by the most refined chemical analysis, and did, therefore, not consider that it was a general property of matter in itself to be magnetic. Nearly 20 years later, in 1824, Becquerel, who had the advantage of utilising electromagnets, invented since Coulomb's time by

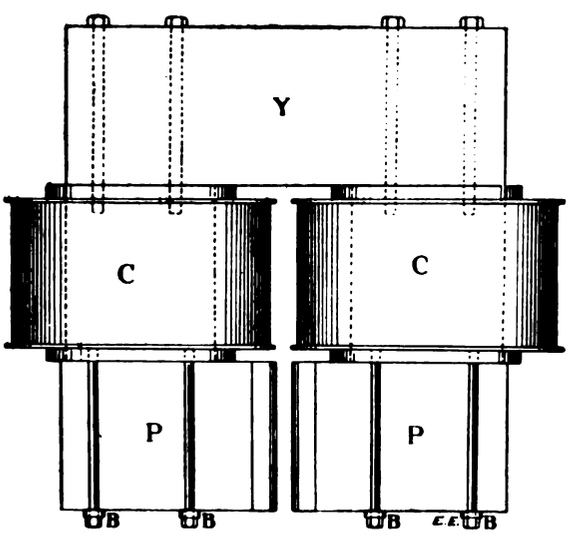

FIG. 1.—Plan of Wetherill Electromagnet.

Oersted, discovered the repulsion produced by the poles of a magnet on bismuth. In 1846 Faraday published the results of his very interesting and exhaustive experiments, carried on with the most delicately arranged physical apparatus, showing that all matter, solid, liquid, and gaseous, was magnetic—*i.e.*, either attracted or repelled by the poles of a magnet. He accordingly made the division into paramagnetic and diamagnetic substances, the former including those attracted, and the latter, constituting by far the greater class, those repelled. He gave the following lists:—Paramagnetics: iron, nickel, cobalt, manganese, chromium, cerium, titanium, palladium, platinum, osmium. Diamagnetics: bismuth, antimony, zinc, tin, cadmium, sodium, mercury, lead, silver, copper, gold, arsenic, uranium, rhodium, iridium, tungsten. Uranium was later found to be paramagnetic (by Verdet); and almost all amorphous and organic substances belong to the diamagnetic class.

The paramagnetic substances may again be subdivided into such as are highly magnetic and such as are only feebly so. The first class is completed with the substances iron, nickel, cobalt, magnetite, and pyrrhotite. It is with the second class that we are especially concerned here. The knowledge of the paramagnetic property of many substances has been of great scientific interest since the time of Faraday's demonstration. In 1871 Fouqué, and since then Doelter and other mineralogists, have made use of this knowledge to some extent in the mineralogical laboratory. But it remained for Mr. J. Price Wetherill, of South Bethlehem, Pa., to design magnets capable of producing a sufficiently concentrated field to make practical the separation of these feebly paramagnetic substances on a commercial scale. Mr. Wetherill, who is the general manager of the Lehigh Zinc and Iron Company, was led to this result in his endeavour to improve the grade of the zinc ore of Sussex County, N.J., used for the manufacture of spelter. This ore is a crystalline granular aggregate of franklinite (FeO, ZnO, MnO) (Fe_3O_4, Mn_3O_4), willemite (Zn_2O, SiO_2), and calcite, with smaller amounts of zincite (ZnO), fowlerite, (NnO, ZnO, SiO_2), tephroite (Mn_2O, SiO_2), and garnet. It was the object to obtain the zinc-bearing minerals willemite and zincite as free as possible from the franklinlite, garnet, tephroite, and fowlerite, the iron and manganese

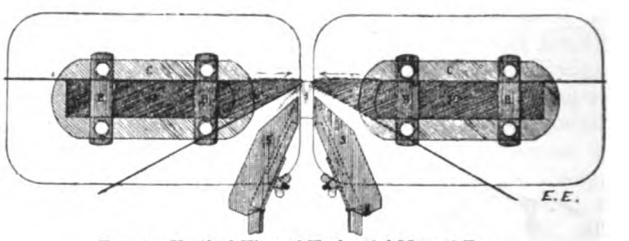

FIG. 2.—Vertical View of Horizontal Magnet Type.

bearing minerals, as the presence of the latter is fatal to the direct metallurgical production of zinc. After repeated and painstaking experiments, Mr. Wetherill finally succeeded, in the latter part of 1895, in accomplishing this result to perfect satisfaction, and patents have since been granted in the United States, Canada, England, Germany and other European countries, for the method of, and apparatus for, separating paramagnetic substances of very low magnetic permeability or susceptibility. The accompanying illustrations show the form and arrangement of the magnets, as well as the principal features of the mechanisms for effecting the separation of substances subjected to their influence. The electromagnets are arranged in the general form of a horseshoe, as shown in plan (Fig. 1), and consist of five parts, made of soft forged iron; two cores and bobbins, C, joined together by a yoke, Y, and having attached to each of their other faces, by means of brass clamps, B, a pole-piece, P, as shown. The yoke is 31¼in. long by 10½in. wide by 2½in. thick. The cores are 12½in. long by 10½in. wide by 2⅝in. thick, made rectangular in cross-section, with the long edges rounded to a radius of one-half the thickness. These cores are wrapped with 19 layers of No. 5 insulated copper wire, making 915 ampere-turns. The pole-pieces are 15½in. long by 10¾in. wide by 2½in. thick, and are tapered at the free ends at an angle of 30deg., the points being rounded. The total weight of this magnet complete is 1,259lb. The mechanisms for effecting the separation of minerals are of two principal types, as shown in the drawings, representing vertical views (Figs. 2 and 3): (1) The horizontal magnet type

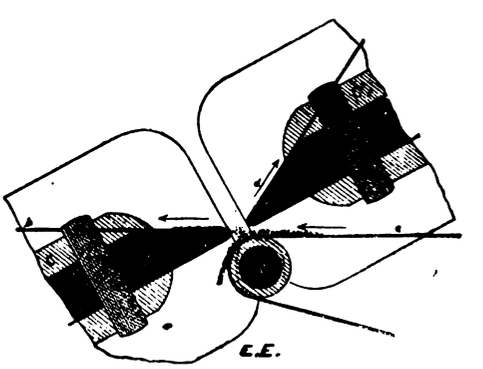

FIG. 3.—Vertical View of Inclined Magnet Type.

(Fig. 2), in which the material is fed by means of hoppers, in a thin layer on canvas belts, *a*, revolving in the directions shown by the arrows about each pole-piece, P, and is delivered directly into the opening between the two pointed pole-pieces. Two shutters, S, made of brass and of the same width as the pole-pieces, are situated one beneath the point, T, of each pole; they are adjustable so that the magnetic particles, which adhere slightly to the belts as they round the pole-points, are carried to one side by the moving belts, while the non-

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magnetic particles fall vertically in the central space between the two shutters. The result desired can be regulated by changing the position of the shutters, the speed of the feed belts, the distance between the pole-points, or the amperage of the electric current through the coils. (2) The inclined magnet type (Fig. 3), in which the material enters on the feed belt, *a*, revolving about a brass roller, R, and is delivered in close proximity to the space between the poles. The magnetic particles are withdrawn and lifted up into the highly intensified field existing at this point, and they are removed by the horizontal belt, *b*, revolving around the lower pole-point in the same direction as the feed belt; while the non-magnetic particles fall vertically from the brass roller. The revolving belt, *d*, around the upper pole simply serves the purpose of keeping that point brushed free from magnetic particles that would otherwise have a tendency to stick to the bare points, and ultimately choke the opening. The intensity of the magnetic attraction can be accurately adjusted by changing the distance between the poles, the distance of the brass roller from the poles, or the amperage of the electric current. The question of paramount interest is: How are these magnets capable of effecting a separation that has not been practicable heretofore? How is it that substances possessing such infinitesimal magnetic permeability that they have been commonly considered as non-magnetic are attracted here, and actually lifted by the poles of the magnets? The answer lies in the extremely condensed magnetic field at the pole-points, which is produced by means of the correctly-proportioned cores, yokes, and pole-pieces employed, and especially by the tapering ends of the latter. These ends being of less sectional area than the magnet cores, a vast number of magnetic lines are forced through and across the points. The amount of amperage necessary to generate these lines in sufficient number is comparatively small. The magnetising power of a magnet may be attained either by increasing the amperage of the current, or by increasing the ampere-turns—*i.e.*, the number of turns of the coil on the core—the one or the other of these functions remaining constant. In the Wetherill magnets the latter fact is taken advantage of, and with 915 ampere-turns of No. 5 wire the quantity of current or amperage is reduced to an economic minimum. The No. 5 wire is capable of carrying a current of 25 amperes, but this quantity is rarely necessary for most minerals. For instance, limonite and pyrolusite, which are perhaps among the most stubborn of the feebly magnetic minerals, require from 10 to 20 amperes; red hematite and garnet are usually attracted with from four to eight amperes; and franklinite and siderite with as low as one to four amperes. The amount of voltage is an inconsequent factor, depending solely on the size and length of wire and the number of amperes used—*i.e.*, it represents the pressure requisite to drive the necessary amperage through the magnets. For coils wrapped with No. 5 wire the voltage is equal to about twice the number of amperes used—*i.e.*, the resistance is two ohms; for coils wrapped with No. 10 wire the resistance is five ohms. To illustrate the intensity of the magnetic field it may be mentioned that the current of a single bluestone cell (such as is used in telegraphy) is usually too powerful to permit of a satisfactory separation of the highly magnetic substances magnetite or pyrrhotite, the particles adhering to the points so tenaciously that the moving belts are incapable of pulling them off. For this purpose it is found best to reduce the strength of the current by means of resistance coils. The ability to delicately adjust the magnetic intensity of the field permits, in many cases, the successive isolation of several products, showing a slight difference in permeability from a mixture containing the same. For instance, in the New Jersey zinc ore, franklinite can first be separated at one to three amperes, and then the garnet at four to eight amperes. This brings up the interesting question of the possibility to tabulate the minerals in distinct groups capable of being magnetically separated from one another—*i.e.*, in the order of their relative attractability. It is, however, a matter of very considerable difficulty to do this accurately, for the reason that the magnetic permeability of each mineral in itself is subject to wide variations; for instance, some particles of franklinite will be attracted at one ampere, while others will require as high as four amperes; some garnets will be lifted at three amperes, and others not until six, seven, or eight amperes are reached. Nevertheless, various attempts have been made in the past by physical investigators, with more or less success and reliability of results, to determine the magnetic permeability of substances, and it may be of interest to give some of their determinations.

Delesse (*Annales des Mines*, IV. Ser., vol. xiv., p. 429) gives, among many others, the following comparative values, taking the magnetic attractability of steel at 100,000.

Magnetite	65,000
Siderite	120
Hematite	93 to 43
Limonite	72 to 43

Plücker (*Pogg. Annalen*, vol. lxxiv., 1848) gives, taking metallic iron at 100,000:

Magnetite	40,227
Red hematite	134
Hydrated ferric oxide	156
Proto-sulphate (vitriol) of iron	98
Pyrite	150
Hydrated Mn_2O_3	70
Mn_3O_4	167

These results verify one important point—namely, the undoubted existence of a wide gap between the strongly and the weakly magnetic substances—according to which the paramagnetics are divided into two classes, as mentioned in the beginning of this paper. The accuracy and value of the figures, otherwise, is extremely doubtful, and in some instances they are known to be absolutely erroneous and misleading, so far as experience with the Wetherill magnets goes. A striking instance of discrepancy is furnished by pyrite and iron vitriol, the former of which Plücker rates at 150, and the latter at 98. Yet the fact is that iron vitriol is attracted with ease at eight amperes, while iron pyrite is the only iron-bearing mineral that does not, so far as present experiments have gone, come within the attracting limit of the magnets at all, although it is still hoped that it will be possible to further increase the intensity of the field by which it will be made effective upon a wider range of minerals than has been successfully treated so far, including iron pyrites. Again, whereas Plücker places the permeability of the manganese salts not far from, and even below, that of pyrite, their attractability is, in reality, far greater. It is, indeed, a curious and interesting fact that the manganese salts are, as a rule, more magnetic than the corresponding iron salts; for instance, manganous sulphate (c. p.) requires only one ampere, while ferrous sulphate (c. p.) requires eight amperes to be attracted. It does not appear then that the magnetic permeability necessarily depends upon the amount of iron in a substance, or upon the chemical condition of that iron in a ferrous state, as has been thought by many. But how is this property of matter best explained? Without here desiring to enter into a discussion of the theories concerning the magnetic properties of matter, it may be stated briefly that, in view of existing facts, the magnetic molecular theory seems the most satisfactory to us. This theory accounts for the magnetism of bodies by the existence of magnetic molecules and explains the variation of permeability as due to the arrangement and structure of these molecules. The ratio of the sum of the volumes of the magnetic molecules to the entire volume of a body is the magnetic density of that body. It is upon this that the capacity of a body for magnetism seems to depend, and it has been shown to vary with the temperature and other physical and chemical conditions. In conclusion, the author gave some actual results obtained in concentrating different ores by the Wetherill process—zinc, iron, silver, and manganese ores.

Among the materials which have been separated successfully are: (1) a mixture of apatite and rutile, occurring in a deposit near Charlottesville, Va.; (2) monazite sand from North and South Carolina, from which rutile and garnet were completely removed; (3) garnetiferous rocks and schists, from which it was desired to obtain the pure garnet; (4) garnetiferous copper ore from Mexico; (5) corundum ores, from which garnet and other deleterious ferruginous minerals were to be removed; (6) ores containing siderite, as in cryolite from Greenland and the foreign zinc-blende ores.

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SHEFFIELD.

REPORT ON TRAMWAY TRACTION.

(Continued from page 500.)

VIENNA.—Population, 1,364,548.

The deputation having heard that electric traction was being adopted by the tramway companies in Vienna, and having to pass through the city, decided to make enquiries and obtain any information that might be available. They obtained interviews with her Majesty's consul and the representative of Messrs. Siemens and Halske, and the result of their enquiries is as follows: Though the streets along which the present tramways run are usually fine, broad thoroughfares, some of them are very narrow, and while the gradients are generally flat, there are also a few steep ones. The sharpest curve has a radius of 60ft. Asphalte is extensively used, also granite paving, and a little wood. The weight of the rails is about 82lb. per yard. The length of the Vienna Tramway Company's lines is 50 miles, and that of the New Vienna Company's lines is 19 miles, and the gauge is 4ft. 8½in.

The tramways are at present in the hands of two companies, the old and the new. The old company has only horse traction, but has decided to try electricity. The cars of the new company are worked by horses in the city and steam-engines in the suburbs. The systems of tramway haulage in Vienna at present, are: (1) horse; (2) steam—in suburbs only; (3) electric overhead—Modling to Hinterbrutel. The deputation made enquiries as to the use of accumulators, and were informed that they had been tried on a small scale, but none were running at the time of their visit. The concession to the old company is till 1925, and that to the new company till 1934. Nothing need specially be said about the horse tramways, except that the cars are indifferent and old-fashioned. The old company have 2,834 horses, 40 winter and 114 summer cars, 250 saloon cars, 204 for one horse, and 55 cars with inside and outside seats, and 195 cars for cleaning purposes, etc. The new company have 511 horses, 93 carriages for horses only, and 104 for steam or horse traction; also nine cars for their own purposes. The steam traction is all outside the city, and is not very extensive. The engines are separate from the cars. Generally, the steam trams were similar to those seen in other places, and the appearance was most unsightly. At present, the only electric line is an old one (constructed about 10 years ago), from Modling to Hinterbrutel, on the overhead system. The length is about 1¼ miles, and the gradients are very flat. The line was constructed by the railway company mainly for the convenience of persons having business in Vienna and residing in the suburbs.

The deputation were informed that everyone in Vienna favoured the introduction of electric traction on account of its cheapness, but the Government at present opposed it. The old company, however, have obtained permission to try electricity on the overhead (Thomson-Houston) system, and a line about three miles long is to be opened next year as a trial line with a view to demonstrate the desirability of a change from horses and steam and inducing the Government to consent to extensions of the electric system. The tramways in Vienna are in a very backward state, and public opinion on the tramway question is not so advanced as at Berlin or Hamburg, although it seems as if the question was now to be taken up with more vigour. What cars there are compare very badly with those at Elberfeld, Remscheid, or Hamburg. Although there are three electric light companies supplying private consumers, the streets are not lighted with electricity, as there is an arrangement with the gas company terminating in 1903, which cannot be disturbed earlier. The overhead electric seems to be preferred to the conduit, as the latter is considered expensive, but the deputation doubt whether it will ever be allowed in the centre of the city.

MILAN.—Population, 450,000.

For the information obtained in Milan, the deputation are indebted to F. Armstrong, Esq., H.M. consul, and to Signor Ponzie, the assessor of the Municipio di Milano, who is the head of the municipal department having charge of the tramways. The total length of the streets in Milan is 203 miles. Some of them are narrow, the narrowest being 20ft. The gradients are flat, the steepest being 1 in 33, and the sharpest curve has a radius of 52ft. The cross-section of some of the principal streets is very different to the ordinary section of English streets, the gutters being in the middle and the section falling from the kerbstone to the centre, instead of from the centre to the kerb, as in England. On many of the tramway routes there is no paving, the roadways being of macadam. The roadways are very badly worn near the rails, and in many places the rails stand above the surface of the macadam, and are dangerous—in fact, the roads are generally bad. This is partly attributable to the fact that as a change of traction is imminent no repairs are being done to the tramlines. In consequence of the state of the track the cars oscillate a great deal if they are going at a fair rate of speed.

It is intended to pave the new lines, and the rails are to be the girder section with large base laid on concrete, instead of on sleepers with gravel bedding, as heretofore. In Milan it is not considered practicable to keep a road paved with different materials (*i.e.*, consisting of strips of paving and of macadam) in good condition. The tramways have until recently been worked entirely by horse traction by a company, under a concession, the lines being owned by the Municipality, though they were laid by the company. The capital of the company is about £337,000. The total length of the tramways is about 26 miles of double track. Only about 2½ miles are at present worked by electricity instead of 12½ miles, as stated in the Glasgow report. There must be some discrepancy therefore between the figures given to the Glasgow deputation and the actual length of lines worked by electricity as inspected by the Sheffield deputation. All the lines are under contract to be converted in about two years. The gauge is 4ft. 8½in. The systems of traction in Milan are: (1) horse; (2) electric overhead (Thomson-Houston). Accumulators were experimented with, but the results were unsatisfactory. The cars were found too heavy, and the acids gave off objectionable fumes. The terms of the concession are: To horse company: expires this year; the company pay 9½ per cent. of gross revenue to Municipality; the company maintain the track. To Edison Company: duration 20 years from January, 1897. The Municipality receives all income, and is to pay the company about 3¾d. per car mile. For every trailer car the company are paid $1\frac{9}{10}$d. per mile extra. For all additional cars over and above those running on December 31, 1901, which may be put on between January 1, 1902, and December 31, 1906, the Municipality will pay the company at the rate of 4d. per car mile; and for any additional ones that may be put on between January 1, 1907, and December 31, 1912, the Municipality will pay the company at the rate of 4¼d. per car mile. The rate of $1\frac{9}{10}$d. per car mile for each trailer car will be maintained for the entire duration of the contract. If the cars are run beyond the ordinary hour, the payment received from the Municipality is slightly increased. The company furnish cars, overhead work, electricity, drivers and conductors, etc. The Municipality pay for the rails, paving and excavation, etc., and the company will pay the Municipality about £290 per mile of single line per annum for maintenance (wear and tear). After deducting from the total income received by the Municipality the sum paid for car mileage and the cost of maintenance as mentioned above, the remainder is divided between the Municipality and the company, in the proportion of 60 per cent. to the former and 40 per cent. to the latter.

There is a provision in the concession to the effect that if the cost of production of electricity is decreased, the rate paid per car mile shall also be lowered, if required by the Municipality. The company light the streets at a fixed scale, and have also a concession for lighting private premises. It is stated that the old company served Milan well, and the horse system seems to have been very successful. The old company made strong efforts to obtain a further concession, but were outbidden by the Edison Electric Company. At present the new company are working the

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horse lines with the rolling-stock taken over from the old company. The Thomson-Houston system has been adopted, and this company has constructed and equipped the 2½ miles now in use. The construction is as previously described in the reports relating to Hamburg, etc. Rosettes are used largely in the centre of Milan, power to affix having been obtained from the Government. Poles of the lattice pattern are used outside the town, but these are not so satisfactory in appearance as those seen elsewhere. The construction of the overhead apparatus must have been much cheaper than in the other cities visited. In Milan it is estimated that the conduit system would cost in contruction about four times as much as overhead electricity. The cost of traction is less than with horses (said to be 3·8d. per mile against 4·5d.). The present station is temporary, and the horse-power is only 150. Besides supplying power for the cars, it supplies the electricity for the street-lighting. The Edison Company are, however, building a new station, which is to have four engines of 800 h.p. each, one of which will be kept as a reserve. From this station the current (3,500 volts alternating) is carried to a transforming station in the centre of the city, and there transformed to 550 volts continuous. Later the power will be produced by water from Paderno, about 18 miles away (13,500 volts alternating), and conveyed to the principal station referred to. It will there be transformed to 3,500 volts alternating, and, finally, be carried to the station in the centre of the city. There is also another power station for supplying private houses with electricity. Of the cities visited this is the only one where the power will be obtained by water. No accumulators are used either at the station or on the cars. There are 163 cars and 20 trailers (including horse cars). The cars are small, but not so well built or finished as some of those the deputation had previously inspected, and they are not divided into classes. The cost is about £560 each, and the weight nearly seven tons empty. Each car has one 20-h.p. motor, and carries 40 passengers. The distance travelled per car per day is about 93 miles. The "fishing-rod" trolley is preferred in Milan because the "bow" trolley wears the line too much. It was stated (from experience with the fishing-rod pattern) that the wires on a curve of, say, 50ft. radius would last four years, while on the straight, practically there is no wear. The usual fares are 1d. from the centre to any part, and the distance varies from a little over one mile to about 2½ miles. The ticket system is in force. Workmen's cars are run in the mornings at half the usual fares—*i.e.*, ½d. for any distance from the centre. During the summer these cars are run from 6 a.m. to 8 a.m., and during the winter from 7 a.m. to 9 a.m. There are no stopping places provided; the cars stop when required. Up to the present there have been no accidents with the electric cars. Guard wires are placed over the trolly wires where the telephone wires cross. The maximum speed allowed is from 7½ to 9½ miles per hour. The employés work 10 hours per day and are provided with uniforms. Their wages range from a minimum of 3d. per hour.

The deputation were somewhat disappointed with the present state of the tramways in Milan, the electric lines being of much less extent than they had been led to expect, and cheapness of construction has apparently been a great consideration. The trams did not run steadily, probably owing to the absence of concrete; and at the time of the deputation's visit everything was in a state of transition, nothing was finished. Before consenting to the introduction of electricity, the Municipality seemed to have considered every form of traction available, and in addition to trying accumulators they investigated the Serpollet system. The gas cars used at Dessau were also seen, but considered unsatisfactory on account of the cost of running, and it was found that the smell and vibration were objectionable. This was observable even when the cars were standing. The latter system, it is said, is only suitable for small towns. The introduction of electric traction has been very favourably received, and the municipal authorities have no objection to it. The deputation were informed that in Milan underground conduits were impracticable, partly because of the absence of a sewerage system, and in consequence of which conduits could not be drained, partly because when sewers were laid it would be necessary to interfere with the conduits, and partly on account of the expense.

The total car mileage per year is about 3,400,000 miles, but with the new traction it is expected the annual mileage will be increased to about 5,600,000 miles, this being partly brought about by an increase in the number of cars, extensions of lines, and by an extension of the hours of running. The receipts are estimated at about 6d. per mile run. The increase of income with the new service during the year 1897 is estimated to amount to about £22,000, as compared with the year 1894, when horses were used.

(To be continued.)

INSTITUTION OF ELECTRICAL ENGINEERS, April 8.

Sir HENRY MANCE (president) in the chair.

SOME RECENT DEVELOPMENTS IN ELECTRIC TRACTION APPLIANCES.

BY A. K. BAYLOR.

(Concluded from page 504.)

ELECTRIC BRAKES.

In dealing with modern mechanical traction the question of proper brake facilities is of the utmost importance. As compared with the ordinary horse car, a mechanically propelled car is necessarily heavy. A large factor in this increased weight is the heavy truck frame necessary, and to this is added the weight of the driving equipment. Moreover, the size of car bodies has been increased, and their weight is proportionately greater, due to the heavy framing which is required throughout, in order to withstand the strains incident to mechanical traction service. The difficulty of braking such cars is increased in direct proportion to the increased weight, and in addition to this the average speed of an electric car is nearly, if not quite, twice that possible in ordinary horse service, which is a more serious consideration than the weight, as the difficulty of braking increases with the square of the speed. Under these conditions the best possible arrangements of hand brakes and levers impose an undue burden upon the motorman, and call for an amount of brute force inconsistent with perfect handling of the vehicle. The application, therefore, of power brakes to street cars is worthy of very serious consideration, as they enable the motorman to stop his car under all conditions without muscular exertion, leaving him free and on the alert for any emergency.

As the most recent developments in electric car equipments are in this direction, I am here considering them at some length. Air brakes on street cars have been fairly successful, in so far as they permit of the application of powerful braking effect without taxing the driver; but upon electric cars, where the generating power of the motors may be availed of for braking, air brakes have little to recommend them. In the usual form of air brakes used in street cars, the air pressure is drived from eccentrics driven from the axle, so that pressure can only be generated while the car is running. It is undesirable to use a separate motor for operating the pump in ordinary practice, on account of cost, inefficiency, and the limited space available for additional apparatus outside of the necessary driving motors and other accessory equipment. It is difficult even to find room for air receivers on the average street car. When the pump is driven from the axle the receiver must of necessity be of ample dimensions, as repeated applications of the brake may follow one another at short intervals of space, the pressure absorbed in each application exceeding that generated between stoppages. A continuance of this process may so reduce the pressure that it will be inadequate for controlling the car in case of emergency. With a properly constructed electric brake, on the other hand, the frequency of stoppages is immaterial, as it is the current from the motors, driven by the motion of the car itself, which furnishes the braking force. Moreover, the efficiency of mechanical friction brakes is greater at low speeds, and falls off rapidly as the speed increases; the electric brake, on the contrary, is most effective at high speeds, as the faster the motor armatures are revolving the more promptly will current be generated.

The idea of converting traction motors into generators and utilising the current for braking purposes is an old one, and has been applied in practice to a limited extent for many years. Hitherto electric braking has been little used, although any ordinary motor equipment embodies a practical emergency brake which may be applied by short-circuiting the motors either directly or through resistance. This practice imposes such severe strains, both upon the windings and gearing, that it can

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only be used as an emergency measure, and is quite out of the question for regular braking. In order to apply this emergency brake when there are two motors on the car, it is only necessary to put them in parallel and throw the reversing switch as if to go backwards. The generated voltages will then oppose each other, and the weaker one will be overcome, resulting in a counter current, through the corresponding motor reversing its field. The motors now being in series instead of in parallel, with nothing but the motor windings in circuit, a powerful current is generated, which increases until the momentum of the car has been checked. It is, of course, clear that whenever a traction motor is to be thus used as a generator it must be reversed, otherwise the first effect of generation would be to oppose the residual field and reduce it to zero. It sometimes happens that the voltages of two motors in parallel so nearly balance each other that the difference in potential is insufficient to quickly build up the fields, and this insufficiency may be aggravated by resistance at the brushes or some other part of the circuit. Under such conditions the car would run some distance before the generation of a current strong enough to act as a brake. To avoid this possibility "emergency switch" connections are now so made that the motors are independently short-circuited, and the full potential of each motor is brought at once into play. The effect of thus turning the motors into generators is practically instantaneous, and the electrical and mechanical strains are excessive. It is clear that the magnetic drag upon the armatures due to their generator action furnishes the entire retarding force, and the braking effect is delivered to the wheels through the gearing. Gear wheels or pinions have been repeatedly stripped or broken in this way, and frequent use of this method of stopping is a serious tax upon the insulation of the motor windings. However, to avoid collision or running down a pedestrian such a switch is effective, and therefore valuable, and at such times the breaking of a gear or the burning out of a motor is not to be considered. The strain upon the motor may be reduced by introducing resistance in circuit; but if this resistance is sufficient to afford full protection to the motors it will be impossible to stop quickly, and therefore the value of the arrangement as an emergency brake is destroyed.

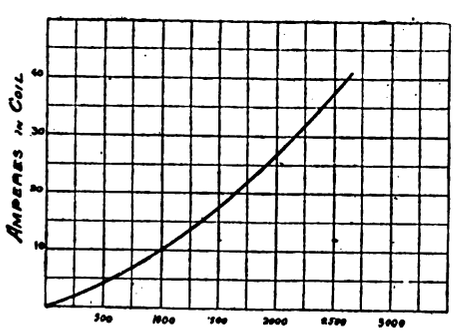

FIG. 14.

The latest form of electric brake is based upon an entirely different principle of action, and permits of the car being controlled at all times by the motors in stopping as well as running. The arrangement consists of a circular iron plate made fast to the axle and turning with it, and an electro-magnet also, in the form of a disc, which is mounted so that it cannot revolve. The magnet disc is usually mounted upon the motor frame. One of the axle-bearing caps is cast with projecting lugs to support it. With this form of brake all forces tending to urge the car ahead are opposed directly and simultaneously, reducing internal strains to a minimum, and bringing the vehicle to rest in the least possible time. The current from the motors is thrown by graduated steps through the magnet discs, bringing them into close contact with the axle discs, the resulting friction retarding the latter, and with them the car wheels, while at the same time the generator action going on in the motors tends to brings the armatures to rest, thus increasing the braking effect, and relieving the gearing from strain. In addition to these forces, there is another retarding action, due to the eddy currents set up in the axle plate as it revolves in the field of force surrounding the magnet. From the curves shown in Figs. 14 and 15, it will be seen that this Foucault current effect is an item of considerable importance in the efficiency of the brake. Fig. 14 shows the static pull, in pounds, on the magnet disc with a given excitation in the coils, with the car at a standstill. In Fig. 15 the curves represent running tests. The upper set of lines show the actual coefficient of retarding effect for different currents in the brake circuit, and the lower set of lines represent the coefficient of retarding effect for corresponding mechanical pressures, all readings being taken, as nearly as nearly as possible, under similar conditions. It will be seen from these curves that the actual efficiency of the electric brake at a given current is about twice what it would be if acted upon by a direct mechanical pressure corresponding to the static pull with such a current. This additional retarding effect is due to eddy currents and magnetic strains set up in the shoe and disc, and is, of course, secured without wear on the parts. To prevent excessive wearing, hard metals must be used for the discs, and some difficulty was at first encountered through residual magnetism, and the tendency of the discs to cling together after the car had come to rest, requiring an excess of power in starting again. It is, of course, impracticable to use soft iron, as the wear on the friction surfaces would be excessive, but the difficulty has now been obviated by connecting the brake circuit, through a resistance, in shunt with the first running position of the controller, by which means a weak current is sent through the brake magnets as soon as the handle is moved to start the car. The shunted current flows in the reverse direction to that delivered to the magnets by the motors, and overcomes any residual field that may be present in the discs. Formerly, in dealing with trail cars, with this form of brake a separate magnet disc was placed on the rear axle of the motor-car in the form of a drum, upon which was wound up a chain actuating a mechanical brake on the trail car. This plan is obviously imperfect, as there is no certainty that the brakes on the rear car will retard the wheels in unison with the electric brakes on the motorcar. The present practice, therefore, is to mount upon the axles of the trailer magnetic and axle discs similar in every respect to those on the motorcar, excepting that the rotation of the magnet is prevented by a connection to the truck frame, there being no motor to support it. The trail car magnets are connected in series with those on the motorcar, thus ensuring an absolutely uniform braking effect on every disc. As a factor of safety, the train, as in railway practice, should be under full control of the man in front, who has a clear view before him, and who must in all cases of emergency rely

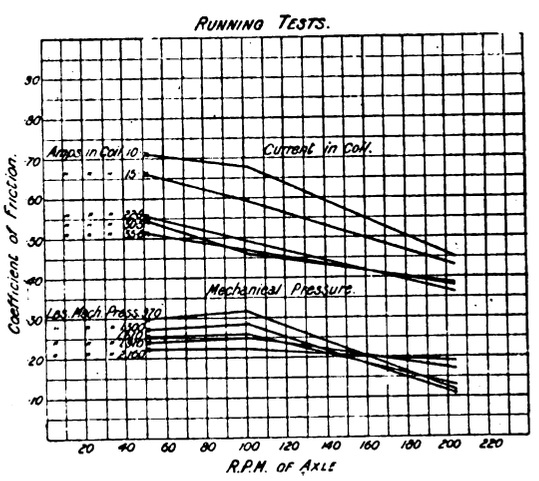

FIG. 15.

upon himself only to avoid accident. With a proper system of signalling, an independent brakesman on the trailer, if skilful, may under normal conditions stop his car in approximate unison with the motor, but he is of absolutely no assistance to the motorman in cases of sudden emergency, and the added inertia of his car at such times reduces the efficiency of the brakes upon the motor. As a factor of economy in power consumption also the motorman should control the train, as much current is wasted through too early application of the trailer brakes imposing a drag upon the motor.

An electric brake has an advantage over any simple friction device when the car must be stopped within a minimum distance. It is well known that a better braking effect can be attained by retarding the wheels up to a limit just below the slipping point than by passing this point and skidding the wheels, and not only does skidding prevent effective braking, but it usually means flattened wheels—a result both troublesome and expensive. Under the most favourable conditions it requires skill and precaution with ordinary friction brakes, whether operated by air or by hand, to bring a car to rest without skidding the wheels, and in emergency the first impulse of the motorman is to set his brakes hard, which will, as a rule, cause skidding. Thus at a time when a quick stop is most necessary there is least liability of its being effected with mechanical friction brakes. With an electric brake this tendency to skid the wheels is prevented automatically, for the armature is connected through the gears and axles to the wheels, and the latter cannot stop turning without also stopping the armature, and with it the current from which brake action is derived. When the wheels begin to turn again they are again retarded until the car has been brought to rest. It should be noted that this action is essentially automatic, and requires no skill and experience on the part of the motorman, being, in fact, quite beyond his control; therefore with such a braking device greater speeds

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are possible with a given degree of safety, and the personal factor of the motorman in this particular is practically eliminated. It has been found in practice that even with an electric brake a slight flat wheel might occur if the full current from the motor were free to flow through the magnet discs. This is due to the fact that the first surge of current would stop the wheels; and, although they would begin to turn again, an appreciable time would be required to overcome the inertia of the armatures and the sticking of the discs, and during this interval there would be danger of skidding. Moreover, the first flow of current from the motors under these conditions is far in excess of that necessary to stop the wheels, and the surplus only heats the motors, imposing a strain on the insulation of the windings while doing no useful work. To overcome this difficulty, an arrangement known as the "limit switch" has been provided, which consists of a small coil of wire in series with the brake discs. When energised, this coil lifts an armature, making connections which cut out the fields of both motors, thereby stopping the current. The armature of the limit switch is controlled by an adjustable tension spring, which is set to allow for the current being cut off at a point which prevents the wheels from actually stopping. This limit varies with different weights of car and different conditions of track, but with the ordinary electric car and average track conditions it is between 30 and 35 amperes; and when this is divided between two motors there is, of course, no danger of heating the conductors or destroying the insulation. It should be noted that but for the residual magnetism left in the discs, and their consequent tendency to stick together until demagnetised by the line current, an electric brake would not hold a car absolutely still on a gradient. It is evident that when the car has been stopped and the current from the motors ceases, the wheels but for this sticking would begin to turn again, as already described. As a matter of fact, on heavy grades this sticking is insufficient to hold the car, and unless the auxiliary hand-brakes are applied the car will start again by gravity. As soon as it does this, however, the generating action begins again in the motors, and the effect in practice is that the car will move down the grade at a snail's pace, the current from the motors all but balancing its tendency to move.

The electric brake connections in the controller are usually placed upon the reverse side of the power cylinder, only one handle being used, which is turned one way to supply power and the other way to apply the brake, the same resistance with different connections serving with both circuits. It is possible to continue the shaft of the controller down through the platform, connecting it with the ordinary brake rigging and peripheral brake shoes (which should always be placed upon the car as an auxiliary). When arranged in this way the controller handle, after passing through the various braking steps, may be turned farther, setting the brake shoes, which will require but little pressure, the car being practically at a standstill. This seems inadvisable, however, as the brake shoes would in all probability be applied at every stop, and unnecessary binding of the wheels and possible flattening would ensue. It may be noted, however, that with an electric brake one flat spot on a wheel has no tendency to produce another, as is the case with peripheral friction brakes that tend to grip the wheel where flattened, causing skidding that would not normally occur. The saving by the use of electric brakes in wear and tear on wheels and replacement of brake shoes is a considerable item of economy in ordinary service. The wear on wheels due to the grinding action of peripheral brake shoes where frequent stoppages are necessary amounts to more than that due to rolling friction on the tracks, and the brake shoe has to bear its share of the effects of this grinding action. A source of considerable waste in power consumption on individual cars with ordinary equipment is the tendency of motormen to put on brakes before power is completely cut off, and to throw on power before the brakes are fully released. With an electric brake operating from the reverse side of the controller cylinder this is impossible, as the handle must pass through zero, or "off" position, in going from power to brake, and in going from brake to power.

Various forms of so-called electric brakes have been devised whereby the ordinary rigging and shoes are employed with some form of electromagnet to take the place of the usual handle in applying power to the chain. Such brakes may be operated by current from the overhead line or from batteries on the car. The brake deriving its power from the line is unreliable, as the trolley may leave the wire at a critical moment, rendering the brakes inoperative, and storage batteries necessitate the addition to the car equipment of heavy and expensive apparatus. In common with air brakes, such devices are open to the criticism that in providing an auxiliary it is necessary either to duplicate the rigging and shoes—which is impracticable in the space, already overcrowded—or to rely upon a reserve source of power only, trusting to one set of shoes and connecting mechanism. With air brakes, too, they must be classed as uneconomical for electric cars, since such cars must of necessity embody in the motors an ample and flexible braking power, whether it is availed of or not, which runs to waste when any other force whatsoever is used in braking. We might as logically run our electric cars by horses, with the motors dragging upon the axles, as to use some other and less effective means of braking than that obtainable from the revolving armatures while their inertia urges the car ahead.

Discussion.

Mr. P. Dawson said at one time it was believed in the United States that the three-wire system might be useful for long-distance tramway work, but now it was recognised that a much better system was the high-tension alternating or three-phase current with sub-stations, in which motor-generators converted down to 500-volt continuous current. On the Continent they had watched the three-wire system carefully, and decided to prefer the sub-station method The only case in which three-phase motors were applied directly to the cars was at Lugano. They worked there successfully, but the system very greatly upset the telephones, and he (the speaker) did not know whether this difficulty had been successfully overcome. He had seen the electric emergency brake stop a tramcar and trailer within half a car length.

Mr. J. S. Raworth said some of the matters in the paper hardly needed to be brought before the Institution, though they might before the British public. English engineers had been so convinced by the cogent arguments of the gentleman on his right [presumably Mr. Crompton], that one would hardly find an engineer who would do anything but direct couple his dynamos and engines. But there was this advantage, that they would have it on record in print in the *Journal* of the Institution that in this matter the United States were so many years in arrear of English practice. The multipolar dynamo stage had been gone through here some years ago, and the multipolar would be in demand if they really wanted machines big enough. But there were advantages about the bipolar dynamo, to retain which they had decided to subordinate a great deal. With the bipolar that Crompton or Siemens had shown them how to turn out they had a commutator which would wear with a surface like glass, and never gave any trouble. As the result of the work of Mr. Sayers, followed up by Mr. Mordey, it would soon be possible to obtain the same result with all the dynamos of commerce. It might be the practice of the United States not to properly specify the dynamo, but in England it was usual to fix a temperature limit; and as to sparking, why they never allowed that at all. There were exceptions, however, and he had seen specifications which specified very little except that the magnets should be cast iron, and the object of that appeared to be to get the machine of a particular firm.

Mr. E. W. Rice (U.S.A.), without withholding any admiration of the magnificent work done in England, remarked that some pioneer work in direct coupling had been done in the States, and now again much of the latest direct-coupled work there would bear comparison with anything anywhere. It was, however, quite true that in this respect English engineers had led the way for a time. At present, however, they had some very fine direct-coupled traction plants at Brooklyn, Chicago, Philadelphia, and other places; and the direct-coupled dynamo had become the standard type in the States for both tramway and lighting machines whenever they could get their customers to favour it. In America they had had to face the problem of longer lines than could be served at 500 volts. Starting from Boston, it was possible to ride 50 miles by tramcar on all sides—except, of course, the side that led straight out to sea—and the same thing was true of many other large cities like Chicago, Cleveland, and so on. Usually there were separate generating stations at each city or place passed through supplying current for about five or eight miles each way. But that did not meet all the cases. The three-wire system had been therefore tried in Pittsburgh and Portland and other places, but had been abandoned on account of the difficulty of balancing the current on both sides. It was generally recognised that a multiphase generator and sub-stations to convert to continuous was a better method, and that system was now being extensively considered for long-distance work. With a step-down transformer with its secondary terminals coupled to a converter or rotary transformer, which, as they all knew, was simply a direct-current machine fitted with collector rings, there was an advantage of some per cent. in efficiency over a motor-generator on account of the superior efficiency of a stationary transformer compared with a motor, not to mention other incidental advantages.

The discussion was then adjourned.

At last night's meeting of the Institution the following were the candidates balloted for:

Foreign Member.—André Hillairet, 22, Rue-d'Azir, Paris.

Associates.—Sidney Andrews, 67, Lord-street, Liverpool; Harry H. Beit, Douglas, Cork; W. B. Edgar, Messrs. Johnson and Phillips, Old Charlton, Kent; Reginald M. Hook, Post Office Telegraphs, Limerick; Henry Lionel Howard, British Insulated Wire Company, Prescot, Lancs.; S. C. Maulik, Assistant Superintendent of Indian Telegraphs, Shillong, Assam.

Students.—John T. Callaghan, Faraday House, Charing Cross-road, W.C.; Reginald George F. Dumaresq, Faraday House, Charing Cross-road, W.C.; William Laurence Walters, 161, Algernon-road, Lewisham.

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TENDERS.

The stock phrase, "the council does not bind itself to accept the lowest or any tender," is to be found in all specifications issued by corporate bodies. It would also, in our opinion, be wise to add another clause to the effect that the council binds itself not to divulge the reasoning by which they decide which tender is to be accepted. We assume that the specifications issued by consulting and borough engineers do accurately specify what is wanted from the manufacturers. Granted that this is so, there is every reason for the advisers of the corporate bodies to pass over tenders which in their opinion do not meet the requirements of the specification. This fact can be often ascertained by the drawings sent in, and more often by the personal knowledge of the expert of the general work of the firm in question. The acceptance of a higher tender in such cases is in the interests of all concerned, as the manufacturer passed over would have had to amend his designs in executing the work, perhaps leading to a monetary loss. In spite of this, the acceptance of a higher tender always rankles in the breasts of those firms whose tenders, although lower, are not accepted. There have been two or three such cases lately, and we suppose that the Plymouth awards will be no exception in giving offence to general tenderers. In this case we do not doubt but that the able borough engineer showed his committee good cause for the selection of the favoured tenders, and that this was done without bias. Still, we are equally certain that he will not endorse the ill-judged remarks of the gentleman who supported the report before the Council. We are indebted to the local Press for the following assertion, which we trust may be incorrectly reported: "In every case except Ferranti's alternator, to clean the machinery they would have had to remove the steam-pipes and several heavy pieces of machinery by means of cranes." After carefully reading the remarks following this extraordinary statement we can only conclude that the speaker was referring to the lack of field racking gear in the other designs, and we should like to know if such gear was specified. What the steam-pipes had to do with it we do not understand, but it might be well for the gentleman to make some enquiries as to how often the armatures of the alternators not accepted required to be cleaned in such a way as to necessitate the use of cranes. He might also then ascertain whether the necessity of frequently wiping down the armature and field-magnet poles is a recommendation in favour of a particular type. This reminds one of the craze developed in England for alternators in which the armature coils can be easily replaceable. The fashion was set by defective designing. When it was found that coils did burn out, the manufacturer said, "Oh, but I can replace my coils in rather less than no time." Hence the fact that coils wound *in situ* could be made so secure that no faults would occur was overlooked, and the less mechanical replaceable coils are usually asked for. We wish such criticisms could stop here, but regret to say that the explanation of the committeeman went further, and disparaged before the Council the

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machinery that was not accepted. The opinions expressed on this subject we do not care to reproduce in our columns, although the speaker was privileged when making comparison for the guidance of the Council. We have not the slightest doubt but that either of the other alternator makers would have found no difficulty in fulfilling the requirements of the specification; and the fact that a particular type was preferred, in spite of a higher price, should not be used as a ground for imputing defects in their manufacture. We would again reiterate our statement that, although the lowest tender may not be the cheapest in the long run, reasons why a higher tender is preferred should not be publicly discussed by non-technical men to the detriment of such unaccepted tenderers.

THE TRAMWAYS INSTITUTE.

The papers read at the Huddersfield meeting of this society will be found elsewhere in our columns. Mr. Pogson's communication on the municipalisation of tramways will repay careful reading. We have expressed the opinion before that a tramway is not a subject suitable for municipal ownership, and the Huddersfield results somewhat confirm this. The average cost to the general ratepayer for the last sixteen years has been equivalent to a 1¾d. rate. In spite of this, the venture has proceeded on easy lines. No Sunday running has been provided, but also the working hours of the men have been reduced from twelve hours to eight per day. This commendable step, of course, has resulted in a considerably increased cost. The balance-sheet for the past year shows more favourable results, but we still think that with a company in possession a paying traffic would have been developed earlier. One of the gentleman discussing the above paper hailed from Birmingham, and stated that "every step a corporation took toward municipalisation was a gross error." He supported his contention by giving figures of the returns from municipal electricity works. Figures can prove anything, and hence we learn with surprise that twenty-four stations out of forty-one made deficits. We should be glad to see the names of the twenty-four stations so unfortunately situated. We should also like to see the length of the Birmingham gentleman's face when he hears how much goodwill the Birmingham Electric Light Company would ask for the transfer of their business to the Corporation.

HARROGATE ELECTRICITY WORKS.

The formal opening of the Harrogate electricity works, described recently in our columns, was fixed to take place on Wednesday, the 14th inst., and on the invitation of Colonel Thwaites (the chairman of the Electricity Committee) we journeyed down to the celebrated "Spa of the North" to take our humble part in the proceedings. The keen wind which prevailed on our arrival in the town was fortunately tempered by the bright, warm sunshine, and having an hour to spare before the appointed time of the ceremony, we hailed a cab and drove to the well-known Queen Hotel, the selected rendezvous, where we found the wiring contractors busy putting the finishing touches to the installation of electric light, which was to be the illuminant for the first time on this auspicious occasion. After an interval of rest, which afforded us an opportunity to refresh the inner man, we started off for the works, which are situated to the north of the town about two miles distant. On the way we had ample opportunity to look around us, and marvelled not a little at the trim appearance of the buildings, and the well-kept, clean pavements and roads, of which any less favoured town might be proud. On our right we passed the new municipal baths, which the Corporation are erecting at a cost of over £100,000, and which we learn are to be lighted throughout by the electric light. It is a truly magnificent building, and to all outward appearances will be well worthy of this enterprising town and Corporation when completed. We were now on the confines of the town, and entered the approach to the electricity works, which is at present little more than a rough cart track skirting the irrigation farm, upon which the works are located. However, we managed to go through the ordeal of bumping and jostling without a collapse, which is quite within the bounds of possibility in the present state of the road, and alighted at the main entrance, which gives access to the engine-room. Here we found a goodly number of councillors and friends already assembled, and having a few minutes at our disposal before the commencement of the proceedings we made a cursory inspection of the building, and then mingled with the throng. There was much kindly greeting and handshaking, Mr. Wilkinson, the electrical engineer, flushed and energetic, having a nod of recognition or a word of welcome for everybody, and plenty of evidence that he and his assistants had had a busy morning putting things into shipshape, the ominous caution, "wet paint," being prominently displayed. We early noticed the presence of the Bradford electrical engineer, Mr. Gibbings, and Mr. Wilmshurst, the Halifax engineer, and other shining lights in the electrical world. Awaiting a favourable opportunity, we buttonholed Mr. Wilkinson, from whom we gathered that the works already had received 100 applications for the electric supply, many of which would be acceded to before the commencement of the holidays, and that the supply would be continuous from that day. They had one arc lamp erected in the centre of the town, and it was proposed to immediately erect lamps in Station-square, the market hall, municipal offices, new baths, Victoria Baths, and the free library, and intended to adopt electric motors on the sewage farm, and for the oat-crushing plant for the town's depôt.

The rumble of wheels over the newly-gravelled road outside heralded the entrance of the Mayor of Harrogate (Councillor J. H. Wilson), closely attended by Colonel Thwaites, in military attire, and accompanied by his wife and the genial Mayor of Bradford (Councillor Thos. Speight), who is also chairman of the Electricity Committee at Bradford, and we immediately took up our station in front of the switchboard at the end of the building, upon the neatly-railed platform of which the principal figures in the coming ceremony arranged themselves, the numerous ladies present being accommodated with chairs immediately beneath.

The MAYOR OF HARROGATE, in opening the proceedings, said that day would be an eventful one to the town of Harrogate. It was now over 50 years since the town was first lighted by gas. They had depended upon a company to provide them with light, and he was convinced that the Corporation had taken a right step in arranging for Harrogate to have a more modern illuminant, and had shown what municipal enterprise could do in carrying out the work themselves. He had every confidence that the enterprise would be a great success, and in a year or two the ratepayers would gain a great deal by the undertaking they were inaugurating. He had not the least doubt that the machinery and appliances which had been selected by the engineer would be the best. Harrogate owed a great deal to Colonel Thwaites and his committee for the energetic manner in which they had pushed on the work, together with whom he must couple the name of Mr. Stead, the borough surveyor.

Having called upon Mr. WILKINSON, the electrical engineer, to describe the machinery to the uninitiated,

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which he did in a clear and lucid manner, the MAYOR then presented Colonel THWAITES, on behalf of himself and the Corporation, with a handsome gold key, whereupon the Colonel, after thanking the Mayor and Corporation for the gift, and giving a word of welcome to friends, said that the key would be a lasting memento of an event of great importance to Harrogate. They were pressed to have the light for Easter, and had succeeded in accomplishing the task. He must, however, apologise for the unfinished state of the engine-room and plant, which was entirely on that account. He extended a cordial invitation to any present to visit the works when they were in proper working order. The great reason, he explained, for erecting the works so far out of the town was to avoid having a chimney in sight, the absence of which they prided themselves upon, and because they would by so doing be at no cost for water. He felt sure they had adopted the right system, and that in a year or two the undertaking would be a great financial success. He then proceeded to unlock the case of the switchboard, and the Mayoress (Mrs. Wilson) and Mrs. Thwaites having set the engines in motion, he switched on the current amid hearty applause, the building becoming illuminated and also, as arranged, the arc lamp in the central square of the town.

The MAYOR OF BRADFORD, in moving a vote of thanks to the Mayor of Harrogate for presiding, said he considered that day a red-letter day in the annals of the Harrogate Corporation. He commended the chairman of the Electricity Committee upon the admirable adaptation of the system they were inaugurating to the requirements of a town like Harrogate. When the Bradford supply was inaugurated, the alternating system was not such as it was that day. The system at Bradford provided for a large number of motors, and there they had about 100 at present on the circuits, working cranes, hoists, and other machinery, including one of 22 h.p., which was driving one of the most modern printing-presses in the country at the offices of the *Bradford Daily Argus*. He considered the continuous system more adapted to a town like Bradford. He hoped the Harrogate system would have the success which had attended the system at Bradford, where the net profit in 1895 amounted to £2,200, which had increased in 1896 to over £4,000. The adoption of electricity as an illuminant in the many beautifully-decorated hotels and houses in Harrogate would, he could assure them, save much expense in renovation, notwithstanding the increased cost over gas, and they would be further compensated by being blessed with better health.

The MAYOR having replied, the ceremony concluded, and the assembled guests were invited to partake of refreshments, which had been thoughtfully provided at the opposite end of the engine-room—an invitation we obeyed with alacrity, our appetites being sharpened by the bracing air for which this popular health resort is famous.

We now drove back to The Queen, where we were to be entertained to dinner by Colonel Thwaites. After dressing, we made a tour of inspection of the multitudinous rooms of the well-appointed hotel, which was by this time lighted up, and meeting Mr. Wilkinson, who had been here, there, and everywhere, and whose energy had been untiring throughout the whole proceedings, were anxiously interrogated as to "what we thought of the effect" and "didn't we think the volts were right," to which we had to accord our ready assent.

The interval before dinner quickly passed in such good company as we were privileged to meet, and then we were escorted to the brilliantly-lighted and handsomely-decorated dining-room, and sat down to an ample repast, Colonel Thwaites presiding. The loyal toasts having been duly proposed and honoured,

The MAYOR OF BRADFORD proposed "Success to the Harrogate Electric Lighting Undertaking." In doing so he said they had in Bradford at their old station 2,200 h.p., and at the new station, which would be opened in about a couple of months' time, 1,200 h.p., bringing the total up to 3,400 h.p. The area of the borough was 17 square miles, and the area of the direct electricity supply nine square miles. The outlying districts would be well supplied by motor transformers from the new works. The boilers would be what was termed the induced-draught type, equal to 600 h.p. each. The motors on the Bradford circuits gave them a day load of 300 h.p. Bradford was looked upon as the pioneers in the electrical world. They had inaugurated a system, which was the first inauguration in the United Kingdom and on the Continent, of supplying to all their consumers incandescent lamps free of charge—of course, under certain conditions. In conclusion, he complimented Harrogate on having taken the step it had done. He felt sure that it would conduce to the welfare of the borough and the credit of the Corporation.

Thus ended an eventful day in the history of Harrogate and a thoroughly enjoyable one for ourselves, of which we carried away with us many pleasant reflections. The unanimity and enthusiasm displayed by the Electricity Committee and the Council generally on this occasion augurs well for a prosperous future. The residents being mainly of the wealthy class, it is a matter for wonder to us that the Corporation have not adopted electricity as their illuminant long ago, and now that they have taken this step we trust their success in this direction will be unbounded, and further contribute to the welfare of this attractive borough.

THE NATIONAL TRAMWAYS INSTITUTE.

The annual general meeting of the Tramways Institute was this year held at Huddersfield, and resulted in a representative gathering. The members met in the town hall, and were welcomed by the Mayor, Alderman J. Lee Walker. We are indebted to the *Huddersfield Daily Chronicle* for parts of the following report:

Mr. JOHN FELL, J.P. (the president of the institute), returned thanks to the Mayor on behalf of the institute for the hearty welcome extended to them. He said that it was the first time they had been welcomed by a municipality. For a long time a feeling had been growing up in the institute that the municipalisation of tramways was a foregone conclusion, and he could assure the Huddersfield Corporation that the institute had not by any act of its own attempted to place any obstacle in the way of municipalisation of tramways.

The following paper was then read:

The Huddersfield Tramways and the Municipalisation of Tramways.

BY J. POGSON, M.I.M.E., GENERAL MANAGER OF THE HUDDERSFIELD TRAMWAYS.

After giving a brief geographical description of the county borough, and a statement as to its population, etc., Mr. Pogson went on to say that the Corporation of Huddersfield occupied a high position among the municipalities of England. No town of the same population could show the same extent and variety of municipal institutions. In no single instance had the public spirit of the Corporation been shown to greater advantage than in connection with the tramways undertaking. Until recently there was no other instance of a municipality operating its own tramways. There was no other instance of a municipality having constructed, operated, and developed its own tramway system. At the period of construction of the tramways the Corporation made every effort, by means of repeated advertisements in various journals and publications, to effect a lease of the tramways, but owing to the sparse and scattered population, together with the severe gradients prevailing, they were unable to obtain any satisfactory offer. Under the circumstances, the Corporation made application to Parliament for power to work the tramways, but were only able to obtain the necessary permission under a license from the Board of Trade on the terms and conditions as set forth in Section 17 of the Act, which provided "that if at any time a company made to the Corporation a tender in writing to take a lease of, and to work the tramways for such period (not being less than seven years unless the Corporation agreed), at such rent and upon such terms and conditions as should in the opinion of the Board of Trade be adequate and proper, and such company at the same time offered to purchase the horses, cars, engines, and fixed and movable plant of the Corporation not included in such lease at a price to be fixed, unless otherwise agreed on between such company and the Corporation by a competent valuer to be appointed by the Board of Trade, then upon payment of such price the Corporation should demise the tramways to such

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company at such rent and upon such terms and conditions, and the powers of the Corporation to work the said tramways shall cease and determine." The working of the tramways subject to the foregoing conditions had been continued by the Corporation up to date, but application was being made to Parliament during the present session for absolute powers to work in place of the present conditional powers, and from the progress and present position of the Bill there was good reason to hope that the application would be successful. After referring to the futile efforts of the London Tramways and General Works Company in 1877 to secure powers to construct tramways in Huddersfield, which scheme was opposed by the Corporation, he stated that in 1879 the Corporation decided to promote what was generally referred to as an omnibus Bill, seeking powers for the construction of tramways, street improvements, and other matters, and the Act was passed in the session of 1880, and received the Royal assent on August 2, 1880, and the system of construction adopted was a modification of the system known as the Barker system—viz., a light section of rail spiked to a metal chair. The roadway was excavated to a depth of 6½in. below the level of the rails for the paving, and two trenches were cut, one under each rail, 18in. wide, to receive two continuous beds of concrete 7in. deep. The paving consisted of 6in. setts from Rossendale Valley, grouted with pitch. Ten miles of track were laid on this system, the whole of which were inspected and a certificate of fitness granted on November 29, 1882. The extensions which had been made from time to time had been laid with a 7in. girder rail 98lb. per yard on a concrete bed, and (with the exception of about 1,900 yards of track at Lindley) had been paved with granite setts. The tramway system consisted of 11 sections. The result of the trial run of an engine on November 13, 1882, was considered satisfactory. The purchase of other engines was delayed in consequence of negotiations for the lease of two of the sections of the tramway system to the Hallidee Cable Company. In February, 1883, that company entered into an agreement with the Corporation to rent two of the sections on the basis of 5 per cent. interest on the capital outlay, the company undertaking to bear the cost of conversion for cable traction. The company expended a considerable sum of money in excavating and partly building a power station in Manchester-road, and in the payment of rent for the lines, but eventually abandoned the undertaking with the consent of the Corporation in December, 1884. Since then the Corporation had not entered into any negotiations for leasing either the whole or any portion of the tramways. The first engine and car commenced to run for traffic on January 11, 1883. With the exception of one section (Moldgreen), the whole of the tramways had been worked by steam haulage. The Moldgreen section was opened for traffic on May 9, 1885, and was worked by horses. Steam haulage was substituted on April 1, 1888. In the early days of the undertaking the Corporation purchased a large wooden erection in Northumberland-street (which had formerly been used as a circus) for the purpose of a tramway depôt. In a few years the place became too small for the purpose, and a new permanent depôt, large enough to contain 30 engines and 30 cars, was built in Great Northern-street, and was occupied for the first time on June 20, 1887. After the trams had been running a few years it was found that the ordinary cars, which were four-wheeled cars, constructed to carry 34 passengers, were too small, and larger cars, of the bogie type, to carry 60 to 66 passengers, were substituted. This class of car at first was open at the top, but eventually it was thought desirable to cover them, and they were covered in accordingly. It was then found that the Wilkinson engines were too small, and unsuitable to deal with the larger cars and heavier traffic, and these were superseded by engines of the loco. type. The increased traffic soon began to have a serious effect on the permanent way. The system of construction proved unsuitable and of insufficient strength to withstand the wear and tear. The first portion—Acre-street—was renewed in May, 1888. In February, 1891, the general construction and repaving of the permanent way commenced, and was carried on without interruption until November, 1893, and the last portion—paddock—was dealt with in October, 1895. This completed the entire reconstruction and renewal of the tramways undertaking (both depôt, permanent way, and rolling-stock) as it originally existed, except about 1,000 yards of track between Lockwood and Beaumont Park, and which had never been in regular use since the period of construction. The estimated cost of the reconstruction and renewal was fully £40,000. This had all been charged against the revenue of the department, and had naturally been the cause of financial difficulties. He proceeded to read a statement of the authorised borrowing powers, the loan debt, and the capital expenditure from the commencement in 1881 to March 31, 1897, for which he was indebted to the courtesy of Mr. Potts, the borough accountant. Since the commencement, the undertaking had, he said, been subsidised from the rates to the extent of £41,283, an average of £2,577, or 1¾d. in the pound per annum on the borough rate. The deficiencies for the years 1889-90-91 were very slight, and showed that the revenue of the department had practically overtaken the expenditure. The larger deficiencies of 1892-3-4-5 were caused by the heavy expenditure incurred in extending and developing the system under the additional powers obtained by the 1890 Acts, also for the reconstruction and renewals as before mentioned. In addition to the above subsidy, £20,982 was transferred to the depreciation fund. This fund was created for renewal purposes, and used accordingly. It should not, therefore, be regarded as a deficiency in addition to the subsidy of £41,238 from the rates in aid. In connection with the working of the tramways the Corporation had had the misfortune to have two serious accidents, which together cost £9,980. 18s. 1d. for compensation in respect of loss of life and personal injury. The causes contributing to the financial difficulties of the undertaking might be summed up as follows: (1) delay in commencing to work owing to inability to lease the undertaking; (2) insufficiency of income, owing to the extensive nature of the undertaking compared to population; (3) reconstruction and renewals; and (4) heavy accident claims. No assistance had been required from the rates during the last two years. The results for the year ending March 31, 1897, were most encouraging. The following is a summary: miles run, 423,564; traffic receipts, £28,511. 4s. 7d.; parcels, £453. 1s.; other receipts, £86. 19s. 4d.—total, £29,051. 4s. 11d., or 16·46d. per mile. The expenditure, including loco. power, traffic, maintenance of ways and works, repairs to engines and cars, management, rents, rates, and taxes, compensation (sum annually set aside), miscellaneous, amounted to £18,794. 5s. 11d., or 10·6d. per mile, leaving a surplus of £10,256. 19s. The surplus was dealt with as follows: interest and sinking fund equal to £4. 7s., 6 per cent. absorbs £6,079. 6s. 5d., depreciation £3,000, leaving a surplus of £1,177. 12s. 7d. Previous to 1888 the trams were run 14 hours per day. It was necessary for the public convenience that the services should be increased. The drivers and conductors at that time were working an average day of 12 hours. The wages of the drivers were 32s. per week, and the wages of the conductors 23s. per week. It was thought undesirable to further increase the hours of the men. Eventually a scheme was adopted increasing the services to 16 hours per day, and dividing the day into two shifts of eight hours each. For the reduced hours the drivers were paid 26s. per week, and the conductors 21s. per week. During the past year the wages of drivers were increased to 27s. per week, a few special men being increased to 28s. The conductors' were increased to a uniform rate of 22s. per week. The present rate per hour is—drivers 6¾d. and 7d., and conductors 5½d. In judging the results obtained in the working of the undertaking, it should be remembered that the trams were not run on Sundays. An important feature in connection with the tramway system was the postal letter-boxes attached to all the cars, which were cleared every hour from 8.30 a.m. to 9.30 p.m., and again at 11 p.m. The number of letters collected in this way averaged 33,000 a month. The Corporation had a contract with the postal authorities whereby postmen and telegraph messengers travelled on the cars in connection with their official duties, and also to and from their homes. The contract sum was £300 per annum, and was inclusive of the letter-boxes. Waiting-rooms were provided at the various termini, and in many cases at the 1d. stages or other important points along the line of route. Twenty of these were already erected, and others were in course of construction. In addition there were two large rooms in St. George's-square at a rental of £50 each per annum. To one of these a ladies' lavatory was attached with a woman in attendance. Since January, 1893, accident claims had been dealt with direct instead of through a third party, and the sum set aside—viz., £255 per annum—was the sum formerly paid to an insurance company. The total sum set aside amounted to £1,083. 15s., and the amount paid in compensation was £500. 13s. 9d., leaving a balance in hand of £583. 1s. 3d. Since August last a scheme had been in operation for the removal of sanitary refuse by means of a special truck running on the tramlines. About 50 tons per day were conveyed from a central point to a tip at the borough boundary. It was intended to extend and develop the scheme at an early date. The rolling-stock consisted of 26 engines and 26 double-deck bogie cars. The authorised borrowing powers were £140,500, and the capital expended up to date amounted to £138,854, at the rate of £6,260 per mile of track, and including the depôt, fixed plant, rolling-stock, and 20 waiting-rooms. Dealing with the subject of the municipalisation of tramways, he said that it was only within the last few years that municipalities had shown any desire to acquire and work tramway undertakings. With the exception of Huddersfield, the only municipalities working their own tramway undertakings at present were Glasgow, Leeds, Sheffield, Blackpool, and Plymouth, and in each case those municipalities took over the tramways from a private company as a going concern. In connection with the agitation, the experience of Huddersfield had been largely quoted; it had been regarded as an object lesson from both sides—those who favoured

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municipalisation and those who were in favour of tramways being continued in the hands of private companies. It was not fair to regard Huddersfield as a financial test of a municipal tramway; there was no choice but to municipalise for the reason that there was no prospective profit. For the working of the undertaking the Corporation must be held responsible, and submit themselves to the judgment of others. The duties of a popularly elected body, and the fitness of such a body to undertake work of such a nature, was a question on which there was room for the wide difference of opinion. In the opinion of many a tramway undertaking was regarded as a trading concern, and outside the duties of a public body. The work in connection with municipal government had greatly increased in recent years, and the demands made on the representatives of the public were of a serious nature, and could only be met by men with a considerable amount of leisure, and the nature of the work was such that only men of good practical knowledge and business habits could hope to bring about success. The public agitation in favour of acquiring and working tramway undertakings had been so far successful. The Standing Orders of Parliament had been suspended, and corporations were practically free to exercise their own pleasure in the matter. That was desirable. Restriction could not be maintained in face of public opinion. Possibly, if restrictions were removed altogether the desire to acquire and work might decrease, and a better feeling between local authorities and lessees result. It was only natural that local authorities would resent restrictions which placed them at a disadvantage as lessors, and probably caused lessees to take advantages which they would not otherwise attempt. The primary reason for a tramway system was the convenience of the public, and the undertaking must be worked in a manner calculate to secure public appreciation. In the case of public representatives, they were in constant touch with the desires and opinions of the public. Tramway companies as lessees had to submit themselves and the results of their work to the same tribunal on the expiry of the lease. So far as the practical work in connection with a tramway undertaking was concerned it seemed reasonable to suppose that a Board of directors, few in number, and selected on account of special qualifications, would be able to manage an undertaking of such a nature better than a popularly elected body acting through a committee consisting of at least 20 members, and whose actions were reviewed by the larger body in a public manner every month. In both cases, but especially in the latter case, authority and responsibility must be to a great extent in the hands of the management. In the conflict of interests which must arise during the changes which were certain to take place during a 21 years' lease, it was important that the spirit of compromise should largely prevail on both sides. In the case of any difference of opinion or dispute which did not lend itself to amicable treatment, it was a long time to wait before a remedy could be applied. There was, therefore, naturally an unwillingness on the part of the public to have their hands tied for such a long period, but so far as a tramways company was concerned the period of 21 years was quite short enough; in fact, it was almost too short in which to commence and continue operations, pay a reasonable dividend, and redeem the capital. One could scarcely credit corporate bodies with desiring to acquire tramway undertakings unless there was a material advantage to the public at stake. The difficulty under which private companies labour was the fact that their powers were only for a limited period. This, together with the constant changes of conditions, made it impossible for them to make the same permanent arrangements as if the period were unlimited. The concluding years of a lease were naturally anxious times, and it was not unreasonable to expect that the public convenience would suffer to some extent in the desire of the company to serve their own. In too many instances tramway companies had confined their undertakings to the populous portions of a borough, and had been difficult to deal with when extensions had been contemplated. It was a difficult matter to reconcile such conflicting interests; they could not be settled by an exploiting capitalist, but might be by a company content with a moderate dividend, and willing to co-operate with the local authorities. The argument that municipalities avoided the risk of having to contribute rates in aid by leasing the tramway undertakings has very little weight, and in Huddersfield, especially, no importance was attached to it. Here it had been a choice between no subsidy, no tramway; and no tramway, no subsidy. In many cases a tramway extension was well worth a temporary subsidy, and the decision might fairly be left to those who were willing to pay the subsidy in return for the tramway. So far as the tramway undertaking within a municipality was concerned, there was no way but to leave to committees the free choice whether they would operate or lease. In the case of inter-communication between groups of boroughs and districts, the suspension or the abolition of the Standing Orders of Parliament would make very little if any difference.

Mr. JOHN WAUGH (Bradford), in criticising the paper, said the first point was that the Huddersfield trams did not run on Sundays. When they had a capital of £130,000, and one-seventh part of it was idle, they had one solution of the mystery why the Huddersfield trams did not pay.

Mr. MASON (Birmingham) referred to the chequered career of the Huddersfield trams in their early history, and was glad to hear that they were now not unremunerative. The municipalisation of tramways involved socialism, and every step corporations took in that direction was, in his opinion, a gross error. Committees were amateurs and largely unacquainted with the work, and, unlike directors, they changed from year to year, and the work was done with less profit than under capitalists. In order to prove his contention about municipal corporations he drew attention to the parliamentary return upon electric lighting works. There were 41 corporations and local authorities who had started these works with a capital of £2,238,502. Of these, 24 made deficits and 17 made profits, and when the deficits were subtracted from the profits it left only £4,640 as a result upon the working of the large capital mentioned.

Mr. LIGHT (Liverpool) said that if they did not run on Sundays in that city they might as well go away and leave the place altogether. He said that Liverpool had decided to go in for electricity as a motive power.

Mr. PARKER (Wolverhampton) spoke strongly in favour of electricity as a motive power, and said that if he could go into the figures he could put a very different complexion upon those quoted by Mr. Mason. In Manchester the electric works reduced the rates by £25,000. Engineers were as willing to work for corporations as for companies.

The PRESIDENT, in summing up, pointed out the difficulties in the way of municipalisation. That of running through different districts was a large one, and another, though it might be theoretical, was important, and that was by employing a large amount of labour the Council might control municipal electors. This was an unhealthy and dangerous power. He thought the failure to run on Sundays a great mistake both from a tramway and a public point of view.

Mr. POGSON then replied to the criticisms made upon his paper.

The following paper was then read:

The Walker System of Electric Traction.

BY JUSTUS ECK, M.A.

In introducing the "Walker" system of electric traction to your notice, I first wish to draw attention to the scope of the paper. There is no intention at the present time of dealing with the intimate technicalities of the electric traction question that would come before such a society as the Institute of Electrical Engineers, but to point out to you the various specialities and advantages of this system so far as they concern the tramway owner, manager, or engineer. To explain the origin of the word "Walker" system, I should like to remind you that as early as 1883 a very powerful organisation, called the Walker Manufacturing Company, was organised in Cleveland, Ohio, as a general engineering firm, and which gave special attention to cable tramways for street work, and which, after carrying on the various departments of this work for 10 years, became convinced that electricity would be the probable motive power for most power traction lines in the future, as it presented the great advantages of easier extension and addition to existing power lines, a low cost of operation and the possibility of working over large areas, with a moderate capital outlay.

Entering so late in the field was no detriment to the Walker Company, who conceived the idea that electric generators and motors are, after all, only pieces of machinery and require but high-class workmanship and material to make them as reliable as steam-engines or waterwheels. Previous to the time of their entering into the manufacture, there was an impression that all electrical machinery was somewhat mysterious and unreliable in working, but they decided not to be influenced by this impression. The striking and immediate success of the application of their electrical manufactures convinced them and everybody else of the soundness of this policy. The essential points of the Walker system consist of the application of extensive street railway experience to the perfection of many small details, with a net result that the road apparatus is so simple that no skilled man is required as driver, and the station apparatus is so reliable that a service free from breakdowns is secured to the travelling

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public, and a remunerative investment to the purchaser. Messrs. Laing, Wharton, and Down, electric traction engineers, of London, the British representatives, are adding to the value of the system by modifications to suit the requirements of the British tramway engineer. They also, when starting in this line of business, carefully considered the question of patents, and decided in this matter as follows: that as the principles and details of dynamo and motor construction had been well understood by scientific men and manufacturers for nearly 50 years, there were no valid patents which prevent anyone from constructing such machinery substantially in any form desired; but still they decided to have a respect for all valid patents, and also have no intention whatever of going behind the moral right of any inventor to his invention. Whilst adopting this honourable position, they have at the same time every intention of rigidly protecting their own patent rights, which cover various details of the manufacture, etc., of their machines.

Before going directly to the subject of the machinery, it will be well to draw your attention to the fact that the factory where it is now covers over 10 acres of ground, and contains tools of very large size capable of dealing with dynamo and other machines weighing up to 170,000lb. per piece, and also that during the last few months two additional sites have been purchased, and are being rapidly equipped for the enlargement of the works to meet current demands. During this short period of three years 22 types of generators and six types of railway motors have been successfully designed and manufactured in quantity to standard. Engines and boilers of various efficiency, and having many points to recommend them, may be bought from a large number of well-known engineering firms in this country and elsewhere. Any modern engine that is capable of delivering its power with a fairly regular speed, provided it has good flywheel power, is suitable for driving a Walker railway generator. The Walker Company are also makers of specially suitable engines for this work. The Walker railway generator is the fount of the electric power, and in designing it great care has been taken to eliminate the mistake of starving it of either iron or copper; the want of either of these materials decreases the efficiency and also the life of a dynamo, with the further disadvantage, viz., that when any emergency or extra demand is put upon the generator it is apt to fail at the very time, when greatest trouble is the result. In America, where heavy snowstorms are frequent, it sometimes happens, even in a well-designed generating station, that the load on the generators has been for several hours fully 100 per cent. above the normal output for which they were constructed, and it is under these circumstances that the maker who puts extra material into his generator and the user who buys it realise the value of the extra cost. The generators are made of several sizes, with varying numbers of pole-pieces, and embrace a range of power from 100 kilowatts to 1,600 kilowatts (or to put it in horse-power, from 135 to 2,150), with speeds going down as low as 75 revolutions per minute. Every dynamo has a certain number of pole-pieces, and in the case of the Walker railway generator the number varies from four to fourteen. Each of these pole-pieces consists of a number of plates of iron notched at one end. These are built up side by side with two stout outside plates, and then held radially in clamping frames with the dovetails outwards at their proper angular distribution. They are then put in the mould and an iron yoke cast round them. Iron is preferred, as it secures better regulation, and the necessary cross-section required for magnetic purposes ensures at the same time a greater rigidity in the machinery, coupled with less cost. The surface contact between the dovetails and the yoke is at least twice the cross-section of the latter, so as to secure an even and economic field. Half rings with pole-pieces projecting inwards are thus obtained. Two of these when bolted together form the ring of magnetic poles in which the armature rotates. Each pole-piece is, as you will notice, sawn nearly in half from the centre, the object of this being to secure greater rigidity to the magnetic field, thereby minimising the change of position of the brushes with varying loads, and on the pole-piece is a band of steel, the pole-shoe, which retains in its place the field spool. The field spools are most carefully made, and are insulated with mica and millboard, and wound as follows: The shunt winding by the side of and separated from the series winding by a layer of mica and millboard. The shunt coils are wound in the usual way with wire, but the series coils consist of thin copper tapes, so thin that there is only one turn for each layer, the number of layers and size of tape being in proportion to the amperes and output of the machines. As the tape of copper winds on, adhesive insulating tape is also laid beween each layer. The tops of the windings are protected by prepared cloth and finally by neat rope winding. To the ring of field magnets at four of the neutral points is attached a ring of somewhat smaller size which carries the brush rocker and brush-holders, there being one brush to each pole. One object of this arrangement, which is used on all direct-coupled generators, is to enable the outer bearing to be removed without interfering with the brush-holders, and another is that the adjusting worm screw, which traverses the brushes either forwards or backwards, works upon a very large circumference, so that greater accuracy of adjustment is obtained. Trial has proved these generators to be sparkless at the commutators without shifting the brushes up to 50 per cent. and even 75 per cent. overload.

The armature consists of a solid forged-steel shaft, on which is mounted a cast spider, of the section here shown; the object of the radial cutting is to free it from strains, and to this is attached, by means of dovetails, the disc segments. These disc segments overlap, and when a sufficient number of them are in place they are firmly bolted together between heavy cast-iron end discs, thus making a rigid core for the armature coils. Each slot is carefully tooled out, and special insulation is laid into it in the following order: First of all, a millboard trough is made, then a trough of oiled linen, then one of mica, then one of oiled paper, and then one of millboard again. Into this the conductors are laid, and a hard wooden strip is put on the top, the various layers being separated by a strip of composite insulation. Finally, the millboard, mica, and other insulating substances are closed over, and the whole securely bound in by means of wire laid into grooves turned in the disc segments, thus securing minimum air-gap. Lap winding and wave winding is employed. All the coils are machine-formed, so that they are easily laid in place and brought down to the commutator segments, where they are securely soldered. They consist of copper tape tinned for convenience in soldering, and are waterproofed. The back ends of these coils have a very neat appearance, so that it seems almost a pity to enclose it in the canvas binding, which, however, is a necessity to keep out dirt and grease. The back and front ends are further protected by a brass ring, so that it is perfectly safe to handle the biggest armatures in spite of their great weight.

The commutator consists of a spider-wheel overlaid with insulating strips, on which are placed drop-forged copper segments, held down with insulating material under end caps, and the whole then bolted together, thus making an extremely simple and at the same time a very reliable form of commutator, from which many of the complaints usually found in such delicate parts of a generator are eliminated. All the segments are of drop-forged pure copper, so that the commutators are free from soft places and holes. The commutator is keyed to the armature spider, so that both can be removed together from the shaft, which is a step in advance of most makes.

The armature is mounted in the usual way in first-quality self-aligning bearings, and supplied with all the necessary lubricating apparatus, which in standard patterns consist of two oil-rings in an oil-well; a gauge-glass shows the height of the oil in this well. The bearings are of such ample size that reliable lubrication is secured this way. In most of the large machines arrangements are made for allowing the field magnets to slide axially, so that the armature may be examined at any time without taking these heavy parts to pieces. The generators are made usually for generating at 550 volts, sometimes up to 800 volts; but arrangements are made in the wave windings so that by changing the commutator and altering the connections, a lower voltage for cell charging and other purposes can be obtained without deviation from standard patterns. The generators are belt or rope driven or direct-coupled to engines according to size and requirements.

The current from the generators passes to the Walker switchboard, which is built in sections, there being as many generator sections as there are generators, and also a Board of Trade section, having on it the special instruments required by the Board of Trade, and also the various feeder panels for supplying the feeder circuits to outlying parts of the tramway system. These switchboards are made either of slate or marble, and have an arrangement of angle-iron pieces running vertically, by means of which the switchboard is easily added to when extensions of the tramway system takes place. This construction also secures that desirable result—namely, a fireproof switchboard—which is also a handsome addition to the generating station. To secure absolute perpendicularity of the board a long turned buckle is provided in place of the upper end stay, so that this desirable feature is quickly obtained. The angle-iron pieces mentioned before form very convenient supports for carrying up heavy cables from large generators to the switchboard, and the whole is so arranged that when the switchboard is completed it is almost as neat at the back as in the front. The generator panel usually consists of two main switches connecting the positive pole of the generator to the line 'bus (or main) bar, and the negative pole to the earth bar. The positive wire passes on through the ampere-meter, which measure the current output, and then through an automatic circuit breaker, which protects the generator from excessive currents. Switches are also provided for the field circuits and for regulating the resistance in the shunt field. The feeder panel usually has two feeder circuits to it, each provided with a circuit breaker and an ammeter for indicating the current passing out to that section; also a main switch for isolating the circuits. The standard size of the panels is 90in,

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in height and 24in. in width for all sizes up to 3,000 amperes for the generators and 1,500 for the circuits. The resistance switches are carried on the front of the panel, but the resistance coils themselves are carried on the back, allowing them to be easily examined, and at the same carrying any heat generated in them away from the measuring instruments.

The current from the switchboard passes by underground or overhead feeder wires to the tramway line, and then should this be of the overhead construction it is collected by the Walker trolley, which differs from the ordinary V-wheel trolley in that it consists of a roller mounted at the end of the pole. This eliminates all trouble with turn-outs and crossings, and prevents the breakage of span wire which often occurs when such is used, thus materially lowering the expenses of upkeep. This roller is mounted on ball bearings, and requires no oiling even up to 30 miles per hour, or 5,000 revolutions per minute. The Walker trolley has also the advantage of collecting the current with perfect certainty, and it also enables the car to be run at full speed when changing from one line to another, it being almost independent of the setting of the overhead wire. When using the ordinary trolley a great amount of care has to be exercised in keeping it to the line when passing points or curves. The trolley pole retains a fixed position as regards the vertical longitudinal plane of the car when working, but when hauled down can be reversed for running backwards. The current being thus collected passes through the two main switches and a lightning guard to the Walker controller, which regulates the speed and direction in which the motor runs. There are one or two forms of controllers in use, but it is claimed for the Walker controller that it is superior to these in the following points: When the controller is turning the current off from the motors, there is always considerable difficulty in obviating dangerous sparks, and in some cases a magnetic blow-out arrangement has been used to obtain this effect. These, however, at all times require current in them, so that there is a constant waste at this point; and further than this, unless there is a large current in the blow-out coils the spark-breaking power is extremely small. The method employed in the Walker controller is subdividing the breaking spark between 32 contacts in series, so that the sparking effect obtained between each of these contacts is very small, it being 1-32 of the total amount at each point. At the same the inductive spark from the blow-out coil is saved. Another particular point is that directly the controller handle is turned back to reduce speed the current is immediately shut off the motor, so that it is possible for the motorman to immediately put on his brakes without any harm happening to the motors. The controller, which is of the series-parallel type, is both fire and water proof, and occupies a minimum of space. It has two handles—one for controlling the speed and the other the direction—and these are so interlocked that unless the direction handle is fully over either "forward" or "back," the speed-regulating handle will not move. In addition to this, it is so arranged that unless the spark-breaking cylinder is so placed that the circuit is broken it is impossible to move the direction handle. To eliminate any resistance effect of the spark-breaking contacts, an arrangement is made so that the whole of these are cut out of circuit when the controller handle is moved forward In order to promote the long life of the controller, and as the spark cylinders are apt to wear when going on one face, these cylinders are so made that they may be inverted and double wear obtained by using the other face. Another noticeable point is the absence of the usual vulcabeston fences and bridges, thus allowing the controller to be kept clean and under easy inspection. The swinging of the cover is also an improvement permitting of very easy access.

The motors are of similar construction to the dynamos so far as the armatures are concerned, the exception being that the armature discs are in entire rings; they are each stamped out of the plate at a single blow. The coils are soaked several times in asphaltum, and so made entirely waterproof, and also subjected to a 5,000-volt pressure test before use. The field magnets, however, differ very considerably from those of the generators, although the winding is carried out on the same principle. The field magnets are of soft cast steel, and form a complete box when closed together, and the coils, which are waterproofed, are held in place on the four poles that are inside by brass clips held by a set screw. This box formed by the field magnets is so arranged as to open either upwards or downwards, thereby providing for inspection from the top, through the floor of the car body, or from below in the car pit. The armature is held in place firmly during either of these operations and can also be taken out above or below. The bearings are outside the magnet case and are easily detached. The armature windings are so arranged that there are only two brushes, and these are 90deg. apart, and are built in such a manner that the brushes can be easily placed under the trap. Oil-rings are provided outside the magnet case, so that all oil drippings, etc., are prevented from running into the armature. The commutator has very high insulation, it being entirely of mica with 2in. of surface between the live parts and the frame. It also has a very long life—gears have run over 1,000,000 miles. The whole when closed up is practically dust-proof, the spur-wheel and pinion running in a case containing oil, so that vibration and jar from this is unnoticeable. One great speciality of the Walker motor is its method of suspension, and the value of this will readily appeal to anyone who has studied the subject of rail depreciation on power traction lines. The motor is hung upon springs both in front and behind, so that should the car when in motion meet with an obstruction or a raised point it does not strike the rail with a hammer blow equal to the weight of motor added to that of the wheels, but with a blow in which a spring is inserted, which means a very different life to the permanent way and electric bonds. This same spring also comes into effect when the motor is started to work, and no unpleasant jolting from rapid application of power is observed, the springs first having to become compressed before the motor can exert its full power from the pinion. The rear end of the motor is hung in the well-known way for most electrical motors for this class of work, and has also a spring. Too great value cannot be placed on the suspension of motors, as the even riding of these affects, first of all, the track with its many points and expensive crossings; next, the electrical bonding of the rails, causing the springiest of bonds to become brittle; then the spur-wheel and pinion, also the armature wires, which must in course of time feel the effect of constant jolting; and finally, most important of all, the comfortable riding of the passengers.

Realising the great importance of having the motors as nearly perfect as possible, greatest care has been taken in designing them to embody every improvement suggested by actual use that comes to the notice of the company; and as a result of this the following points come strongly to the front in the Walker motor: It is extremely accessible from the top and from underneath, whilst retaining all the advantages of being free from dust, water, or oil inside. All the parts are interchangeable, and all bolts in the main body are of the same size, and drop in from the top, and have locked nuts and spring cotters. The weight is reduced to a minimum for the strength and freedom from breakdown that is essential. All motors are tested under 5,000 volts pressure before passing out of the shops, and the unstinted use of mica gives an insulation that keeps the armature free from the burn-outs not at all unknown on some systems. Every motor is carefully tested for power before leaving the works in the following manner: It is set to run on a Prony brake till the full rated power is obtained for one hour continuously at the pinion and at the end of this time if the temperature rise is under 150deg. F. it is passed. Rating motors in this way has been found to keep them within safe heating limits in the hottest of American summer weather, with the heaviest loads for which they are constructed. All the motors for railway work are what is known as single-reduction type, which means that the power from the armature spindle is transmitted through a pinion on it to a spur-wheel keyed to the wheel axle. This permits of hanging the motors on the Walker spring suspension principle, and also allows them to run at moderately high speeds, thus securing a reduction in weight. There are other incidental advantages in this spur gearing. The gearing is enclosed in a malleable iron housing, which keeps it free from dust and dirt and also acts as an oil-well, into which the larger spur-wheel dips and gathers oil, making the friction in the gear low and the noise of it inappreciable.

In dealing with the apparatus so far, nothing has been said of efficiency. The mechanical friction is, as must be evident from the design, extremely low. The electrical efficiency is equally good. The efficiency of a Walker generator is found to be practically constant from 30 per cent. load to 30 per cent. overload, and to averge 93 per cent., and rising to over 96 per cent. When starting railway motors they take at first the maximum current; this, however, soon drops to half and less, and during portion of the time of running the motor is receiving no current. It is therefore important that the motor should have good efficiency at overload as well as at light load; also in many cases gradients require long application of medium power. It will be found that the Walker motors comply with these requirements, the efficiency rising rapidly up to quarter load and then to a maximum at one-third load, to continue about the same to 25 to 35 per cent. overload. The motors are made in six sizes, as under:

No.	3	...	25 h.p.	...	800lb. pull	...	20	miles per hour		
,,	4	...	30 ,,	...	1,000lb. ,,	...	30	,,	,,	
,,	5	...	35 ,,	...	1,200lb. ,,	...	35	,,	,,	
,,	10	...	50 ,,	...	2,000lb. ,,	...	40	,,	,,	
,,	15	...	75 ,,	...	3,000lb. ,,	...	50	,,	,,	
,,	20	...	125 ,,	...	5,000lb. ,,	...	50	,,	,,	

The pull is reckoned at 10 miles per hour in all cases, and with 33in. wheels.

To further prove the efficiency of the motors, the Walker motors No. 3 size have 144 turns of magnet wire, against 191 of one of the large opposition makers. To secure the extra space for this larger number of turns, the cross-section of the

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wire is 25 per cent. less, thus adding further resistance to the circuit. The same applies to the winding of the equivalent motor to our No. 10 size, except the discrepancy in cross-section is still greater. The Walker Company do not interest themselves particularly in the construction of car bodies or trucks or wheels, preferring to leave those parts to firms who make a speciality of such articles. As they construct their motors to standard designs, there is no difficulty of attaching these parts to the parts constructed by other firms.

The discussion which followed this paper was technical in character. It was taken part in by Mr. PARKER, who said that nothing novel had been introduced in the paper, and others, and Mr. ECK answered questions, and undertook to furnish certain details which were asked for by the president and others, to be published in the institute's *Journal*.

The PRESIDENT then stated that Mr. George Livesey, chairman of the South Metropolitan Gas Company, had approached the tramway companies working under municipal authorities, asking them to be represented on the Local Taxation Commission; and, the meeting not dissenting, the hon. solicitors of the institute were desired to take up the matter of adequate representation, so that tramway companies might, if possible, get relief from the local taxation which pressed so heavily upon them.

The members of the institute afterwards agreed to alterations of rules so as to embrace, as associate members of the institute, tramway companies and others interested in tramways. The PRESIDENT also announced that the council had had some little difficulty regarding a new institution to be formed on similar lines to their own. It was proposed to get over the difficulty by the amalgamation of the two associations, and thus secure the extension of the institute in the direction of making it a light railways as well as a tramways institute. From the number of orders before the House of Commons this year, it was also thought desirable that they should prepare a model Bill, and get the Board of Trade to endorse it as a guide for the future. Members agreed to leave both these matters in the hands of the executive council, and the formal proceedings were then closed with the usual votes of thanks.

The members afterwards inspected the town hall, technical schools, the sewage works, and various features of the local tramway system.

NORWICH TRAMWAYS.

REPORT OF THE PARLIAMENTARY COMMITTEE.*

At the meeting of the Norwich Town Council on the 14th inst. a report and recommendations from the Law and Parliamentary Committee was presented upon the schemes of the New General Traction Company, to construct electric tramways, and of the British Electric Traction Company, Limited, to construct light railways in the city and adjoining districts. The schemes have, since they were brought under the consideration of the Law and Parliamentary Committee, been greatly modified. At a meeting of the committee on the 2nd inst., the town clerk presented a precise report upon the routes and financial and other proposals by the companies as modified, and at a subsequent meeting, after a long discussion, the following amendment to a motion by Mr. Councillor Tillett was moved by Mr. Alderman White: "The committee having considered, side by side on their merits, the proposals of the New General Traction Company, Limited, to construct electric tramways in the city and Thorpe, and of the British Electric Traction Company, Limited, to construct light railways in the city and district, are of opinion that the interests of the city will be best served by making an arrangement with the New General Traction Company, Limited." Upon a show of hands for and against the amendment there were 10 for, 7 against, and 2 neutral. The Chairman declared the amendment carried, and it was resolved accordingly. The committee report that the New General Traction Company, Limited, have given an undertaking to withdraw their Bill from Parliament at any time upon the request of the Corporation. The Bill is expected to come before a committee of the House of Commons immediately after the Easter vacation. The local enquiry by the Light Railway Commissioners into the amended scheme of the British Electric Traction Company, Limited, will probably be held at Norwich on May 14.

* We are indebted to the *Norwich Mercury* for this report.

The "concise statement" by the town clerk as to the routes and financial proposals of the two companies is as follows:

ROUTES OF THE ELECTRIC TRAMWAY.

1. Prince of Wales-road and Thorpe-road to near the county lunatic asylum.
2. King-street to Bracondale, terminating below Martineau's-lane.
3. The centre roadway of the cattle market, Golden Ball-street, All Saints'-green, Upper Surrey-street, Queen's-road, and City-road, to below Lindley-street.
4. Castle Meadow, new street Orford-hill, Orford-hill, Red Lion-street, St. Stephen's-street, St. Stephen's-road, and Newmarket-road, to the Judges'-walk.
5. Bank Plain, new street Bank Plain, to St. Andrew's-hill, St. Andrew's Broad-street, St. Benedict's-street, and Dereham-road, terminating near the Lord Nelson public-house.
6. Upper King-street, Magdalen-street, Magdalen-road, and Denmark-road.

The following routes are in connection with the above lines:

7. From Thorpe-road (No. 1) along Riverside-road, Bishop Bridge-road, and Mousehold Heath to the public road leading from Plumstead-road to Sprowston-road.
8. From the junction of Upper Surrey-street and Queen's-road (No. 3), along Queen's-road and Chapel Field-road to St. Giles's-street.
9. From Orford-hill (No. 4) along Little Orford-street, The Walk, St. Giles's-street, St. Giles's-road, and Earlham-road, to the cemetery gates.
10. From St. Stephen's-street (No. 4), along Rampant Horse-street, Theatre-street, Chapel Field, and Unthank's-road to the lodge at Eaton Hall.
11. From Dereham-road (No. 5) to Earlham-road along Heigham-road.
12. From Dereham-road (No. 5), along Barn-road, Station-road, Oak-street, Sussex-street, St. Augustine's-street, and Aylsham-road to near Prospect-place.
13. From Magdalen-road (No. 6), along Magpie-road to St. Augustine's-street.

ROUTE OF THE LIGHT RAILWAY COMPANY.

1. Prince of Wales-road and Thorpe-road to the Tuns Inn, Thorpe St. Andrew.
2. The lower road of the cattle market, also the centre road of the cattle market, to a junction at Golden Ball-street, thence along Golden Ball-street, Ber-street, and Bracondale to Trowse Newton.
3. Bank Plain, Redwell-street, Prince's-street, St. Andrew's Broad-street, St. Benedict's-street, Dereham-road, and Lower Hellesdon-road to Costessey.

The following routes are in connection with the above line:

4. From Thorpe-road (No. 1) along Riverside-road, Barrack-street, Bull Close-road, Magdalen-road, Denmark-road, and the Wroxham-road, Sprowston. (The company will construct the line along Riverside-road, Barrack-street, and Bull Close-road to Magdalen-road if the Corporation desire that part of the line to be constructed, but the company consider it will not be wanted if No. 6 be constructed.)
5. From Golden Ball-street (No. 2) along All Saints'-green, Upper Surrey-street, Queen's-road, St. Stephen's-road, and Newmarket-road to Eaton Village.
6. From St. Andrew's Broad-street (No. 3) along Duke-street, Pitt-street, St. Augustine's-street, and the Aylsham-road to beyond Philadelphia-lane.
7. From Dereham-road (No. 3) to Earlham-road along Heigham-road.
8. From Magdalen-road (No. 4) to St. Augustine's-street along Magpie-road.
9. From Denmark-road (No. 4) to the Grange, Old Catton, along the Spixworth-road.
10. From All Saints'-green (No. 5) along Westlegate-street and Rampant Horse-street, terminating opposite Briggs's-street.
11. From Queen's-road (No. 5) to St. Giles's-street along Chapel Field-road.
12. From St. Augustine's-street (No. 6) to Magdalen-road along Waterloo-road.
13. A line commencing at the foot of Guildhall-hill, and passing along St. Giles's-street, St. Giles's-road, and Earlham-road to Earlham-rise. This line is connected with routes No. 7 and 11.

STREET WIDENINGS, ETC., BY THE TRAMWAY COMPANY.

(1) Red Lion-street; (2) Castle Meadow; (3) Little Orford-street; (4) Magdalen-street and other streets from Tombland to near Magdalen Gates; (5) new street Orford-hill. The tramway company are to carry out the widening of these streets, with money to be provided by the Corporation, and to contribute to the cost as hereafter stated, whatever the cost may be. Before purchasing any property by agreement with the owner, the company are to submit for approval the price at

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which it is proposed to acquire it to three members of, and to be nominated by, the Corporation. If the expenditure on the above street widenings does not exceed £100,000 the company will also contribute to the cost of widening (6) Unthank's-road; (7) St. Andrew's Broad-street; (8) and making a new street from St. Andrew's-hill to Bank Plain. But the company will not make a contribution to Nos. 6, 7, and 8 to any sum in excess of £100,000. In lieu of No. 8 the company offer to substitute an alternate route from St. Andrew's-hill to Tombland, or by Prince's-street and Redwell-street to Bank Plain.

The Corporation are to raise by loan the money that will be required for widening the streets. The company are to repay to the Corporation one-half of the sinking fund and interest that will be payable annually until the loan is extinguished, after the amount paid annually in local rates by the company has been first deducted. The payments to be made by the company to the Corporation are to be secured by a first charge upon the undertaking of the company. Application is to be made to Parliament to authorise all moneys borrowed by the Corporation under the Act to be repaid in 60 years, but Parliament may require the loan to be paid off in 30 years. The sum to be set apart annually as a sinking fund with accumulations in the way of compound interest at 2½ per cent. and the interest on the loan at £3 per cent. will be as follows:

If the loan be sanctioned for 30 years—for each £1,000 borrowed	£52	15	10
If the loan be sanctioned for 40 years—for each £1,000 borrowed	44	16	8
If the loan be sanctioned for 50 years—for each £1,000 borrowed	40	5	0
If the loan be sanctioned for 60 years—for each £1,000	37	3	4

The company estimate the sum that will be payable on the undertaking in local rates when the tramways, generating stations, and other buildings are fully completed, at about £800 per annum. The company are to expend, or contract to expend, to the satisfaction of the Corporation, not less than £50,000 upon the construction of the tramways before any work of street widening is commenced; and are not, without the consent in writing of the Corporation, to make any tramway in any street authorised to be widened until the completion of the widening.

The tramway company, before commencing any work, will deposit at a bank in Norwich to the credit of the Corporation £10,000 in cash, or security to be approved of to that amount. Such deposit is to be forfeited to and become the property of Corporation if the company do not complete the tramways, or such portion as the Corporation require, and open them for conveyance of passengers within the time limited by the Act—*i.e.*, as to tramways dependent upon street widenings within two years after completion of the widenings; and as to the remainder of the tramways within five years after the passing of the Act.

Street Widenings, etc., by the Light Railway Company.

(1) Duke-street; (2) Pitt-street; (3) Westlegate-street; (4) St. Andrew's-street; (5) Prince's-street and Redwell-street. The company state that they do not ask the Corporation to make any contribution towards the cost of construction or of carrying out these street widenings, or to bear any portion of the interest charges in respect of the necessary capital outlay, nor to be relieved of local rates. The company offer to widen the above streets to the reasonable requirements of the Corporation. The company offer also to widen Barrack-street to such a width as the Light Railway Commissioners may determine should a line be laid in that street.

Purchase of the Tramways.

At the end of 14 years the Corporation may purchase the undertaking upon terms of paying the then value of the undertaking as a going concern, together with such a premium as shall, in the opinion of an arbitrator to be appointed by the Board of Trade, be equal to seven years' net maintainable profits. At the end of 21 years or any succeeding seven years the Corporation may purchase the undertaking upon terms of paying the then value of the undertaking as a going concern. In case of difference an arbitrator is to be appointed. At the end of 50 years the Corporation may purchase the undertaking under Section 43 of the Tramways Act, 1870.

Purchase of the Light Railways.

Before the expiration of 15 years the Corporation may purchase the light railway undertaking for such an amount of Norwich Corporation Stock as will produce an annuity of 6 per cent. per annum upon the sum expended by the company, and chargeable to capital expenditure, less the aggregate amount of the dividends from the date of such expenditure to the date of purchase. Between the end of 15 years and 35 years the Corporation may purchase the undertaking upon the same terms as in the last paragraph, with the exception that the amount of stock is to be such as will produce an annuity of 5 per cent. per annum. At the end of 35 years, or at the expiration of every succeeding 10 years, the Corporation may purchase the undertaking upon terms of paying the fair market value as a going concern. In case of difference an arbitrator is to be appointed by the Board of Trade upon application of either party.

Other Provisions.

One of the directors of the tramway company is to be a person resident in Norwich, and to be appointed by the company subject to the approval of the Corporation. If the company and the Corporation fail to agree, the mayor is to make the appointment. All the appropriate clauses of the Tramways Act, 1870, as to streets, by-laws, etc., will be incorporated in the Bill of the tramways company. The Corporation will obtain by consent other clauses for their protection. The light railway company offer to submit to the same clauses of the Tramways Act, 1870, as the tramway company, and to such other provisions as the Light Railway Commissioners may consider requisite for the protection of the Corporation.

Final Modifications.

In reply to a letter from the town clerk the secretary of the New General Traction Company wrote: "I am directed by my Board to state that as a final proposition they agree to modify the proposal of the company already before the Corporation to the extent shown in the following resolution, which was this day passed by them—viz.: 'That if the Corporation raise a loan of £110,000 the company will pay half the sinking fund and the interest during the existence of the loan after the amount paid annually in local rates by the company has been first deducted. The company to enter into a contract with the Corporation of Norwich to widen and make the undermentioned streets to the extent shown on the parliamentary plans, and initialed by Mr. Hopkins and the town clerk—*i.e.*, (1) Red Lion-street; (2) Orford-hill new street, Castle Meadow; (3) Magdalen-street, Fye Bridge-street, and Wensum-street; (4) Little Orford-street; (5) Unthank's-road; (6) making new street from St. Andrew's-hill to Bank Plain for the sum of £110,000, it being understood that if that sum shall not suffice to widen and make such streets the liability for completing the contract rests entirely upon the company. All surplus lands thus reclaimed to belong to the company." It was further resolved that in case the Corporation should prefer to carry out the works themselves, the company is prepared to contribute to the cost of such works on the same terms as the Corporation is invited to do if they be carried out by the company on the first-mentioned above proposal. In taking the additional liability upon themselves above stated, my Board desires it to be distinctly understood that this offer is absolutely final, and, with a view to the position of their Bill in Parliament, it must also be understood that the offer must either be accepted or rejected by the end of this week."

Suggestions were also made to the Electric Traction Company, who wrote—first, with regard to the widenings: "We have carefully considered your suggestion with reference to making a new street from St. Andrew's Broad-street to Bank Plain; but, in view of the very irregular formation of the ground, which will cause considerable engineering difficulties, and necessitate a very large expenditure, we do not deem it practicable to adopt the suggestion, and think it better to adhere to our former proposal—viz., to widen St. Andrew's-street, Prince's-street, and Redwell-street. We consider this will be a much greater improvement, as it will remove the existing inconvenient corner at Prince's-street and Redwell-street, whereas the proposal to make a new street from St. Andrew's-street to Redwell-street will not overcome the inconvenience of the present corner, but will accentuate the inconvenience by leaving a separate block of buildings and creating new and additional street corners. We feel sure that if your committee will view this property from the back as well as from the front of the premises they will arrive at the same conclusion we have. As stated in a previous letter, we do not consider the suggested line along the Riverside-road and Barrack-street necessary now that we have arranged to provide other routes connecting the north of Norwich with the railway station, but as your committee consider it desirable that this line should be made, we will agree to construct it and carry out the widenings which the tramway along this route will involve, although the total cost on widenings will thereby be materially increased beyond the amount we are prepared to expend. We agree that the widening of Barrack-street shall be in accordance with the reasonable requirements of the Corporation, but should any difference arise between the Corporation and ourselves, the matter in difference shall be determined by the Light Railway Commissioners.

"We note that your committee are in favour of St. Giles's and Rampant Horse streets being connected by a line along the walk and Briggs's-street, but we fear the physical obstacles are too great to admit of their being removed for the sake of tramways. We are quite willing, however, to agree to construct this additional line, provided we are not called upon to bear

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the cost of any street-widening that may be necessary. It is even a question deserving your best consideration whether the scheme would not be very much improved by omitting the proposed lines along Rampant Horse-street and along St. Giles's-street, thus getting rid of the two termini in the congested parts of the city, and practically providing a circular route around the busy parts of the city by means of the lines along Chapel Field-road, Upper Surrey-street, Cattle Market-street, Bank Plain, Prince's-street, St. Andrew's-street, St. Benedict's-street, Heigham-road, and St. Giles's-road, and again joining Chapel Field-road, we could arrange our traffic along this road so as to provide a frequent service, and then radiate from this circle by separate services of cars in the various outlying directions shown on our plan. We propose to make the width of Duke-street, Pitt-street, St. Andrew's-street, Prince's-street, Redwell-street, and Westlegate-street at least 23ft., which we consider amply sufficient for the purposes of the tramways, but we are prepared to consider any suggestion the Corporation may have to make in regard to this matter. The street widenings we agree to make are in Duke-street, Pitt-street, Westlegate-street, St. Andrew's-street, Prince's-street, Golden Ball-street, Redwell-street, and also in Barrack-street. We think it well to reiterate that we do not ask the Corporation to make any contribution whatever towards the cost of making the widenings we have specified, and which we consider necessary for the purposes of the tramways we have proposed, neither do we ask the Corporation to take any part in these financial arrangements for raising the necessary capital, or to bear any part of the interest charges on such capital, all of which we are prepared to do ourselves.

"It will be our desire when we establish a local company to undertake the working of the tramways to obtain as far as possible the advantages of local influence, and it will be our endeavour to secure local gentlemen as directors. When, therefore, we constitute the Board we shall be glad if the Corporation will nominate, say, two of the directors of the local company. We may add, further, that we shall be glad when the time comes to consult the Corporation on other matters connected with the formation and constitution of the local company.

"We are prepared to insert the usual clause in the orders to the effect that before we open or break up any road within the city of Norwich for the purpose of constructing any tramway we shall deposit in a bank to be approved by the Corporation to a joint account in the names of the Corporation and ourselves a sum of money to be calculated at the rate of £500 for every mile of tramway, and so in proportion for a part of a mile of tramway, by the order authorised to be constructed within the city. Such sums shall be invested at our risk in such securities as the Corporation may approve, and the interest thereon shall belong to us. On the completion of the reinstatement of the roads to the satisfaction of the surveyor to the Corporation, the sum deposited shall be paid out, or the securities in which the same is invested shall be transferred to us.

"We have already made it quite clear, we think, that the light railways we propose to construct are the same as tramways, with a gauge of 3ft. 6in., and overhead electrical equipment. The reason why we have proceeded under the Light Railway Act instead of under the Tramways Act, 1870, is simply that the new Act provides for a simpler, cheaper, and more expeditious procedure."

METEOROLOGICAL SOCIETY.

At the monthly meeting of the Royal Meteorological Society on Wednesday, Mr. E. Mawley presiding, Mr. W. H. Dines read a paper on the relation between cold periods and anti-cyclonic conditions of weather in England during the winter. So far as England is concerned, the author's observation has led him to the conclusion that anti-cyclonic conditions are not accompanied by exceptional cold. Out of 74 frosts he found that 16 only accompanied a barometer pressure exceeding 30·20in., and the majority of these were of very short duration. Almost every frost in the period had a low pressure. A paper by Mr. A. Lawrence Rotch, of the Blue Hill Observatory, Mass., was read, describing the use of kites at that observatory to obtain meteorological records in the upper air. Three kinds of kites have been used—viz.: (1) the Malay kite, which presents a convex surface to the wind; (2) the Hargrave cellular kite; and (3) a flat kite with a fin or keel on the front, devised by Mr. Clayton. These kites are attached to a wire carrying self-recording meteorological instruments, and a steam winch automatically distributes the wire on the drum and records its pull. A paper by Mr. A. B. MacDowall on "Suggestions of Sunspot Influence on the Weather of Western Europe" was also read. The author believes that there is a tendency to greater heat in the summer half-year, and to greater cold in the winter half-year, near the phases of minimum sunspots than near the phases of maximum.

JUBILEE ILLUMINATIONS.

The Electrical Company, of 122 and 124, Charing Cross-road, are laying themselves out for making extensive decorative signs for the approaching Diamond Jubilee celebrations. In all illuminated signs the designs can be varied to suit the taste of the purchaser, but with electricity as the lighting power this is especially the case. So the designs which we were allowed to inspect at the above premises this week are only examples of what can easily be done, and are by no means the limit of the capacity of the firm. The system of wiring adopted is somewhat unique. Screw socket lamps are employed for the coloured groundwork, mounted on a wooden frame. The screwed support for the lamp is mounted on the wood by a saddle-piece, and the top contact consists of a piece of brass wire driven through the board. The other contact is made to the screw on one leg of the saddle which projects through the wood. Bare wire is then led round by the various contacts and soldered to them. The whole back of the board with the bare wires is painted with asphalte and then covered with a wood backing. This arrangement gives a good and cheap method of making decorations which will stand any amount of bad weather for the time being. The largest sign on view measured 5ft. by 9ft. high. It consists of a recessed rectangle painted black, containing a bust of her Majesty the Queen. The crown on the bust is pointed with some 24 small incandescent lamps connected up in series of 12 lamps each. Palms and ferns surround the bust at the sides and bottom, giving a pleasing effect. The rectangle is surrounded with three lines of lamps coloured red, yellow, and blue respectively. These lamps are of 16 c.p., and are wired as described above. The woodwork slopes out at a slight angle, and is painted white. Surrounding the whole is a large crown worked out in lamps of all colours. The general effect is most pleasing, but without the aid of colour printing no adequate illustration can be given. There is also on view a Maltese cross, measuring about 6ft. by 6ft., in the centre of which is a medallion bust of the Queen. The four points of the cross contains the following inscriptions in lamps: a crown, "1837," "1897," and "V. R." A smaller design, somewhat on the lines of the first to be described, is also in course of construction. The fact remains, as stated above, that these signs are only typical of what can be done; and although many will be quite content to take these stock articles, yet the firm will be pleased to get up more extensive illuminations to suit special positions. The system of wiring and cheap material required allows such special arrangement to be carried out at a moderate charge.

FORTHCOMING EVENTS.

The following are some of the announcements for the forthcoming week:

TUESDAY, APRIL 27.—Institution of Civil Engineers, annual meeting (members only), 8 p.m.—Oriental Telephone Company's meeting, Cannon-street Hotel, 3.30 p.m.—Royal Institution (Dr. Tempest Anderson on "Volcanoes," Tyndall lectures), 3 p.m.—Society of Arts, John-street, Adelphi, 8 p.m. ("Delft Ware," by Dr. Glaisher).—Also at Glasgow, meeting of the Institution of Engineers and Shipbuilders in Scotland.

WEDNESDAY, APRIL 28.—Institution of Electrical Engineers, students' meeting, at 28, Victoria-street (paper by Mr. F. Johnstone on Accumulators).—Institution of Mechanical Engineers, at Civil Engineers, 7 30 (Canal Propulsion, by Mr. Robinson.—Crystal Palace lecture—Eastern Extension, Australasia, and China Telegraph Company's meeting, at Winchester House, 2.30 p.m.—Indo-European Telegraph Company's meeting, Winchester House, 12.30 p.m.—Society of Arts (Mr. Jones on "Asbestos and Asbestic," and discovery of the latter at Danville.—Also at Liverpool, annual meeting of the Liverpool Engineering Society.

THURSDAY, APRIL 29.—Royal Institution (Canon Ainger on the Poetic Revival of 1760-1820), 3 p.m.—The Institution of Mechanical Engineers entertain the Duke of Cambridge at its Jubilee Dinner at the Hotel Cecil, 7 p.m.

FRIDAY, APRIL 30—Royal Institution (Prof. J. J. Thomson on Cathode Rays), 9 p.m.—Institution of Mechanical Engineers (Fans and Electric Motors, by Mr. Walker), at the Civil Engineers, 7.30.—Also at Newcastle, meeting of the North-East Coast Engineers (Gravitation Stamp Mills).

SATURDAY, MAY 1.—Royal Institution (Dr. J. P. Mahaffy on the Greek Theatre), 3 p.m.; also at 5 p.m., annual meeting.

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COMPANIES' MEETINGS AND REPORTS.

WILLANS AND ROBINSON, LIMITED.

The ordinary general meeting was held on Wednesday, 14th inst, at the Cannon-street Hotel, E.C.

Mr. Mark Robinson presided, and in moving the adoption of the report congratulated the shareholders on the satisfactory balance-sheet presented to them. They had for the first time to pay a considerable amount of interest upon debenture stock, not the entire charge for a half-year (which would in future be £2,125) but £1,315 towards it. It was satisfactory that they could so easily bear that charge before the capital sum it represented had had time to giv effective help to the revenue account, and it was still more satisfactory to note that even had the full half-yearly charge for debenture interest been payable it would have affected neither their dividend nor their capacity for amply building up the reserve funds, and they would still have had a good amount to carry forward. In fact, the half-year's profit was up by nearly £1,800 in spite of adverse circumstances. They reserved in all £3,000, against £2,500 hitherto, but £2 000 of this was reserved for the redemption of the debenture debt. If they could keep up this rate of putting by they would be able to redeem it in the prescribed time for repayment. The other £1,000 was carried to the reserve fund, which, without this, stood at £10,000. The sum carried forward to the next half-year was £2,052. 10s. There was no doubt that their long series of prosperous half-years must suffer something of a check in the present year. The disorganisation of work involved in such a move as they had made was bound to tell unfavourably both upon output and upon rate of profit; but no company could be in a better condition to meet a temporary check. Already they felt the strength which came of prudent valuations and of saved-up profits. The directors did not look forward to any such falling off in profits as would bring the inviolability of the reserve fund into question. Taking the principal items in the accounts, he stated that work in progress and the stock of materials and stores were both largely increased owing mainly or wholly to the increasing business. The placing of the newly-issued shares had been accomplished successfully. The question of how to deal with the premiums received, which amounted to £13,500, remained to be considered. The directors thought that they should be applied first in writing off the expenses of the move to Rugby, then in writing off a substantial amount from those assets at Thames Ditton which were directly affected by the move, and, finally, if any balance remained, in writing down patents. The money applied in those ways, though it disappeared from the accounts, remained in the business. The removal of tools, castings, stores, etc., had been a long and troublesome operation, and was not then complete. Work was going on satisfactorily, all things considered, both at Rugby and at Ditton; and the system of doing at the latter place a considerable portion of the lighter class of repetition work, under the charge of a foreman, promised to work well, all non-standard work being dealt with at Rugby, together with the heavier work of all kinds, and all erecting and testing. Neither the foundry nor the boiler shop were yet at work. The former, as regarded the building, had been ready for some time; but, as castings could be obtained from other foundries without much difficulty, attention had been concentrated upon the machine shop and the other shops in connection with it. The boiler shop, which was commenced many months after the other buildings, was unready from the same cause which hindered the other shops for so long – the difficulty in obtaining structural steelwork from the contractors. The North-Western Railway had treated them very well, and there had scarcely been a break in their clerical work while removing the books, etc. They had presumed to call the new works the "Victoria Works," as that year was the sixtieth in Queen Victoria's reign. The appointment of additional directors was strongly urged at the last meeting. The Board had consulted some of the largest shareholders on the question, and they had found evidence of a widely-held opinion that the undertaking had now grown to a size which required a larger number of directors. They therefore thought it right to recommend an increase, and they also suggested the names of Lieutenant-General Sir Richard Sankey, who had had long and valuable experience in the conduct of public works in India, and again as chairman of the Irish Board of Works. Sir Richard Sankey was also one of their largest shareholders. The other gentleman they recommended was Mr. Thomas Orger Lazenby.

Captain F. J. B. Beckford seconded the adoption of the report, which was carried unanimously.

A dividend for the half-year at the rate of 6 per cent. on the preference shares and 7 per cent. on the ordinary shares having been declared, the members of the Board were re-elected, and Lieutenant-General Sir R. H. Sankey and Mr. T. O. Lazenby were appointed additional directors. Messrs. Cooper Bros. and Co. were re-elected auditors, and the proceedings closed with a vote of thanks to the chairman and directors.

ORIENTAL TELEPHONE AND ELECTRIC COMPANY, LIMITED.

Report of the directors for the year ended December 31, 1896, to be presented at the third ordinary general meeting of the Company, to be held at the Cannon-street Hotel, London, on Tuesday, April 27, 1897, at 3 30 p.m.:

The revenue account shows a balance to credit of £9,826 transferred to profit and loss, which, with £806. 3s. 3d. brought forward from 1895, and deducting £2,858. 8s., the amount of the interim dividend paid in October, leaves £7,773. 15s. 3d. for disposal. The directors recommend that this sum should be dealt with as follows: £5,716 16s. in payment of a final dividend of 8d. per share, free of income tax, making 5 per cent. for the year; £1,427. 5s. in part liquidation of the loss consequent on the compulsory expropriation of the Colombo exchange by the Ceylon Government; and to carry forward £629 14s. 3d. The revenues of the Indian companies show steady improvement. The accounts of the Bombay Company show a surplus of about Rs.30,000 after providing for dividend, but the directors of that company deemed it advisable to make no increase in the rate, feeling that the business of the Company might be somewhat affected during the current year, consequent on the dislocation of local trade by reason of the plague. The Telephone Company of Egypt has declared its usual dividend of 6 per cent. on its preferred shares, and the operations of the Company in that country are being extended. The China and Japan Company has paid its debenture interest, and is making progress. The Hongkong branch, which for many years showed unsatisfactory results, is now improving. The business in electric lighting which the directors had hoped ere this would have become profitable to the Company in India, has been much interfered with during the past year through the general retrenchment of expenditure owing to the severe famine and plague prevailing. Considering these adverse circumstances, the turn-over during the year has not been altogether unsatisfactory, giving hope that when the general trade of the country revives, this branch of the Company's business will become more than self-supporting. The directors feel convinced that a development of electric lighting, and the use of electricity as a motive power, must take place in the near future. The expenses written off in connection with this branch include outlays during the year at Bombay, Madras, and Rangoon, in addition to the expenses at the head office in Calcutta. It is hoped that this increased expenditure may be productive of good hereafter. Under Article 65, the retiring directors are Mr. Henry Grëwing and Mr. William Addison, both of whom, being eligible, offer themselves for re-election. The auditors, Messrs. Deloitte, Dever, Griffiths, and Co., also retire, and offer themselves for re-election.

NORWICH ELECTRICITY COMPANY.

The annual meeting of the shareholders of the Norwich Electricity Company, Limited, was held at Norwich last week. The Mayor presided.

The fifth annual report testified to a considerable increase in the number of consumers both for lighting and motive power, necessitating an addition to the generating plant and an extension of the premises in Duke-street. The cost of producing the current having diminished, the charge for current for lighting had been reduced by 12½ per cent., taking effect from January 1. The revenue account showed a credit balance of £5,869. 19s. 11d., from which must be deducted £780 for interest on debentures. The directors proposed to declare a dividend of 4½ per cent. free of income tax, amounting to £1,645. 18s. 11d., to place £2,500 to depreciation account, and to carry forward £944. 1s. In the general balance-sheet the capital expenditure shows £65,661.

The **Chairman** moved the adoption of the report, and said the Company had made a most gratifying advance. The income in 1895 was £5,845, while last year it was £9,470. The number of customers had risen from 450 to 675. The Company was now on an extremely firm basis.

Mr. Wild seconded, and said that the singular prosperity of the Company was due to the excellent management, scientifically and commercially.

Mr. H. S. Patteson moved the thanks of shareholders to the chairman and Board of directors with an honorarium of £500 free of income tax in acknowledgment of their services. The directors had had no remuneration except that a sum of 100 guineas was voted to the chairman for his exceptional services in establishing the Company on a firm basis.

The motion was agreed to, and acknowledged by the **Mayor**.

Mr. C. R. Gilman and Mr. R. J. Colman were re-elected directors, on the motion of **Mr. D. Steward**, seconded by **Mr. G. M. Chamberlin**.

Votes of thanks to other officers of the Company, and to the chairman, concluded the proceedings.

BOURNEMOUTH AND DISTRICT ELECTRIC SUPPLY COMPANY, LIMITED.

The sixth annual general meeting of this Company was held at the Company's offices at Bournemouth last week, the chairman, Mr. Aymor H. Sanderson, presiding.

In moving the adoption of the report and balance-sheet, the **Chairman** called attention to some of the principal items in the accounts, and afterwards referred to the progress made by the undertaking during the past year, and the directors' proposals for the immediate future. In remarking on various special items of expenditure, he said there could be no doubt that the whole of the money spent on capital account during the last year had been thoroughly well and judiciously expended, from which good results were already apparent. Turning to the revenue account, he said the total income for the year had been £8,243, as against £7,431 in the previous year, showing an increase of 15 per cent., which he hoped they would agree with him in thinking was very satisfactory, especially in view of the fact that their expenditure upon coal and other fuel had, at

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the same time, actually decreased by 11 per cent. The average price paid by their consumers during the last year worked out at only 6½d. per Board of Trade unit, and in several instances reached the low figure of 5¾d. per unit, a price which compared very favourably with the charge made by any station in the United Kingdom. The prospects of the Company for the present year were most encouraging: the equivalent of 542 additional 8-c.p. lamps had been connected since January, and 302 were awaiting connection. He had every confidence that the result of the present year's working would certainly equal, and in all probability far exceed, their anticipations.

Dr. Hooker seconded the motion and it was carried.

Mr. R. Percy Sellon was re-elected as a director and Mr. R. H. Marsh as auditor to the Company.

CONTRACTS FOR ELECTRICAL SUPPLIES

CONTRACTS OPEN.

Magdeburg.—Tenders will be received on May 1 by the city engineer (Herr Wirtz) for three electric cranes.

Brussels.—Tenders will be received on 28th inst. at the Brussels Bourse for work in connection with the installation of telegraphs at 70, Chaussée St. Pierre, at Etterbeck.

Dusseldorf.—Proposals will be received by the municipal authorities of Dusseldorf up to May 20 for the conversion of the horse tramways of Dusseldorf to electric traction.

Dieppe.—Tenders will be received on the 29th inst. at the Sous-Prefecture at Dieppe for furnishing and fitting the telegraph and post office. Applications should be made by the 24th inst.

Liege.—Tenders will be received by the Provincial Government of Liège on May 3 for the construction, maintenance, and working of an overhead electric tramway from Grivegnée (Bonne-Femme) to Chênée.

Arnay-le-Duc (France).—The municipal authorities of Arnay-le-Duc, in the Côte d'Or, have advertised that they are prepared to consider propositions for the electric lighting of the town. No date is specified.

Bucharest.—The Roumanian Government will want tenders on August 20 for the supply of 55,000 porcelain insulators (double bell), and other porcelain telegraphic fittings. Application should be made to the Direction of Posts and Telegraphs at Bucharest.

Dundee.—The Dundee Gas Commissioners are prepared to receive tenders for the supply of arc lamps, pillars and accessories, Lancashire boiler and fittings, high-speed steam-engine and dynamo, accumulator battery and switching gear. See advertisement.

Barcelona.—Applications will be received on June 8 at the Spanish Government Office of Works (Direccion General de Obras Publicas) at Madrid for a concession for electric railways or tramways between Barcelona and the neighbouring places. About £2,000 will have to be deposited by the undertakers as a guarantee.

Amsterdam.—The Consul-General of the South African Republic invites tenders for the supply of (1) insulators and (2) hard-drawn copper wire. Tenders which have not been received before 24th inst., Doelenstraat No. 8, at Amsterdam, will not be regarded. Specifications (in two tenders) will be procured on demand by Mr. F. J. Belinfaute, late A. D. Schinkel, Paveljoensgracht, The Hague, at the price of 1sh. each.

Belfast.—The Electric Committee are prepared to receive tenders for the supply and erection of plant. Specifications and conditions of contract may be obtained from the Electrical Engineer, Central Station, Chapel-lane, on payment of £1. 1s. per copy of each section, which sum will be refunded on the return of the specification with a bona fide tender. Full particulars appear in our advertisement columns.

Hull.—The Electric Lighting Committee invite tenders for the supply of South Yorkshire steam coal from May 1 to October 31, 1897, in accordance with the conditions set forth in the form of tender, which may be obtained at the Electric Light Station, Dagger-lane. The contractor will have to enter into the usual form of contract required by the Corporation. Tenders, endorsed "Tender for Coal," to be sent under seal to the Chairman of the Electric Lighting Committee, Town Hall, Hull, by noon on 29th inst.

Blackburn.—The Corporation require tenders for the erection of a new chimney, 150ft. high, at the electricity works, Jubilee-street. The specification, form of tender, and schedule of quantities may be obtained on the payment of £2. 2s. (returnable on receipt of a bona fide tender) at the office of Mr. E. M. Lacey, consulting engineer to the Corporation, 10, Delahay-street, Westminster. Sealed tenders, endorsed "Tender for Chimney," to be delivered to Mr. Robert E. Fox, town clerk, Town Hall, Blackburn, by noon on 24th inst.

Aberdeen.—The Corporation are prepared to receive tenders for the manufacture, delivery, and erection of an electrical storage battery, to consist of 125 cells of 400 ampere hours capacity, also for battery-regulating switches. Sealed tenders, addressed to the Town Clerk, Town House, Aberdeen, must be received by the first post on 27th inst., endorsed "Offer for Electrical Storage Battery" or "Offer for Battery-Regulating Switches," as the case may be. Specifications can be obtained, on payment of 10s., on application to Mr. Alfred Blackman, city electrical engineer, Cotton-street, Aberdeen, the amount to be refunded on receipt of a bona fide tender.

London, N.W.—The St. Pancras Vestry are prepared to receive tenders for the wiring and other works in connection with electric lighting of the Whitfield-street baths and wash-houses. Copies of the specification and conditions of contract can be obtained, and a plan of the general positions of the lights inspected, at the Electricity Department Offices, 57, Pratt-street, N.W., on payment of a deposit of £1, which will be returned on receipt of a bona fide tender. Tenders to be sent to Mr. C. H. F. Barrett, vestry clerk, Vestry Hall, Pancras-road, London, N.W., endorsed "Tender for Wiring Baths and Wash-houses," by 12 noon on 27th inst.

Blackburn.—The Corporation are prepared to receive tenders for the supply and erection of electric tramway equipment as follows: two steam dynamos, switchboard, instruments and connections, steam and exhaust pipes, valves, etc., posts and bracket arms, etc., overhead line equipment, underground cables, pilot wires, etc., section boxes, etc, railbonding, etc. Tenders, in conjunction with the above, are also invited for street-lighting—both arc and incandescent. The specifications and plans, with conditions and forms of tender, may be obtained at the offices of Mr. E. M. Lacey, the consulting engineer to the Corporation, 10, Delahay-street, Westminster, S.W., on payment of £7. 7s. for each copy, which sum will be refunded on the return of the specification filled up, with bona fide tenders. Tenders, sealed, and endorsed "Traction," to be delivered to Mr. Robert E. Fox, town clerk, Town Hall, Blackburn, on or before Saturday, May 8 next.

Valletta (Malta).—Sealed tenders will be received at the office of the Receiver-General and Director of Contracts, Valletta, until 11 a.m. on May 4 for supply, either separately or jointly, of any or all of the following: (1) a 200-kilowatt steam alternator; (2) a steam-engine, to drive directly the 200-kilowatt alternator; (3) a water-tube boiler and accessories, to evaporate 6,000lb. of water an hour at 150lb. of pressure from 60deg. F. Tenderers in England not having a representative in Malta are to deposit with the Crown Agents the sum of £200, to be forfeited in case of non-compliance with any of the provisions of this notice, or with any agreement consequent thereon. Tenderers in Malta are to deposit a similar sum at the office of the Director of Contracts. Tenderers are to undertake to deliver at Malta, on the wharf, to erect and to allow and cause to be tested all or any of the above before October 1, and to contract to pay, as liquidated damages, ½ per cent per diem on the contract price for each day of delay up to final completion. Tenderers are also to state the earliest date on which they can deliver on the wharf at Malta, and the abatement in the price tendered, which they would be willing to allow in case the Government of Malta undertakes to erect the plant at the expense of the Government. Particulars, specifications, etc, may be obtained on application to the Superintendent of Public Works in Malta, or to the Crown Agents for the Colonies, Downing-street, London.

RESULTS OF TENDERS.

Dresden.—The lowest tenders for telegraphic material (wire) for the Saxon State Railways at Dresden, on March 10, were from Felten and Guilleaume.

Yarmouth.—The Town Council have accepted the tender of Messrs. Allen, of Bedford, for the condensing plant at the electric light works at £1.151. This was the lowest tender.

Newington, S.E.—The Vestry have accepted the tender of Messrs Sharpe and Piper, amounting to £1,750, for an electric lighting installation at the baths, including wiring, lamps, and all necessary fittings.

Brighton—The Town Council have accepted the tender of Messrs. Babcock and Wilcox, Limited, to supply and fix three water-tube boilers at the Corporation electricity works for the sum of £3,100. They have also accepted the tender of the Fowler-Waring Cables Company for the supply of electric cable and jointing sundries for the year ending April 30, 1898.

London, N.—For the erection of new workshops at Ponders End, Middlesex, for the Edison and Swan United Electric Light Company, Limited, the following tenders have been received:

T. Almond and Son	£3,982
Stimpson and Co.	3,900
Perry and Co.	3,888
W. Gregar and Son	3,737
Fairhead and Son	3,548
W. Cooper	3,399
E. W. Newman (accepted)	3,397

Portsmouth.—The Corporation have received tenders from the firms named for: (*a*) supply and erection of three motor-generators and switchboard arrangements; (*b*) a battery of accumulators, with stands:

Motor-generators, etc.	
Easton, Anderson, and Goolden, Limited (accepted).	£1,888 15 0
Ferranti, Limited	2,595 0 0
Electric Construction Company, Limited	3,304 0 0
British Thomson-Houston Company, Limited	2,097 14 0
Crompton and Co., Limited	4,250 0 0
Accumulators.	
A. B. Pescatore (accepted)	4,200 0 0
Chloride Electrical Storage Company, Limited	4,250 0 0
Lithanode Electric Storage Company, Limited	4,834 13 0
Electrical Power Storage Company, Limited	5,022 0 0
Epstein Electric Accumulator Storage Company, Limited	5,220 0 0
I. E. S. Accumulator Storage Company, Limited	4,638 0 0
Pritchetts and Gold	4,066 0 0

Ashton.—The Town Council have accepted the following tenders: Horsfall Furnace Syndicate, Limited, Leeds, for

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Section "A," refuse destructors; Oldham Boiler Works Company, Limited, Oldham, for Section "B," boiler-house plant; P. R. Jackson and Co., Limited, Manchester, for Section "C," economiser, tanks, pumps, steam and exhaust pipes, etc., for Section "D," steam dynamos, motor-generator, balancing transformer; Dorman and Smith, Salford, for Section "E," switchboard; British Insulated Wire Company, Prescot, for Section "F," part 1, underground mains, junction boxes; Pritchetts and Gold, London, for Section "G," accumulators; Taylor and Hubbard, Leicester, for Section "H," overhead crane; Verity, Limited, Manchester, for Section "J," station wiring; Chamberlain and Hookham, Birmingham, for Section "K," meters; Edward Wood, Manchester, for iron roof. The tender of the British Insulated Wire Company, Prescot, for Section "F," part 2, arc lamps and columns, was accepted.

Plymouth.—The following were the tenders received and considered by the Town Council at the adjourned meeting on April 14:

Contract No. 1.—Steam alternators, dynamos, etc.

Crompton and Co., Limited	£11,783	0	0
Siemens Bros. and Co., Limited	12 750	0	0
Brush Electrical Engineering Company, Limited	12,979	7	0
S. Z. de Ferranti, Limited (accepted)*	13,401	14	0

* Includes racking gear for field magnets, etc.

Contract No. 2.—Boilers, piping, pumps, etc.

J. Musgrave and Sons, Limited (accepted)	7.757	0	0
Hick, Hargreaves, and Co., Limited	7,995	0	0
A. Anderton and Co.	8,504	12	2
D. Adamson and Co.	9,356	10	0

Contract No. 3.—Accumulators.

Pritchetts and Gold	1,377	0	0
A. B. Pescatore (accepted)	1,554	12	0
Chloride Electric Storage Company	1,620	0	0
I. E. S. Accumulator Company, Limited	1,992	17	0
E P. Storage Company, Limited	2,271	11	0
Epstein Accumulator Company, Limited	2,409	5	5

Maintenance for 10 years, at per annum.

Pritchetts and Gold	72	0	0
A. B. Pescatore (accepted)	75	0	0
Chloride Electric Storage Company	140	0	0
I. E. S. Accumulator Company, Limited	175	10	0
E. P. Storage Company, Limited	150	0	0
Epstein Accumulator Company, Limited	169	13	0

Contract No. 4.—Crane, etc.

Taylor and Hubbard (accepted)	438	0	0
Littlejohn and Service	467	0	0
Willcocks and Sons	472	0	0
Bedford Engineering Company	485	0	0
Carrick and Ritchie	580	0	0
Ransomes and Rapier	690	0	0

Contract No. 5.—Switchboards, etc.

Edison and Swan Company, Limited (alternative design)	1,505	0	0
S. Z. de Ferranti, Limited (accepted)	1,572	0	0

Contract No. 6.—Cables, etc.

Fowler-Waring Cables Company, Limited	6,034	10	0
W. T. Glover and Co.	6,820	0	10
British Insulated Wire Company, Limited (accepted)	6,963	10	5
Callender Company, Limited	7,407	16	0
W. T. Henley and Co, Limited	7,552	18	9
Siemens Bros. and Co., Limited	7,586	0	0

Contract No. 8.—Transformers, etc.

Edison and Swan Company, Limited (accepted)	964	12	0
Johnson and Phillips	1,037	16	0
Crompton and Co., Limited	1,053	0	0
Siemens Bros. and Co., Limited	1,065	0	0
Brush Electrical Engineering Company, Limited	1,127	5	0
J. Fowler and Co. (Leeds), Limited	1,143	0	0
Electric Construction Company, Limited	1,302	0	0
S. Z. de Ferranti, Limited	1,508	18	0

Contract No. 9.—Arc lamps, etc.

Crompton and Co., Limited (accepted)	2,380	2	0
Brush Electrical Engineering Company, Limited	2,512	10	0
General Electric Company, Limited	2,539	18	6
Brockie-Pell Arc Lamp, Limited	2,703	6	8
Johnson and Phillips	2,780	5	6
Siemens Bros. and Co., Limited	2,832	10	0
Davy Electrical Company, Limited	2,936	5	11

BUSINESS NOTES.

Western and Brazilian Telegraph Company.—For the past week the receipts were £1,951.

Blackburn Tramways.—The time for sending in tenders for the supply and erection of electric tramway equipment has been extended to May 8.

Halifax.—The Town Council have decided to adopt the overhead system of electric traction for the Halifax tramways, the Gasworks Committee to provide all the plant.

Dublin Tramways.—The electric cars of the District Tramways Company will run between Haddington-road and Dalkey every six minutes, and, by permission of the Board of Trade, at an increased speed.

Ramsgate.—At the meeting of the Town Council the town clerk was instructed to oppose that portion of the electric railway scheme relating to the front part of the town, from West Cliff to Bellevue-road.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended April 18 amounted to £1,478, as compared with £1,151 in the corresponding week of the previous year, being an increase of £327.

Edinburgh.—The provisional estimates of the Electric Lighting Committee for the year amount to £19,730, as compared with an estimate of £10,730 last year. The receipts are estimated at £33,050, as against £23,850 last year.

Telegraph Extension.—Telegraphic communication between Iona and the mainland was opened on Wednesday. The first message sent was to her Majesty, in the name of the inhabitants, congratulating her on her record reign.

Bristol Tramways and Carriage Company, Limited.—The traffic returns for the week ended April 16 were £2,219. 7s. 7d., compared with £1,931. 4s. 11d. for the corresponding period of last year, being an increase of £288. 2s. 8d.

Walsall.—It was reported at the Town Council meeting that the total number of consumers supplied on March 31 last was 79. The net income for the month was £135. 2s. The wages paid during the month amounted to £44. The value of coal consumed was £18.

Leadgate.—At the District Council meeting the Gas Committee recommended that the neighbouring urban district councils interested in the lighting of the district by electric light be invited to hold a conference to go into the matter. This was agreed to.

Tramway Exhibition.—A "tramway technical exhibition" is to be held in Hamburg from August 5 to 9 under the auspices of the Verein Deutscher Strassenbahn und Kleinbahnverwaltungen. This society announces a general meeting to be held at the exhibition on August 6 and 7.

Stockport.—The Tradesmen's Association are pushing forward the electric lighting question, and at their last quarterly meeting they passed a resolution calling upon the Gas Committee of the Corporation to lose no time in the matter, and appointed a deputation to wait upon the committee.

City and South London Railway.—The returns for the week ended April 18 were £845 compared with £921 for the corresponding period of last year, being a decrease of £76. The total receipts for the half-year 1897 were £16,684, compared with £15,260 last year, being an increase of £1,424.

Dublin.—A special meeting of the Dublin Corporation was fixed to take place a few days ago to consider the schemes of the Dublin United Tramways Company and the Dublin and Lucan Steam Tramway Company. The Lord Mayor presided, but a quorum could not be obtained, so no business was transacted.

Appointment Vacant.—The Vestry of the parish of St. Mary, Battersea, require the services of a practical engineer to run the electric light installation at the municipal buildings and town hall; wages, £2. 10s. per week. Also a stoker, to assist the engineer; wages, £1. 12s. per week. See advertisement.

Dundee.—A conference has taken place between several residents in the North End and the directors of the tramway company on the subject of the proposed extension of the trams. Electricity is suggested as the motive power at a cost of about £8,000, and the matter is to be brought under the notice of the Town Council.

The Brussels Exhibition.—The official opening of the Brussels Exhibition was postponed by order of the executive committee, owing to the impossibility of completing the triumphal arch before the 24th and to their reluctance to associate the presence of his Majesty with a structure which presents the appearance of a collection of scaffolding.

Para Rubber Syndicate, Limited.—This Company has been registered, with a capital of £10,000 in £10 shares, to prospect, examine, and explore any territories and places in South America or elsewhere, and to carry on the business of indiarubber planters, growers, exporters, manufacturers, and merchants. Registered office: 89, Farringdon-street, E C.

Huddersfield.—The minutes of the Electric Lighting Committee which were adopted at the Town Council meeting showed that in the units metered as compared with March last year there had been an increase of 36 per cent. The increase of consumers from March to April was 17, while 30,779 lamps were connected in March, 31,902 were connected in April.

A New Electricity Company.—The prospectus of Edmundsons' Electricity Corporation, Limited, has been issued to the public for the purpose of extending the business of Edmundsons, Limited. The primary object is to carry out contracts for central-station lighting in Folkestone, Winchester, Salisbury, and Ventnor. The capital will be £200,000.

Harrow.—The surveyor submitted a notice at the Urban District Council meeting from the Harrow Electric Light and Power Company to the effect that they intended extending their mains down South-hill-avenue and along Mount-park-road. With regard to the company's extension at the other end of the district, the surveyor reported a great improvement in the footway by the reinstatement.

Tramways in Japan.—It is stated that in Japan the following street railways are to be constructed to complete organisation with

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an aggregate capital of something like £700,000 : the Fushimi electric railway, a line 28½ miles long, running from Fushimi to Nishinomiya ; another line, 5½ miles long, between Inamimachi and Demachi ; the Tokio circuit tramway, a line 44½ miles long, in Tokio. All these lines will require materials and rolling-stock.

Yarmouth.—It was reported at the Town Council meeting that seven more customers had been obtained for 286 lamps, making the total 215 customers for 10,565 lamps. The income for March was £255. 16s. 8d., and the expenditure £194. 11s. 11d., leaving a balance of £61. 4s. 9d. to meet capital and other charges of £150 per month. Two arc lamps were ordered for the North-parade at a cost of £120, the Council to be charged £16 per lamp per annum.

Royal Electric Company of Montreal.—During the convention of the Federated Canadian Mining Institute at Montreal last month the new factory and generating station of the Royal Electric Company were inspected by some hundreds of visitors on the invitation of the company. The president, the Hon. J. R. Thibaudeau, introduced the general manager, Mr. Wm. H. Browne, who made a speech giving a history of the Company from its start in 1884.

Notice of Dissolution.—We are informed that the partnership which existed between Mr. H. D. Parmiter and Mr. M. H. Barber, A.I.E.E., was dissolved by mutual consent on April 7. Mr. Parmiter retired on that date, and Mr. Barber now carries on the business at 10, Corporation-street, Manchester, as sole proprietor under the title of Donnison, Barber, and Co., and receives and pays all the debts due to and owing by the firm of Donnison, Parmiter, and Barber.

Nantwich.—The minutes of the Sanitary and Lighting Committee were read and confirmed at the Urban District Council meeting. They included a letter from Messrs. Edmundsons, Limited, with reference to the electric lighting of the town. It was decided to write and inform Messrs. Edmundsons that the matter was still under the consideration of the Council, but before deciding anything they had arranged for an interview with the company's representative.

Exeter.—The Electric Light Committee reported at the City Council meeting that notice had been given to the gas company to determine the present contract for street-lighting, and they recommended that as the whole of the main streets from Exe Bridge to St. Anne's Chapel, and the heads of the cross-streets and Queen-street to the Obelisk, can be lighted by electricity with the present plant, this area be exempted from any rearrangement with the gas company. The report was adopted.

Indo-European Telegraph Company, Limited.—The report for 1896 states that the revenue from all sources amounted to £123,540 as compared with £123,735 for 1895. The expenses were : on commercial and general account, £35,363 ; on maintenance account, £32,743 ; showing an increase of £285. A sum of £10,000 has been placed to reserve, and the directors propose a dividend for the six months ended December 31 of 17s. 6d. per share and a bonus of £20s. per share, both tax free, making in all 10 per cent. for the year, carrying forward £7,704.

South Shields.—The electric light is going on prosperously. It is not so long since a sum of £12,000 was granted for this purpose, and it is fully expected that by the advent of another winter the town will not only be thoroughly well lighted, but will have its electric light works in a self-supporting condition. Another £12,000 has just been granted, which brings the capital expenditure for electric lighting purposes up to £60,000. There has been a great demand for the light, and next winter it is confidently anticipated that there will be a still greater increase of consumers.

Collision on the Liverpool Overhead Railway.—An accident, fortunately unattended with serious results, took place a few days ago in the Dingle tunnel of the Liverpool Overhead Railway. A passenger train had just left Dingle Station and was crossing the points to get on to the main line, when it collided with an empty train coming into the station and which over-ran the points. The two carriages that sustained the impact were damaged, and two passengers complained of being slightly hurt. The empty train was partially shot off the line, and the traffic was blocked for about half an hour.

Taunton.—The Town Council at their last meeting considered a letter from Messrs. Reed and Cook, solicitors, asking for the co-operation of the Council in a scheme for the promotion of an electric tramway company in the town. The Mayor suggested that the letter be referred to a joint committee of the Electric Lighting and Streets and Highways Committees for consideration and report, and this was agreed to. The Electric Lighting Committee presented the agreement with the Electric Lighting Extension Syndicate for the introduction of the penny-in-the-slot system into Taunton.

Electric Lighting of Reigate, Dorking, and Barking.—The Board of Trade have decided to grant provisional orders to the Reigate Corporation and the Urban District Council of Dorking empowering them to supply electricity within the area of their respective jurisdiction. For this purpose the Reigate Corporation are empowered to spend £15,000 and the District Council of Dorking £10,000. The Board have also granted an electric lighting order to the Barking Town Urban District Council, who are authorised to expend £15,000. These provisional orders will require confirmation by Parliament before they become operative.

Canton (Waipori) Mining and Electric Power Company, Limited.—This Company has been registered, with a capital of £150,000 in £1 shares, to purchase certain mining properties, claims, and water rights at Waipori, in the colony of New Zealand, to develop, deal with, and turn to account the same in such manner as the Company shall see fit ; also as electricians, mechanical engineers, suppliers of electricity for the purposes of light, heat, and motive power, and to manufacture and deal in cables, wires, lines, accumulators, lamps, machinery, appliances, etc., relating to the above.

West Coast of America Telegraph Company, Limited.—Notice has been given that the West Coast of America Telegraph Company Limited, will on April 30, at their offices in Winchester House, deliver scrip representing first mortgage debentures of that Company, in accordance with the terms of an agreement, in exchange for debentures of an equal nominal amount of the West Coast of America Telegraph Company, Limited, in liquidation, or pay to the holders of the said debentures the principal due on April 30 Debentures of the Company in liquidation are to be lodged three days for examination.

A Very Long Electric Line.—The Railroad Committee of the New Hampshire State Legislature (U.S.A.) has been considering Bills to incorporate the Manchester, Chester, and Haverhill Street Railway, the Nashua, Salem, and Haverhill Street Railway, Nashua, Manchester, and Concord Electric Railroad Company, and the Merrimac Valley and St. Lawrence Street Railway. These Bills cover the scheme to establish a continuous line of electrical railway from the Massachusetts boundary on the south to the Canada line on the north. The scheme is opposed by several influential tramway companies.

Bristol.—An inquest was opened this week at the General Hospital by Mr. H. G. Doggett, coroner, on the body of John Reynolds, who died from injuries received through an accident which took place recently at the electric light works, and which had already involved the death of another man. The inquest on the body of the latter had been opened and adjourned in order that, if the other injured man, Reynolds, should die, the two fatalities might be made the subject of one enquiry. Mr. W. J. Robinson (Messrs. Wansbrough, Dickinson, Robinson, and Tayler) appeared for relatives of the deceased. Evidence of identification and medical evidence having been taken, the inquest was adjourned.

Surbiton.—The Highway Committee reported at the District Council meeting as follows : "We have received application from the Electric Lighting Committee of the borough of Kingston, asking whether the Council would be prepared to enter into an agreement with regard to the electric lighting of the Cranes Park-road and Lingfield-avenue on terms similar to those contained in the agreement of December 14, 1896, made between the Council and the Corporation with regard to the lighting of the assembly-rooms. We recommend the Council to remind the Corporation that the arrangement as to the assembly-rooms was of an exceptional character, and that the Council is not prepared to entertain the present proposal." The report was adopted.

Islington.—At the meeting of the Vestry to be held to-day (Friday) a report from the Electric Lighting Committee will be received stating that they have considered the desirability of revising the present scale of charges for the supply of electricity to private consumers, and that they have resolved to adopt the following scale on and after October 1 next—viz. : for an average of one hour's consumption or under per day during the quarter of the maximum number of lamps alight at any one time, 7d. per unit ; for an average of two hours per day, 7d. per unit for the first hour and 6d. per unit for the second hour ; for an average of three hours per day or more, 7d. per unit for the first hour, 6d. per unit for the second hour, and 4d. per unit for the remainder.

Beckenham.—A letter was read at the Urban District Council meeting from Messrs. Muirhead and Co. enquiring whether the Council were prepared to treat for the transfer to them of the electric lighting order. The Clerk said that at the next meeting of the Council he proposed to suggest that the Electric Lighting Committee should be reappointed to go into the electric lighting question, and therefore it would be better that Messrs. Muirhead's letter be deferred. Mr. Harbert moved that the letter should lie on the table, but this was not seconded. Mr. C. E. Baker reminded Mr. Harbert that the Council had spent considerable money to obtain the necessary powers for electric lighting, and he moved what the clerk had suggested. Mr. Cole seconded, and the proposition was carried.

Stoke-on-Trent.—At the meeting of the Town Council a discussion took place with respect to the erection of poles in the streets by the Electric Traction Company in connection with the electrical equipment of the tramways. Mr. Massey complained that in Church-street a pole had been set back in front of business premises to an inconvenient position. Alderman Marks explained that in sinking the original hole some pipes were met with, and it was to save considerable expense that the pole was set back. It was moved by Mr. Robinson, seconded by Mr. Massey, and agreed to, that the company be called upon to remove the pole and erect it in a proper position. The Council approved plans for the erection of an electricity generating station in connection with the tramways in Woodhouse-street.

Witham.—Mr. J. A. Kuner, electrical engineer, of Witham, has had so many applications for the electric light that, although he has a new engine fixed capable of supplying 100 lights, he cannot meet the demands until more power is added. It has therefore been decided to form a limited company for carrying out the supplying of the electric light in any part of the town. The proposed capital is £1,000. The shares have all been guaranteed to be taken up privately. A meeting will very soon be called and arrangements made to apply to the Board of Trade for a provisional order, which will give the company the sole right of supplying the electric light in the town and also the right to put down

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the mains on the highway. Mr. Kuner will be the working manager and secretary for the company.

Lee.—At a meeting of the District Board a letter was read from the Blackheath and Greenwich Electric Lighting Company, in which they agreed to assent to the terms asked by the Lewisham Board before that body would cease to oppose the company's application for a provisional order. The terms, which would be enjoyed by the other parishes concerned—Lee and Greenwich—were the amending of the purchase clause so that each parish should have the right to purchase that part of the undertaking in its district at 12 months' notice, and, in case of such purchase, that instead of making the dividends for a series of years up to an average of 5 per cent. if the dividends paid had not reached that average, only one payment of 5 per cent. would be required. The company further agreed to allow a discount of 10 per cent. on the lighting of all public lamps.

Eastern Extension, Australasia, and China Telegraph Company.—The report for the half-year ended December 31, 1896, states that the gross receipts, including Government subsidies, amounted to £325,405, against £311,582. The working and other expenses absorb £106,270, against £84,044, leaving a balance of £219,135 and a net profit of £173,062, which, with £33,235 brought forward, shows an available balance of £206,298. One quarterly interim dividend of 1¼ per cent. has been paid for the half-year, and it is now proposed to distribute another of like amount, making a total dividend of 5 per cent. It is also proposed to pay a bonus of 4s. per share, or 2 per cent., making a total distribution of 7 per cent. for the year 1896, leaving £93,798, of which £75,000 has been transferred to the general reserve fund, and the balance of £18,798 is carried forward.

B. C Electric.—Under the title of the British Columbia Electric Railway Company, Limited, a company has been registered by H. Malcolm Hubbard, 1 and 2, Great Winchester-street, E C., with a capital of £250,000 in £10 shares, to carry into effect agreements made between the Yorkshire Guarantee and Securities Corporation, Limited, and the Colonial Railway and General Investment Company, Limited, to equip and work by electricity or other power rail and tram roads, to construct and maintain telegraph and telephone systems, and to acquire patents and inventions, etc. The first directors are F. S. Barnard, Horne Payne, R. M. H. Payne, A. C. Mitchell-Innes, R. N. Laurie, G. P. Norton, and R. S. Sperling, with a qualification of £500 and remuneration of £1,000 per annum and a share in profits divisible. The registered office is 1 and 2, Great Winchester-street, E.C.

Manchester.—The National Telephone Company have now completed their system of underground wiring in the city. It is claimed by the company that, as a consequence of the abolition of the overhead wires, the appearance of the city is greatly improved. The following motion was carried at the City Council meeting in reference to the memorial for the proposed new telephone company: "In compliance with the requirements of the Treasury minute referred to in the memorial now read, this Council expresses its approval of the objects of the proposed company, subject to all terms and conditions being hereafter arranged to the satisfaction of the Corporation, and reserving to the Corporation the status to communicate with and appear before the Postmaster-General or other Government authority in reference to the subject, and as to the conditions of any license affecting the city of Manchester."

Cheltenham.—Alderman Norman introduced the minutes of the Lighting Committee at the Town Council meeting, and entered into an account of the proposed electric lighting in Bath-road, Winchcombe-street, and Leamington-place. He produced the design for the arch over the Pittville Gates. At the end of the quarter they had 9,650 lamps wired as compared with 7,500 last quarter, and 114 customers as compared with 127. They had also applications for about 1,000 more lamps. The receipts for the past quarter had not been quite so large as anticipated, but at the end of the year the receipts a little more than covered their working expenses. Mr. Margrett, as one who had previously criticised the doings of the Electric Lighting Committee, publicly acknowledged that for street-lighting electricity was preferable to gas, and that the system in Cheltenham favourably compared with those in other towns he had visited. The minutes were confirmed.

Glasgow.—In the minutes of the special committee as to the constitution of the new Electric Lighting Committee, the following 17 names were submitted to form the committee—viz., Bailies Cleland and Fife, River-Bailie Anderson, and Councillors Finlay, Graham, Guthrie, Kerr, Maclay, R. M. Mitchell, Paton, Paterson, Primrose, Sorley, D. M. Stevenson, P. G. Stewart. Wallace, and James Willock. At the meeting of the Council Mr. Maclay moved the approval of the minutes, and Mr. R. M. Mitchell seconded. The Lord Provost moved that Mr. Maclay, who had been convener of the sub-committee on gas, should be the convener of the Electric Lighting Committee. This was seconded by Bailie Chisholm and agreed to. Mr. Shaw Maxwell complained that the representatives of the city eastwards from the High-street had been omitted. Mr. Gray also complained that no representatives of the north-west district had been included, and moved that the minute be sent back for further consideration. Mr. Cunningham seconded the amendment. On a division, the amendment was carried by 24 to 22 votes.

Torquay.—At the annual meeting of the Ratepayers' Association a discussion took place on the electric tram question. Mr. W. Beavis said the proposed tramline would be destructive of the refined character of Torquay as a health resort. The line would make it easy for people to live at Cockington and yet have all the advantages of Torquay. He did not see why half the road should be given up to this philanthropic company. Mr. Shrubb entirely agreed with Mr. Beavis. The large number of cabmen would be seriously affected by such a line, which would also be a disadvantage to cyclists. He feared the line would result in Torquay people shopping at Paignton. Mr. Sloman remarked that the question was still *sub judice*. Therefore members of the Council at present should say nothing publicly about it. Unfortunately the association had the reputation of opposing everything. Tor was not directly concerned in the matter; therefore they should say nothing about it. Mr. W. S. Thomas suggested an adjournment. Mr. Tripe was in favour of the scheme. He should like a cheap ride occasionally. Mr. Beavis denied that the affair was in any way *sub judice* Councillors were perfectly justified in giving their opinion concerning the scheme. The further discussion was adjourned.

Belfast.—A special meeting of the Corporation has been held to receive the following report of the Electric Committee: "Your committee have approved of plans, specifications, and estimates prepared by their engineer for the proposed new installation, and they recommend the Council to authorise an application being made to the Local Government Board for their sanction to the Council's raising of a sum not exceeding £65,000 for the first section of the undertaking. The committee are most anxious that no time should be lost, and that they may be in a position to supply current next winter; and with this object they purpose laying down a small portion of the plant as soon as the makers can supply it, and in the meantime pushing on with the erection of the station buildings and the laying of the mains." Councillor Andrews moved the adoption of the report. He informed the meeting that the approximate cost of the additional mains and plant was £50,270, and of the buildings to accommodate this machinery £15,000, bringing the total up to £65,270, and the committee considered that the sum they asked for permission to raise would be sufficient to meet the requirements of electric lighting—for the next two years, at any rate. Councillor Jaffe seconded the motion, and it was carried.

Cardiff.—The Special Electric Tramways Committee appointed by the Corporation reported to a recent meeting of that body the routes upon which they thought it desirable that lines should be laid. These routes included (1) from the docks, *viâ* Corporation-road, Clare-road, and Lower Cathedral-road, to the top of Cathedral-road, with branches from Clare-street through Neville-street to the workhouse, and from the southern end of Clare-road through Tudor-road and Wood-street to St. Mary-street; (2) from Queen-street up Park-place, to the top end of Colum-road, which is an extension of the first-named street; (3) from Fairoak-road, through Ninian-road, Albany-road, Castle-road, Glossop-road, and then, turning eastward, over Splott Bridge, and terminating at the lower end of Portmanmoor-road, less than a mile from the proposed low-water pier. Provided the boundaries of the borough are extended as proposed, it is intended to lay down lines to Penarth; from the top of Cathedral-road to Llandaff; from the northern end of Colum-road to Whitchurch from Crwys-road, to that village; from Ninian-road to the northern boundary of Roath Park. At the Council meeting it was suggested that a circular route be adopted, but, on the motion of Alderman Jacobs, it was resolved that the original scheme be adhered to, and the Council was recommended to apply for a provisional order next session to carry out the work.

Poplar.—At the meeting of the District Board of Works Mr. Valentine moved, in accordance with notice of motion, "That expenses be allowed to the Electric Lighting Committee." He advocated this in order that they might obtain fuller information than they now possessed, with a view to possibly recommending the Board to lay down its own plant. Mr. Bussey seconded, believing that there was an immense amount of data to be gathered which would be for the benefit of the Board, but which they were not at present in possession of. Mr. Stephens argued that it was useless for members to go on a roving commission to acquire information on such a subject. He thought it might be very safely left to the committee to come up to the Board in the event of any expense having to be incurred, and get permission without passing a formal resolution. He failed to see that any good would be accomplished by the passing of the motion. Mr. R. Newman was of opinion that as the matter was so technical it would be far better for the clerk to write to the districts where the electric light was being used than for a committee to go wandering about in quest of information. He was quite sure the result of their wanderings would be next to nothing, if anything at all. Mr. Dalton thought it would be better, if advice must be had, to get it from experienced men than by sending a number of amateurs round the country. It would be better to engage Mr. Stephens to make enquiries and report, as he was a practical engineer; but as to what was proposed, he would vote against it, as he had a recollection of what had taken place with these committees in times gone by. Mr. Valentine said his idea was to get practical information, even if it had to be paid for; he did not say it would be necessary to incur expense, but if it was, then the committee would be able to do so if it would help them in their deliberations. Several members appealed to Mr. Valentine to withdraw the motion, and he consented.

Southampton.—The Electric Lighting Committee reported at the Town Council meeting that the deputy-chairman had arranged with Mr. Manville for the foundations of the chimney shaft for the works to be continued for a further depth of 18in., and the action of the deputy-chairman was confirmed. The Engineer reported that the number of units sold during February was 14,190, being

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an increase of 3,070 compared with the output of February, 1896. As to supplying electric light to the Ordnance Survey Office, Mr. Manville reported that he had ascertained there were at present fitted up at the Ordnance Office 150 8-c.p. lamps, and machinery for working same, and that the Office of Works proposed to extend this number by 450 of 8 c.p., and it was for this latter number of lamps they proposed to take current from the supply mains, the question of discontinuing the use of the present plant for the other 150 lamps not having yet been considered; that under the sliding scale adopted by the committee they would burn these lamps less than two hours per day, and would therefore get no reduction on the highest price of 6d. per unit, and if they burnt them for three hours per day the price would be 5½d. The town clerk was instructed to communicate with the surveyor of the Board of Works, and inform him of the foregoing prices, and that the committee could not legally supply the Ordnance Survey Office with electric light at a preferential rate, but that when the station was thoroughly established and running at a profit, possibly the Corporation would be in a position to reduce the price to all their customers below the figure referred to in Mr. Manville's report. The secretary, Electrical Standardising, Testing, and Training Institution wrote enquiring if improvers would be received at the electric light works, in which case a premium at the rate of £50 per annum would be paid quarterly for each improver so drafted, and the committee recommended the Council to receive one improver at the electric light works in accordance with the terms submitted by the institution. The resident engineer reported the receipt of an application from the Telephone Company to supply current for the equivalent of 16 8-c.p. lamps The distance of their premises from the main was about 155 yards. No light would be used after 8 p.m., and the company were not prepared to pay any portion of the cost of the service; for these reasons he recommended that the application be refused, and this recommendation was adopted. The report was approved.

Plymouth.—At the meeting of the Borough Council the minutes of the Electric Lighting Committee came up for confirmation. The committee recommended the acceptance of various tenders for plant, of which a full list is given in another column. Mr. Willoughby said the only question which might challenge discussion was with reference to the acceptance of some tenders which were not the lowest received. They had had a very fair object lesson that afternoon in the matter of town refuse as to the inadvisability sometimes of accepting the lowest tender. In fact, the greater part of the afternoon had been wasted in consequence. If the Electric Lighting Committee accepted the lowest tender it was quite possible that they might have trouble hereafter, though he did not say they would. The committee had made a very careful examination of the drawings submitted by the various parties who had tendered for the work, and they came to the conclusion, against their will, that they must recommend the Council to accept the highest tender. They had compared one set after another of the drawings, and saw it was no use to come to the Council and say accept the lowest, or any other tender except Ferranti's. In every case except Ferranti's alternator, to clean the machinery they would have had to remove the steam-pipes and several heavy pieces of machinery by means of cranes. On the other hand, Ferranti fixed his machinery in the most complete manner. When a man wanted to clean the armature he would simply have to turn a wheel and it would bring the parts away from one another, the heavy portions of machinery would withdraw, and he would be able to get at it at once. In many other matters of detail the Ferranti machinery was also far better, and it was impossible not to come to the conclusion that the Ferranti tender was the best. They could not afford to lay down expensive electrical machinery with the idea of the light being at any time in possible danger of going out. The committee came to the conclusion that if they had to pay a great deal more than the difference between the lowest tender and Ferranti's, they should pay it. Then with regard to the provision of accumulators, they had consulted the electrical engineer, and decided not to accept the lowest, but the next tender. The accumulator was of known and tried worth, and they must have the best. With regard to switchboards they had accepted the highest tender, by Ferranti, because the system was very much less complicated and had proved the best. That only meant a difference, moreover, of less than £70. The same applied to underground cables. They had accepted the third lowest tender of £6,963, against a lowest of £6,034. On the whole he appealed to the Council to accept the recommendation of the committee. The Council had gone to no inconsiderable expense in order to get the very best possible information with reference to the municipal electric lighting station and its fittings, and he did not hesitate to say they had as good an engineer as could be desired, and to lay out £50,000 involved no small responsibility. The committee, which had so carefully watched over the interests of the Council so far, when they advised them in this matter, had no interests whatever of their own to serve in any way. He saw no reason why he should not say that they had got as intelligent and smart a committee as could be picked up in any council in England. They had no axe to grind in advising any special maker: they were all ratepayers. If the Council, therefore, were to object to that proposition, then they superseded the engineer and the committee, and took the responsibility upon themselves. What was it all for?—a matter of £2,000 or £3,000 on a capital expenditure of £35,029. There was no hardship to the tendering firms, for they advertised that they were not bound to accept the lowest tender. He would not advert to the ungenerous remarks that had been made, suggesting that he and two or three other gentlemen had conspired together to hoodwink the Council. It was too absurd for him to proceed further in the matter. Mr. Stanbury seconded, and the report was adopted unanimously.

Sheffield.—At the meeting of the City Council the Parliamentary Committee recommended the Council to put in force the powers reserved to the Corporation for the purchase of the undertaking of the Sheffield Electric Light and Power Company, and to give notice forthwith for the purchase. Mr. H. W. Chambers (chairman of the Parliamentary Committee) moved the adoption of this minute. He said the matter became pressing on account of the resolution of the electric light company to largely increase their capital. It had been stated in the newspapers and elsewhere that the Corporation were somewhat to blame for letting the opportunity slip by in the first instance when the company first undertook the work. With regard to that action, he was one of those on the Parliamentary Committee who opposed the starting of electric lighting by the town, and he should do it again under the same circumstances. He held that when it was proposed to start a new undertaking, and when it was more or less a matter of speculation as to whether the undertaking would succeed or not, it was no part of the duty of the Corporation to risk the money of the ratepayers in a trading speculation. He should therefore again do as was done in that case, and let private individuals risk their money for the purpose of their own profit. But, although he might see something wrong in the Council risking the ratepayers' money in a speculation of that kind, he saw nothing wrong in providing that, in case that speculation turned out satisfactory and was conducted to a successful issue, the Corporation should have power to take over that undertaking when it had been made a success. It followed that private individuals having risked their money, the Corporation should, on purchase, recoup those individuals and give them a fair amount of profit. With regard to the terms upon which this undertaking was to be purchased, he took it that they were fair. They were accepted by both sides. The terms of purchase were—he believed he was speaking correctly—to a great extent formulated by Alderman Franklin, chairman of the company. They might, therefore, take it that these terms were fair and such as should be carried out. It had been stated in a letter published in the newspapers that the Corporation were not in a position to carry out the terms of purchase because they could not put irredeemable stock into the hands of shareholders. He did not propose to enter into any question of that kind, but he could not bring himself to believe that the terms formulated and agreed upon, and embodied in the provisional order, were altogether of an illusory character. He could not think there was anything which would prevent the Corporation carrying out the terms of purchase. With regard to the actual resolution of the committee, if they were to buy this undertaking at all now was the time to buy it. It had been said that by waiting 10 or 21 years they would be able to purchase on a slightly better basis, but although they might get it on a lower ratio with regard to the principal, he failed to see the wisdom of waiting when they would have to meet the very much largely-increased capital it was proposed to raise. In point of fact they would pay a less amount now than they would be called upon to pay in 10 or 21 years. He would put these two propositions to the Council. If this undertaking were so far a success that the shareholders were recommended, and, in fact, had decided, to increase the capital by nearly £200,000, it was quite good enough for the Corporation to exercise their option of purchase; and it followed that if it be good and right for the Corporation to exercise their right to purchase, it was undoubtedly wise they should do so now. They would have to pay some said £150, and others said £160, for every £100, but under all the circumstances he thought it was the right thing to purchase now, and he had great pleasure in moving the adoption of the minutes. Mr. Styring formally seconded the resolution, which was carried, Mr. Furness alone opposing. Mr. Chambers next moved the following resolution: "That notice in writing under the corporate common seal be forthwith given to the Sheffield Electric Light and Power Company, Limited, requiring them under the powers reserved to the Corporation by Section 60 of the Sheffield Order contained in the Electric Lighting Orders Confirmation (No. 4) Act, 1892, to sell their undertaking to the mayor, aldermen, and citizens of the city of Sheffield, being the local authority for the city of Sheffield as defined by the Electric Lighting Acts, 1882 and 1888." Mr. Styring seconded this resolution, which was adopted *nem. con.*

PROVISIONAL PATENTS, 1897.

APRIL 12.

9222. Improvements in and relating to the covering and fixing of electric wires. Edwin Haslam, Imperial-chambers, Albert-street, Derby.

9276. Improvements in primary batteries. Walter Rowbotham, 24, Harleyford-road, Vauxhall, London.

9295. Improvements in recording telegraphic receivers. Henry William Handcock and Alfred Herbert Dykes, 5, Victoria-street, Westminster, London.

9317. Improvements in plates for secondary batteries. Sir Charles Stewart Forbes, Bart., 21, Finsbury-pavement, London.

APRIL 13.

9323. Improvements in electric signs or illuminations. Bernard Mervyn Drake and John Marshall Gorham, 66, Victoria-street, Westminster London.

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9348. Electric locks. Egidius Julius Mary Scheeren, 52, Chancery-lane, London.

9350. Improvements in electric incandescent lamps. George Tom Cannon, West Malling, Kent.

9387. Improved means for lighting by electricity and incandescence. John Archibald Sinclair, 191, Fleet-street, London.

9425. Improvements in electromagnetic clutches or couplings. Valeré Alfred Fynn, 47, Lincoln's inn-fields, London. (Complete specification.)

9435 Improvements in or in connection with constant-current generation and regulation. William Phillips Thompson, 6, Lord-street, Liverpool. (Thomas H. Hicks, T. Stewart White, and Thomas Friant, United States.) (Complete specification.)

9442. Improvements in pressing electric collector brushes and the like articles. Robert Ritter von Berks and Julius Renger, 322, High Holborn, London.

9456. Improvements in secondary batteries. James Hardie McLean and Charles Douglas Burnet, 24, Southampton-buildings, Chancery-lane, London.

9457. Improvements in electrical transformers. Arthur Francis Berry, 46, Lincoln's-inn-fields, London.

APRIL 14.

9533. Improvements in and relating to reflectors for electric glow lamps. Hans Jacob Miitz, 322, High Holborn, London.

9537. Improvements in commutator truing devices. Percy B. Bosworth, 70, Chancery-lane, London. (Complete specification.)

9561. Improvements in the means for controlling carbon-feeding mechanisms for electric lamps. William Dods Hunter, 18, Buckingham-street, Strand, London.

9563. Improvements in or relating to plates for secondary batteries or accumulators. Henry Tyrer Cheswright, 19, Southampton-buildings, Chancery-lane, London. (Complete specification.)

9564. Improvements in apparatus for the raising and lowering of arc lamps. William James Davy and George Thomas-Davies, 40, Chancery-lane, London.

APRIL 15.

9586. Improvements in current-collecting apparatus for electric tramways. Charles William Godson Little and Arthur James Ireland, Heckington Lincolnshire.

9587. Improvements in electric measuring instruments. Evershed and Vignoles, Limited, and Sydney Evershed, Woodfield Works, Harrow-road, London.

9594. Improvements in electric switches. Arthur Lindley, 55, Market-street, Manchester.

9597. An improved electric reversing switch with liquid resistance. William Henry Vaughan and Thomas Foster 17, St. Ann's-square, Manchester.

9616. Improvements in and connected with coin-freed apparatus for administering electric shocks. Henry John Gerard Pessers, 73, St. Stephen's-road, Upton Park, London.

9631. A new or improved plate for accumulators or electric storage batteries. John Dunn, 22, Glasshouse-street, Regent-street, London.

9675. Improvements in and connected with electric clocks. Louis Anatole Auguste Hennequin, 40, Chancery-lane, London.

9707. Improvements in alternating-current motors. Otto Titus Bláthy and Koloman Kandó, 28, Southampton-buildings, Chancery-lane, London. (Complete specification.)

9708. Improved method of and means for preventing disturbances in telephone circuits by alternating-current installations. Otto Titus Bláthy and Koloman Kandó, 28, Southampton-buildings, Chancery-lane, London. (Complete specification.)

APRIL 17.

9748. An improved method of protecting, supporting, and carrying electric conductors and other wires. George Edward Taylor and Justus Eck, 5, Priory-road, Bedford-park, London.

9770. Improvements in gas lighting and in electric lighting for magnifying purposes and the application of same to lighting in general John Walsh, 65, Wroughton-road, New Wandsworth, London.

9803. A voltaic battery having its depolarisation effected by heat. Henry Etienne de Rufz de Lavison, 28, Southampton-buildings, Chancery-lane, London.

9805. Insulating materials for electrical purposes. Adolf Gentzsch, 28, Southampton-buildings, Chancery-lane, London.

SPECIFICATIONS PUBLISHED.

1896.

6329. Apparatus for producing, storing, and applying electricity, especially applicable to the lighting and heating of railway carriages and other vehicles. Preston and Gill.

6896. Coin-freed apparatus for the measurement of electricity. Atherton, Knight, and Ellis.

7484. Electric meters. Evershed and Vignoles, Limited, and Evershed.

8988. Arc lamps. Thompson. (Wheless.)

9284. Automatic apparatus for switching gear of electrical transformers and other electrical circuits. Walton.

10017. Electric arc lamps. Davy.

10472. Active material for secondary voltaic batteries. Grindle.

23816. Conduit tubes more especially suitable for electrical conductors. Johnson. (Greenfield.)

27041. Conduits for gas-pipes, electric wires or cables, and other analogous purposes. Sayer.

27262. Primary electric battery. Von Burgwall and Ofenschüssl.

29325. Means for attaching and detaching electric light globes. Mayer. (Date applied for under International Convention, June 26, 1896.)

29965. Improvements in and apparatus for treating or purifying, rectifying, ageing, deodorising, and decolourising alcoholic and other liquids or liquefied matter. Johnson. (The Electric Rectifying and Refining Company.)

1897.

859. Process for the extraction of metallic alloys and pure metals by electric heat. Aschermann.

995. Galvanic batteries. Doe.

2789. Storage batteries. Lloyd.

3470. Clamp connections for electrical conductors. Siemens Bros. and Co., Limited. (Siemens and Halske.)

3471. Safety cut-outs for electric circuits. Siemens Bros. and Co., Limited. (Siemens and Halske.)

3906. Electrically-operated switch tongue for railways and tramways Andre and Silbermann.

4878. Electric railway systems. De Redon.

4979. Station indicators for electric railways or tramways. Steffen.

4993. Apparatus for automatically cutting out electrical currents from dynamos when rising above or falling below a determined maximum or minimum, and for gradually turning on such currents. Joseph.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	9¼-9¾
Brush Company, Ordinary	3	3-1
—— Non. Cum., 6 per cent. Pref.	2	1¼-1½
—— 4½ per cent. Debenture Stock	100	104-108
—— 4½ per cent. 2nd Debenture Stock	100	95-99
Callender's Cable Company, Debentures	100	107-112
Central London Railway, Ordinary	10	9¼-10
——	6	5¼-6
Charing Cross and Strand	5	10¾-11½
Chelsea Electricity Company	5	8¼-9¼
—— 4½ per cent. Debentures	100	113-115
City of London, Ordinary	10	22-23
—— 6 per cent. Cumulative Pref.	10	16¼-17½
—— 5 per cent. Debenture Stock	100	132-136
City and South London Railway, Consolidated Ordinary	100	59 61
—— 4 per cent. Debenture Stock	100	139-141
—— 5 per cent. Pref. Shares	10	15¼-16
County of London and Brush Provincial Co., Ordinary	10	12-12½
—— 6 per cent. Cum. Pref.	10	14¼-15
—— 4½ per cent. 2nd Debenture Stock	10	14¼-14¾
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	1¾-2¼
—— 5 per cent. Debentures	—	90-95
Edison and Swan United Ordinary	3	1¾-2¼
—— 5 per cent. Debentures	5	3-4
—— 4½ per cent. Debentures	100	105-110
Electric Construction, Limited	2	1¼-1¾
—— 7 per cent. Cumulative Pref.	2	2¾-3¼
Elmore's Copper Depositing	1	1-1
Elmore's Wire Company	2	1-1
W. T. Henley's Telegraph Works, Ordinary	10	19 20
—— 7 per cent. Preference	10	18¾-19½
—— 4½ per cent. Debentures	100	107-112
House-to-House Company, Ordinary	5	7¼-7¾
—— 7 per cent. Preference	5	9¼-9¾
India Rubber and Gutta Percha Works	10	20½-21½
—— 4½ per cent. Debentures	100	104-107
Kensington and Knightsbridge Ordinary	5	11¾-12¼
—— 6 per cent. Pref.	5	8-8¼
London Electric Supply	5	1¼-1¾
Metropolitan Electric Supply	10	16¼-17⅛ xd
—— 4½ per cent. First Mortgage Debenture Stock	100	120-124
National Telephone, Ordinary	5	6⅞-6⅝
—— 6 per cent. Cum. First Pref.	10	15-17
—— 6 per cent. Cum. Second Pref.	10	15-17
—— 5 per cent. Non. Cum. Third Pref.	5	6-6¼
—— 3½ per cent. Deb. Stock	100	102-105
Notting Hill Company	10	12-13
Oriental, Limited, £1 shares	1	1¼-2
—— £5 Shares	5	8¼-9
—— £4½ shares	4½	7¼-8
Oriental Telephone and Electric Company	1	⅝-¾
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	101-103
St. James's and Pall Mall, Ordinary	5	15-16
—— 7 per cent. Pref.	5	9¼-10¼
Telegraph Construction and Maintenance	12	34-37
—— 5 per cent. Bonds	100	103-106
Waterloo and City Railway, Ordinary	8	10¾-11¼
Westminster Electric Supply, Ordinary	5	13¾-14¼
Yorkshire House-to-House	5	8¼-9

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NOTES.

Received.—The receipt has to be acknowledged of the fifteenth annual *Catalogue* of the Rose Polytechnic Institute at Terre Haute, in Indiana, which is devoted to the higher education in engineering of young men in the Western States.

Association of German Engineers.—This year's meeting of the Verein Deutscher Ingenieure will take place at Cassel on June 14. Among the subjects given by the *Centralblatt der Bauverwaltung* as constituting the programme there is nothing specially relating to electrical work.

The Roller Boat.—It is not electrical, but for the sake of those who heard of her at the Society of Arts it may be mentioned that reports as to the doings of the Bazin boat are conflicting. She has certainly been to sea, but it seems that her speed is quite insignificant. Which was to be expected.

The Junior Engineers.—At the next meeting of the Institution of Junior Engineers on May 7, Mr. Ferriera, of the North London Railway, is to read a paper on "Electrical Railway Signalling." There is to be a visit of the members of the institution to the Blackwall Tunnel to-morrow (Saturday).

Allotropic Changes.—According to a communication of Mr. Moissan published in the *Comptes Rendus*, the black coating which with time appears on a diamond when subjected to molecular bombardment in a Crookes tube consists of a highly stable form of graphite. The evidence is mainly that it is removed by strong oxidising agents.

The Teaching of Chemistry.—The *Revue Générale des Sciences* has a long article by Mr. Haller on the position of chemical teaching at the French universities. Chemistry hardly occupies the position it should in what passes for the highest education in this country, but it would seem that things are no better in France—in fact, much worse.

Cable Interruption.—There has been a difficulty in maintaining telegraphic communication with Jersey, which was followed by a complete interruption for a short time, but communication with the island has now been restored. The break was between Guernsey and Jersey. The local circumstances of the Channel Islands are not exactly what a telegraph engineer would choose if he had the making of them, and the cables have often a trying time of it.

Telephone.—There is described and illustrated in the *L'Electricien* a telephone apparatus in which the circuit is not opened or closed by moving the receiver from its hook or replacing it, but in which the latter is mounted on a bar and the ear pressed against it. This has the incidental advantage of leaving the hand free, which is certainly convenient if it is desired to note down what is said. The particular form of apparatus described is attributed to Mr. Budelmann, of Berlin.

The Institution Students.—The next visit of the students of the Institution of Electrical Engineers will be to the Great Eastern Railway electric light station on Saturday, May 8. The party will meet outside the telegraph office on No. 9 platform, on the west side of Liverpool-street Station, at 11 a.m. As the number will have to be limited, those desiring to take part in the visit must send in their names at once to the students' hon. secretary, Mr. W. Bunn, 23, Oxford-road, Stroud Green, N.

The Midland Engineers.—The Chesterfield and Midland Counties Institution of Engineers meets at Nottingham on May 8. There may possibly be some discussion on electric haulage in collieries and in the use of the magnetic meridian in mine surveying. The proposed meeting in Canada in the summer or autumn of 1897, at the invitation of the Canadian Mining Institute, has been postponed to a more convenient date. At last Saturday's meeting at Leeds, the education of the mining engineer was discussed.

Obituary.—Admiral Sir George Watson, who died at Plymouth on Monday, saw active service in the Chinese War and the Crimean War. Later on he was strongly recommended by Lord Lyons for valuable assistance rendered (in 1857 and 1858) in laying telegraph cables between Cagliari, Malta, and Corfu.—The death has also been announced of Mr. L. P. Casella, at Highgate, at the age of 86. Mr. Casella was much associated with the manufacture and improvement of scientific instruments, and more especially of thermometers.

Iron and Steel Institute.—The annual meeting of the Iron and Steel Institute begins on May 11 at the Civil Engineers'. On Monday evening, May 10, there is reception by Sir David and Lady Dale, and on May 11 the annual dinner, at which the Duke of Teck will be present. The Bessemer gold medal for 1897 will be presented to Sir Frederick A. Abel, and the inaugural address will be delivered by the president-elect (Mr. Edward P. Martin). The list of papers to be read appears to contain little of special interest to electrical engineers.

Electrical Engineer Volunteers.—Little has been heard recently of the electrical engineer volunteers, but it seems that the matter has not been let drop, for it is notified in Tuesday night's *Gazette* that "her Majesty has been graciously pleased to approve the formation of a volunteer corps to be designated the Electrical Engineers, Royal Engineers (Volunteers), and to sanction the following appointment to the command—viz., John Hopkinson, Esq., to be major under the provisions of paragraph 55 of the Volunteers' Regulations, 1896."

Electric Cabs.—Some time ago reference was made to the electric hansom cabs which were shortly to be put into competition with ordinary cabs in New York. The cabs were built, but it appears that the reason for the delay was that it took some time before the company could obtain the necessary permission to run their cabs for hire in the streets. The licenses have been obtained at last, and the *Scientific American* says the cabs are now a well-known sight in the upper part of New York, and occasionally they may be seen going as far down town as Wall-street, winding in among the trucks and cable cars. If a high charge and a reputation for incivility have anything to do with it, the new vehicle ought to have an easier task in supplanting the existing cabs in New York than would be the case on this side of the water.

Steam-Engine Efficiency.—The following preliminary report of the committee appointed last year by the Institution of Civil Engineers to consider and report upon the definition of a standard or standards of thermal efficiency for steam-engines has been adopted by the council: "That the statement of the economy of a steam-engine in terms of pounds of feed-water per 1 h.p. per hour is undesirable. That for all purposes except those of a scientific nature it is desirable to state the economy of a steam-engine in terms of the thermal units required per 1 h.p. per hour (or per minute), and that, if possible, the thermal units required per brake horse-power should also be given. That for scientific purposes the thermal units that would be required by a perfect steam-engine working under the same conditions as the actual engine should also be stated."

Current Distribution.—In a long article by Dr. Zahn, in the *Western Electrician*, on the subject of the

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transmission of heavy currents, mention is made of an experimental method of determining the current distribution and drop on a network of wires in order to avoid the troublesome calculations necessary for determining the proper cross-section of the conductors. The method depends upon an analogy between the deflection of a thread or wire suspended at two points and loaded with weights and a conductor, from which current is taken at various points. It is stated that the results obtained are satisfactory, and that the cost of the apparatus is not unreasonably high. In the face of that, one will not start merely theoretical objections founded on a short description and illustration of the apparatus, but it would obviously require very considerable care in construction and use if anything like accuracy is to be obtained.

Royal Institution.—Canon Ainger has been unable to deliver his course of lectures on Thursdays, so Prof. Dewar's lectures on liquid air have been brought forward to fill their place. The first was yesterday afternoon, which is too late for any description of it to be given in this week's notes. To-night (Friday) there is to be Prof. J. J. Thomson on "Cathode Rays," and next Friday Mr. "Anthony Hope" on "Romance." That gentleman is believed to be capable of many things, but one may safely conclude that there will be nothing in his discourse which will have much bearing upon the exceedingly unromantic matters which make up our usual province. Dr. Tempest Anderson's Tyndall lectures began on Monday, and his description of Mediterranean volcanoes was chiefly interesting for the fine series of lantern slides which were shown. It will be news to most persons out of Sicily that (for her sins) the Lady Anne Bullen, who was for some time Queen of England, is kept in the crater of Etna.

Patents.—The report of the Comptroller-General of Patents, Designs, and Trade Marks for the year 1896 has been issued, and shows that the number of applications for patents, which in the year before showed a decrease of 324 upon that of the previous year, increased in 1896 by 5,132, an increment four times as large as the average yearly one. During the last two months of 1896 the applications came in at the unprecedented rate of 700 per week, the total for the year being 30,194. The increase of 1896, like the decrease of 1895, was mainly in provisional specifications, which showed an increase of 4,677, or 22·6 per cent., while the complete specifications accompanying applications showed an increase of only 452, or 10·4 per cent. It is understood that there are people who like to read statistics of this kind, and believe that some information is conveyed by them. The real fact which lies behind the figures is simply that there has been an enormous "boom" in the cycle trade.

Canal Traction.—Mr. Leslie S. Robinson's paper on "Mechanical Propulsion on Canals," read at the meeting of the Institution of Mechanical Engineers, besides in the matters of electric haulage, referred to elsewhere, is interesting as giving a summary of many things connected with canal traction. First of all, the relations which the cross-section of the canal boat and the canal and the depth of the latter bear to the resistance to traction and to the proper speed are investigated. These make any mere comparison of results on two different canals of very little value. Indeed, it is hardly going too far to say that to be certain of a fair test it would be necessary to run boats of the same shape and size over the same reach. Further, it appears that the use of a steam locomotive on the rails on the tow-path is not barred by curves, but turns out to be not so cheap as a horse. The method of traction advocated in England is the screw propeller, driven either by steam, electric, or oil motors. Warping on a chain in the French fashion will not do on account of the numerous curves.

Electric Traction on Canals.—There is an article (unsigned) in *L'Electricien* on the subject of the application of electric traction on one of the reaches of the Burgundy Canal. There is little that is absolutely new in it, but the conclusion is arrived at that for a speed of a little over 1½ miles per hour the consumption of electric energy is about 10 watts per ton of barge tonnage; but, of course, further and more varied experiments are required before that can in any way be taken as a standard. Some details of the method and machinery adopted on the Burgundy Canal are given in Mr. Robinson's paper at the Institute of Mechanical Engineers, and will be produced elsewhere in this journal. The method of wasping on a chain is one which is in common use on Continental waterways, but is so far as is known to the writer, untried in this country. The author of the article in *L'Electricien*, however, evidently thinks that a case could be made out for the screw propeller driven electrically. From another source it appears that experiments are also to be made on the Burgundy Canal with an electric traction engine hauling like a horse from the towing-path. That seems hardly a promising method.

Tramway Accident.—According to telegrams from Paris, it would appear that on Monday morning two horses attached to a cart belonging to a laundry were left standing in the Avenue de la Republique, on the rails of the electric tramway which runs from the Place de la Republique to Romainville. "Suddenly they were seen to jump up in the air and then fall to the ground, the cause evidently being a strong electric shock from their feet coming in contact with the metals." Both horses are stated to have been killed instantaneously. The tramway line referred to should be a Claret-Vuilleumier line—that is a "closed conduit," one which, however, differs from the other closed conduit systems by the contact points being grouped or bunched and supplied by feeders from chambers at intervals along the line. If, therefore, the mechanism in one of these which provides for making the points "live" as the cars proceed should get put out of order so as to produce a short-circuit there, it might be possible for other of the points to become "live" besides those immediately under the tramcar. This is said to have been the case. Until, however, further details are obtainable, it is not easy to guess exactly how the accident occurred. That both horses were killed, was due to the harness chain acting as a conductor.

Aluminium Again.—People are always busying themselves to find a new use for aluminium. It is a sort of scientific pet. By way of experiment, several regiments of the German army are to try an aluminium helmet. According to the *Army and Navy Gazette*, the helmet is very light, and is bronzed, as a bright metal head-dress, though, no doubt, exceedingly beautiful, might prove useful to the enemy. Germany has already tried aluminium horse-shoes, buckles, and accoutrements, and it is stated that the metal has one drawback which had not been foreseen—namely, that when exposed to the influence of the sun it gets so hot as to blister the skin. If true, that is exceedingly curious. The film of transparent oxide with which it is covered may have something to do with it. After carefully reviewing the various processes now in use for the manufacture of aluminium, the *Engineer* has come to the conclusion that there is hardly any likelihood of the existing methods for winning aluminium being replaced by anything radically different; and the main object of the present manufacturers must be to discover new and better sources of bauxite, and to simplify and cheapen the preparation of the purified oxide and the final electrolysis by

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thorough attention to the small and apparently insignificant details, on which, in all electrolytic work, the commercial efficiency and value of any operation generally depend.

Foreign Code Telegrams.—In a circular forwarded from the General Post Office to British compilers of telegraphic vocabularies and codes and to chambers of commerce, it is announced that the director of the International Telegraph Office at Berne "has consented to further extend the date for the reception of codes to June 30 next." So far back as on September 30, 1896, the Postmaster-General invited employers of codes for cypher telegraphy to forward copies of them to the director if they desired to see their code words appear in the revised edition of the "Official Vocabulary" issued towards the close of 1894. The codes were to be sent without charge, and no undertaking was given that all the words in any codes that might be furnished which are at present legitimately employed would be inserted in the new vocabulary. It would appear that the code-makers, under the circumstances, have not responded very readily to the invitation. The enforcement of the new edition of the vocabulary now being prepared is postponed until after a date to be fixed at a conference to be held in 1901. The length of the interval between now and then affords, doubtless, an explanation of the absence of any general and open opposition to the plan of the bureau to restrict all code telegrams to the official vocabulary. But the *Manchester Guardian* says the tacit refusal of those chiefly interested in the matter to have anything to do with the compilation of the new vocabulary is a significant proof of the reality and strength of the feeling against its obligatory adoption. If all idea of restriction were conclusively abandoned, the commercial community would be ready enough to co-operate, and the vocabulary might become a valuable instrument in promoting and extending the use of telegraphic correspondence for commercial and other purposes.

Wireless Telegraphy.—There has been a long article in the *Elektrotechnischer Anzeiger* on the subject of wireless telegraphy giving a sort of general review of the subject. Poor Mr. Bose apparently is still to suffer from the "popularising" of his work. (It is understood that Mr. Bose does not claim to have devised a commercially practical method of signalling). So it is considered safer to pin one's faith on the Marconi telegraph, the mechanism of which has not been described. Mr. Marconi is congratulated on his good fortune in securing such "weighty protectors" as Mr. Preece and Mr. Goschen. One, however, comes to little definite. There is mention of the alternative difficulties that beset the use of either long or short waves, and a reference to the possibility of the superposition of electric and magnetic waves, whatever that may mean; and the article then goes off into the induction signalling with lightships by methods which have not been by any means a success. Meanwhile there has been a contribution to the literature of the subject in the *Standard*. This, however, is somewhat of a different class. A gentleman, who veils his identity under the pseudonym of "Ignoramus," is apparently quite convinced that anything connected with electricity must be rather dangerous to somebody. "At present," he says, "I do not feel quite sure that an electric wave in the eye may not at any moment be my fate, unless Mr. Marconi quickly invents some mode of controlling his waves, and confining them within certain limits, instead of allowing them to roam about London at their own sweet will. He tells us they go through anything and everything." There was an old riddle as to the thing that went through the wood without touching a tree. It is only possible to recommend "Ignoramus" to investigate that, and to take his science on trust from those who are willing to understand it.

Conduit or Trolley.—Although almost contemporaneous with the trolley in invention, the conduit tramway has up to the present been very much subordinate to the overhead line. So much has been heard as to American practice showing that there is really no choice as to adopting the overhead line, that it may be well to note that the *Electrical World* says that in America within the last two years the conduit line has become a demonstrated success, and has taken its place as a competitor with other systems. The conditions obtaining in many American cities forbade the use of the overhead trolley, and, animal traction being out of the question, had previously practically compelled the introduction of the cable, but now, our contemporary thinks, it is probable that the cable tramways in many instances will turn their expensive conduits into electrical subways carrying conductors and feeders. The equipment of three long and important lines in New York this summer will probably result in the accumulation of much useful experience, and may bring to light some valuable improvements. As to the form of conduit adopted, it is noted that the modern conduit, having an open slot, fixed rigid conductors, and a sliding contact, is substantially the same as the earliest forms proposed. While there have been innumerable patents for all sorts of conduit devices, closed conduits, magnetic contact systems, etc., and a vast amount of ingenuity and thought expended upon this problem, it is held that present practice proves that it was from the first simply a question of good engineering to design a successful system, and that no system of traction has appeared that can compare with the modern conduit railways in satisfaction to the public and safety to life and property. Not a word is said about the open slot in the middle of the street, probably because the opposition to that and some other inconveniences has been lived down in America by the cable-tram companies.

The District Low Level.—The low-level express electric line of the District Company is to come before Mr. Woodall's Select Committee of the House of Commons about the 14th of next month. The only people who will oppose the Bill are the London County Council, and except on the general principle of objecting to anybody but itself doing anything, it is not quite clear why that body is opposing. The Council's petition, however, takes the form of a general opposition to the clauses of the Bill, but not to the preamble. (They could hardly oppose that anyway.) With reference to these clauses, the Council ask Parliament to prohibit the District Railway Company from using steam at any time on the proposed railway unless the line is designed in some way other than that now proposed. (Nobody wants to do it, but it might be a serious nuisance to have a statutory prohibition in the way of sending a steam locomotive down the tunnel in case of emergency or at an hour of the night when the current was off.) The Council further want restrictions to be placed on the removal of the soil excavated from the tunnel. (It is understood that most of it is to be taken away by barges from shafts near the river.) They object to the powers sought to construct a station under the existing Charing Cross Station. (It would have been better if they had insisted on a covered communication with the South-Eastern Station.) They also object to any advertisements being displayed within sight of any public thoroughfare. (Why is a railway company to be treated differently from any other trader?) And, lastly, they want the working classes conveyed under cost price. A financial contemporary says plainly that all these "look like objections for objection's sake alone." They certainly

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seem more than a little unreasonable, for whether or not the new line should prove a profit to the shareholders, which is not the Council's business, it could not be other than a benefit to London and Londoners. But perhaps the Council does not like a scheme which compulsorily expropriates next to nobody.

Telegraph Posts.—Mr. W. C. Renshaw, of Hayward's Heath, has written to the *Times* calling attention to the methods of the Post Office in connection with the erection of telegraph or telephone lines. After referring to various things which the Post Office may legally do, but in the public interest might be expected to refrain from, Mr. Renshaw goes on to refer to acts which are not protected by their statutory powers. "Little regard," he says, "is paid by the officials to the provisions contained in them for the protection of landowners and others, and in defiance of Section 21 of the Act of 1863 the officials do not hesitate to injure the hedges, to dig into the banks of the owners adjoining the road and therein to affix metal stays or wooden struts fastened into buried pieces of wood about 4ft. long without asking for consent. I myself," he continues, "wrote to the Secretary of the Post Office on January 31 complaining of trespasses of this description, and on February 2 received an acknowledgment stating that my letter should receive attention. It has received such prolonged attention that I have never had an answer yet. This very morning workmen were engaged digging a large hole in one of my hedge-banks, which the foreman frankly admitted was my property, but said he was under orders to do it." Section 12 of the Act of 1863 enacts that when a public road passes by the side of any park or pleasure grounds, or crosses or abuts on a private drive to any mansion, the company (and the Postmaster-General has only the same powers) shall not without, or otherwise than in accordance with, the consent of the owner, etc., place any "work" above ground on such public road. This, it would seem, is generally disregarded. As for the open trespass of posts and stays being inserted in private land, that would seem to admit of a very summary remedy if the landowner knew it. In reference to another matter, the Acts contain nothing which authorises the cutting or mutilating of trees, whether ornamental or not. Especially in the subordinate ranks, it is a besetting disease of the official mind, whether Government or municipal, to imagine that officials may do acts which would be quite improper for ordinary citizens. On the contrary, it should in a free country be a particular care of all in any way connected with the Government to look to it that they do not set an example of lawless action. The idea that the British Government cannot condescend to ask permission from a five-rood freeholder is altogether a bad one.

The Civil Engineers.—At the annual general meeting of the Institution of Civil Engineers on Tuesday, Mr. J. Wolfe Barry (president) in the chair, the result of the ballot for the election of officers was declared as follows: President—Mr. J. Wolfe Barry; vice-presidents—Mr. W. H. Preece, Sir Douglas Fox, Mr. James Mansergh, and Sir William Anderson; other members of council—Mr. Horace Bell, Mr. Alex. R. Binnie, Mr. T. Forster Brown (Cardiff), Mr. Henry Deane (Sydney), Mr. W. R. Galbraith, Mr. George Graham (Glasgow), Mr. J. C. Hawkshaw, Mr. Charles Hawksley, Mr. G. H. Hill (Manchester), Dr. John Hopkinson, Mr. J. C. Inglis, Dr. Kennedy, Mr. John Kennedy (Montreal), Mr. George Fosbery Lyster (Liverpool), Mr. William Matthews, Sir Guilford Molesworth, Sir Andrew Noble (Newcastle), Dr. B. B. Stoney (Dublin), Mr. F. W. Webb, Sir William White, and Sir E. Leader Williams. The report of the council for the past year referred to the alteration of the by-laws so as to supplement the existing regulations by the introduction of a test by examination, and to the arrangements made to hold a general conference of the institution in London on May 25, 26, and 27. During the past year two honorary members, 37 members, 279 associate members, and 14 associates had been elected into the institution, being a total of 332; while by death, resignation, and erasure 158 names had disappeared from the register. The roll now numbered 6,204, as against 6,030 at the corresponding date last year. There were also 886 students attached to the institution, so that the total number borne on the books on March 31 was 7,090. The income was £22,285, and £15,417 had been received on capital account to meet the expenditure on the new building. The trust funds had realised £466. The expenditure had been £40,394, of which about one half represented the normal expenses of the year, the balance being incurred principally in connection with the new building, while the expenditure on trust funds account had absorbed £468. The local associations of students at Manchester, Glasgow, Birmingham, Newcastle-on-Tyne, and Leeds continued to do good work. The engineering conference, in which the students would be permitted to take part, would afford an opportunity for members of that class to assemble as usual in London in the month of May. The collection of paintings had been augmented by the presentation by his son, Mr. Henry Vignoles, of a portrait of the late Mr. C. B. Vignoles, past-president.

The Institution.—The discussion of Mr. Baylor's tramway paper, at the Institution of Electrical Engineers, was in many ways an interesting one. There were some critics upon whom Mr. Preece was sufficiently severe. That gentleman also explained that the Post Office experience had shown that even though an electric line (unbonded rails) is shut up inside the iron tube of a tunnel, it is by no means safe to conclude that there will be no appreciable outside leakage of the return current—a thing certainly contrary to what might be anticipated. The best parts of the discussion had a very slender connection with the paper. It was distinctly good to hear Mr. Grove demonstrate in an entirely convincing manner that the three-wire system was the one and only proper way of working the Central London, and then to hear Mr. Parshall follow and show in a still more overwhelmingly convincing way that for that line the three-wire system would be hopelessly wrong. Far be it from one to suggest that there is any way of getting over the facts, figures, and calculations which Mr. Parshall poured upon the meeting, but all his arguments were not of equal strength. For instance, even though the system may have failed in long single-car lines with more or less irregular stoppages, where the cars on one side might get "bunched," it seems perfectly justifiable to admit that the system has a claim to be examined anew for the somewhat different case of a railway in the English rather than the American sense of the word. Moreover, there does not seem anything in the unalterable nature of things why the "cars" must run on a "fixed speed schedule," or why the matter should go on any other basis as regards the time-table than a bad gradient would. Unfortunately, Mr. Parshall's points do not depend upon one another; and if one goes, the others remain. Mr. Baylor confined himself to the statement that the system always had failed. Remarking that his critics had mostly answered each other, he was very brief in his reply; and by sitting late there was time to hear Mr. Raworth's plea for one big engine and one man to oil it. It was an over-rhetorical (and over-rated) statesman

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who professed the inability to draw an indictment against a whole nation. Mr. Raworth is not afraid to indict the whole of the technical Press. And the substance of the counts is for that they, the aforesaid technical papers, all and each of them do at divers times, to wit, constantly procure, insert, publish, and cause to appear, articles on the subject of engine construction which terminate without saying one single word of value to anybody. Fortunately, notes are not articles, so the present writer has a good demurrer, and need not plead to the indictment. But if he stood in the same jeopardy as his superior brethren he might avow that he dare not tell eminent engineers that if an engine is to run generally at half load, it was on the whole quite as well to construct it to be most economical at that load rather than at quite another one, and that it might prove better to vary the expansion than to work only on the throttle.

High Pressures.—In the paper on high pressures for marine engines, read by Mr. W. R. Cummins before the North-East Coast Institution of Engineers, the author recapitulates the arguments as to the economy to be expected from the proposed increase of pressure, considers what type of boiler will best suit the altered conditions, and makes suggestions as to the design of an engine most suitable for the increased pressure. Passing over the thermodynamics, the question is how to carry them out. The difficulty begins with the thickness of the material forming the heating surface, which is a most important point, as the increased temperature of the water will decrease the efficiency of the heating, and if, in addition, the plates have to be made thicker for the increased pressure, there will be a still further decrease in the efficiency. For instance, the thickness of circular furnaces would be increased for the higher pressure, unless the diameter were decreased. The thickness of the plates forming flat stayed surfaces would also need to be increased, the alternative being to decrease the pitch of the stays. Mr. Cummins thinks there is something yet to be done as regards the distribution of the gases over the heating surfaces and the time they remain in contact with the latter, which affects the efficiency of the heating surface to a large extent. He thinks a Scotch boiler working at 250lb. pressure would burn the fuel well and utilise the heat satisfactorily, but extra care would be needed in raising and letting down steam to avoid straining from unequal temperature. The cost of construction would be more than that of the lower-pressure boiler, and the space occupied only a very little less. The water-tube boilers of the Thorneycroft, Yarrow, or Normand type would burn the fuel well, but would not utilise the heat satisfactorily; they would be very accessible for cleaning, and convenient for repairs, and there would be no danger of straining or leakage through unequal expansion. Moreover, the cost of construction would be vastly less than that of the Scotch boiler, and the space occupied considerably less. The water-tube boilers of the Belleville and Babcock and Wilcox types would not burn the fuel so well, but would utilise the heat satisfactorily. The cost of construction and the space occupied by them would be again considerably less than that of the Scotch boiler. The construction of the engine is of less interest to us, more especially as Mr. Cummins is still awaiting the results of further experiments before committing himself as to the precise places where the gain comes in in triple expansion. He, however, declares that "the three-crank engine has now almost displaced the two-crank engine on account of its more equable turning and balance, and four-crank engines are now coming into favour. The four cranks offer great facility for balancing the moving parts, and should, therefore, be adopted for a high number of revolutions and where absence of vibration is of importance"; but tandem cylinders should only be used in cases of absolute necessity, owing to the inconvenience of overhauling the lower cylinder.

Rontgen Radiations.—In America, Prof. Elihu Thomson has been experimenting as to the injury to the skin which sometimes follows an exposure to Röntgen rays. A comparatively short exposure at very small distances from the tube was used. The left hand was covered with a lead sheet of over $\frac{1}{16}$in. in thickness, and an oblong hole of about $\frac{3}{4}$in. long and about $\frac{5}{16}$in. wide cut through over the third finger. Round the finger and under the middle of the opening was placed a strip of heavy tinfoil about $\frac{3}{16}$in. wide, which divided the exposed area into two parts. One of these was covered with two layers of thin aluminium-foil gummed to the finger. Thus there were three areas tested: one covered with aluminium, another with tinfoil, and the third left bare. The finger was quite close to the special form of tube used, and was, in fact, only about $\frac{5}{8}$in. distant from the anode. The exposure was for 12 minutes, and the result at first was two faintly-reddened spots, one corresponding to the part under the opening in the lead shield covered by the aluminium-foil, and the other corresponding to the bare spot. Under the tinfoil there was no action. These reddened spots, though scarcely visible, could be developed by friction, but gradually faded until, at the end of a week, from the time of exposure, they were with great difficulty distinguishable from the rest of the skin. On the ninth day, however, they returned and became painful and swollen. While the part covered by the tinfoil is entirely unaffected, the effect produced through the aluminium leaf is nearly the same as on the bare spot. The rays which produce the mischief, therefore, pass through aluminium, but not through the (comparatively) light metal of the higher atomic weight. It may, therefore, be concluded, at any rate provisionally, that they belong rather to the Röntgen radiations proper than to what is ordinarily called the ultra-violet spectrum. It is probable that they are a special grade of the radiations, and therefore it may prove possible to get rid of them by selective absorption. Meanwhile, so far as the operator is concerned, as was suggested here a very long time ago, any possibility of mischief can be averted by the use of tinfoil. As for anyone else, as Prof. Elihu Thomson observes, according to the law of inverse squares an exposure of 12 minutes at $\frac{5}{8}$in. distance would require, at 10in. distance, for equal effects, about 50 hours, or over two days. There is therefore no occasion for any alarm as to the effects of Röntgen rays, as exposures of sufficient duration to produce harm are rarely, if ever, necessary. Moreover, it is quite probable for various reasons that the action diminishes even more rapidly than in proportion to the inverse square of the distance. In a lecture given before the New York Academy of Sciences, Mr. Nikola Tesla has stated that he has succeeded in discovering a new source of the radiations which is far more powerful than any heretofore available. Unfortunately, however, the difficulty of maintaining it is very great, as this new source is the electric arc formed between a platinum terminal and an aluminium plate enclosed in a glass jar. (It will be remembered that it has from time to time been affirmed and denied that the normal arc contains some Röntgen radiations.) Mr. Tesla also believes that he has succeeded in deflecting the Röntgen rays by a magnet. The theoretical importance of this, if true, would be very great. But further details must be awaited before it can be assumed that the effect observed by Mr. Tesla was conclusive in this respect.

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THE MECHANICAL CONSTRUCTION OF ELECTRICAL MACHINERY.

BY F. M. WEYMOUTH.

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THE DYNAMO.

(Continued from page 519.)

Rails.—In Fig. 159 we showed a plan of some rails wherein a pair of these were joined across so that they formed one casting; and that special design was for a moving bracket for the pinching screw. We now illustrate an arrangement, Figs. 167 to 169 herewith, with three rails

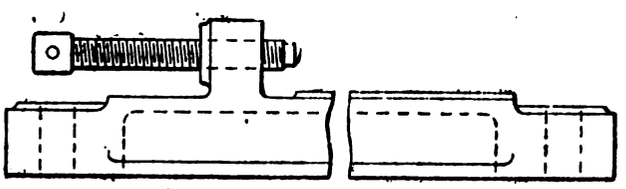

FIG. 167.

cast in one, but with fixed heads, *a a*, for the pinching screws. These latter, as will be seen, are on the outer rails only, and also the slots, *b b*, for the holding-down bolts. It will be noted that as here drawn these slots require the bolts to be tee-headed, as represented in the two views, A and B, so that the heads may pass through the enlarged

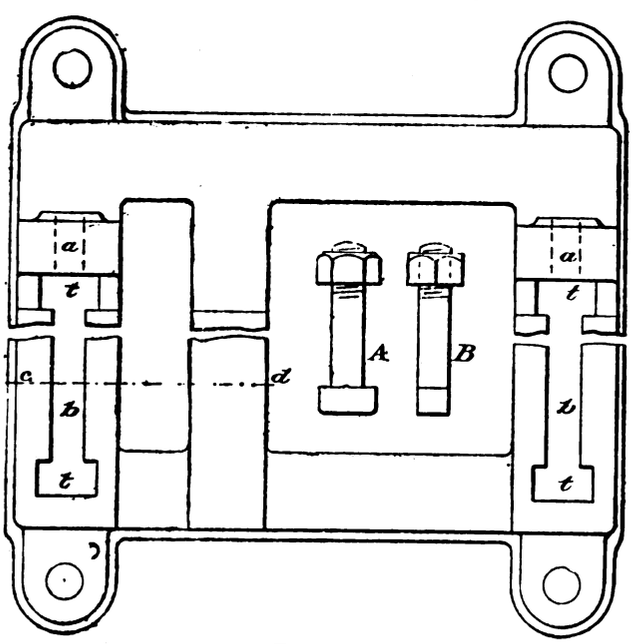

FIG. 168.

slot ends, *t t*. It is, of course, optional instead to put the bolts through from below before bolting the rails down; only probably the other method would be most convenient. The slots here do not run through as in Fig. 159, and consequently the wide spaces, *t t*, are in any case necessary to enable the machining of the slots to be accomplished. As will be seen from Fig. 169, which shows a section on *c d* in

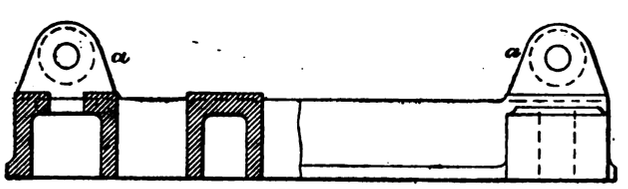

FIG. 169.

the plan, the casting as a whole is designed on the inverted channel section principle, like some bed-plates that we have discussed. This example is taken approximately from a dynamo of the General Electric Traction Company, illustrated in Prof. S. S. Thompson's "Dynamo-Electric Machinery."

Before touching on the question of foundations, which forms the next branch of our subject, we must interpolate here one more bed-plate for a belt-driven machine, which should have appeared on an earlier page. This is a comparatively recent design brought out and patented by Messrs. P. R. Jackson and Co., Limited, Manchester; it is one that has some special features, and is represented in the accompanying illustrations. Of these, Fig. 170 is an

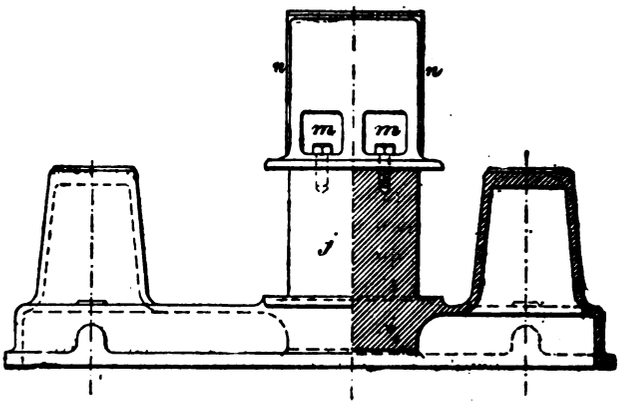

FIG. 170.

elevation with section on *c d* in the plan (Fig. 171); Fig. 172 is a transverse section on *a b* in the plan, but with the pedestals omitted; and Fig. 173 shows an end view of one pedestal, with section on *e f*. In Fig. 171 there is also a section on *g h* through one pole-piece, while the other pole-piece is omitted.

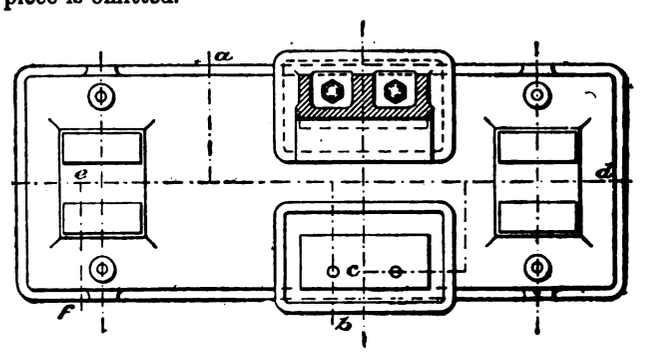

FIG. 171.

From the above it will thus be observed that a leading feature in this bed-plate is that not only the yoke, *i i*, is cast within it, but also the magnet limbs, *j j*, are made part of the same casting. In practice, however, sometimes the pole-pieces also form part of the same casting. The patentees state that they "cast the whole of [these] parts, which may be of steel for instance, in one piece, and then saw, or otherwise divide the casting in such places as is necessary in order to place the field-magnet coils in

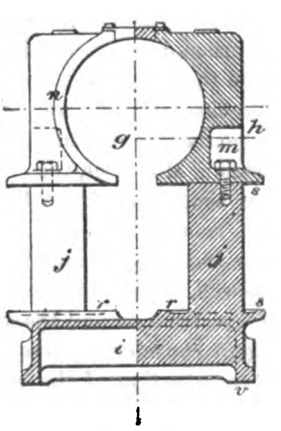

FIG. 172.

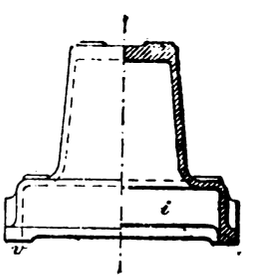

FIG. 173.

position on the cores. Before so dividing the parts, we drill and tap holes for the bolts which are to unite the said parts together. By these means we reduce the number of separate parts, and to a large extent obviate the necessity of marking out and locating the positions which under ordinary conditions the various bolts and parts occupy, which generally occasions considerable expenditure of time and labour, and forms a source of mechanical weakness"

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We are informed by the makers, however, that this process of sawing off the pole-pieces does not apply in the case of the overtype machine represented in our illustrations. The pole-pieces are here cast separate, as shown, which will of course render the operation of drilling the bolt holes more feasible than it would otherwise appear.

Pockets, *m m*, are necessary to enable the bolts to be inserted; and these must have a height equal to the length of the bolt including the head, and must be sufficiently wide to admit the use of the spanner for tightening the bolts. These pockets, at least at a first glance, would appear to interfere with the flow of magnetism within the pole-pieces. Our present illustrations, however, being based on those accompanying the patent (No. 6,791, 1895), these are apparently somewhat exaggerated in dimensions in order to emphasise the speciality. It will be noted that suitable facings and flanges, *r* and *s*, serve to retain the magnet coils when these are in place, and also conduce to a neat appearance of the machine when complete. The bottom is faced on the two sides only, as shown, *v v*. The heavy square bead or flange round the bottom edges is apparently deemed sufficient to resist distortion, instead of one or more extra webs being added, as in other examples of bed-plates we have had under consideration, wherein there has been a yoke cast in the centre. An annular facing, *n n*, is added on the pole-pieces, which may be machined when the pole faces are bored, and so cause a symmetrical periphery or edge of the bore to be produced. Messrs. P. R. Jackson and Co have however, taken out further patents, which are not yet complete. On a later page we propose to introduce another variety of bed-plate manufactured by this firm, with which we shall finally close that branch of our subject.

Foundations.—We may now turn our attention to the foundation, down to which a dynamo is bolted. This is not an unimportant matter. For besides the fact that general stability and absence of vibration is to be attributed to a substantial foundation, those cases also need bearing in mind, which we have touched on, wherewith the proper alignment of the parts of the engine and dynamo when combined is secured only by the foundation, on account of the lightness of construction of the bed-plate, and its want of rigidity. To take the most simple cases first, however, we may commence by dealing with the holding-down arrangements of the rails for a belt-driven dynamo.

Although cases occur wherein a dynamo or motor is simply bolted to timber-work, yet, at least on a ground floor, it is probably more usually to put down a more or less heavy mass of concrete for the machine to rest on. Being firmly bolted to this, the additional weight of the concrete—amounting, it may be, to a ton, or, perhaps, several tons—adds so much to the inertia of the whole mass that no ordinary external or internal cause can overcome it sufficiently to produce within the mass any appreciable motion or vibration. We thus hear of cases in America, at any rate, where engines have been put high up in buildings of many storeys, and in order to obtain a sufficiently massive foundation for such an engine, a large block of concrete whose top is level with the engine-room floor, has been suspended from the beams of this floor, or direct from the engine bed-plate, so that it projected downwards into the storey below. The principle is, in fact, the same, whether the foundation is thus suspended, or whether it is placed in a pit: the total mass has an inertia that no normal source of vibration can overcome.

We may thus revert to the holding-down arrangements for rails. Some of these are illustrated herewith (Figs. 174 to 176), wherein the part lettered A in each represents an end view of a rail. The first of these shows a "jagged bolt," or "Lewis bolt," as it is variously termed. This may be sufficient for small machines, and is cheap and simple. The bolt may be imbedded in the concrete in the first instance: though it carries also the advantage that when a small machine is required to be put down where concrete already exists, it is a comparatively simple matter to knock out a hole with hammer and chisel, and then to grout the bolt in. When two or more bolts are being placed, it is well, of course, to use a wood template with the bolt holes accurately bored through it, and then before grouting to place this over the bolts, letting each pass through its appropriate hole.

It is obvious, however, that a jagged bolt, even if it penetrated to the bottom of a mass of concrete, would only obtain a partial grip on it: though, on the other hand, this must also depend on the quality of the concrete and the grouting. As, however, it is usually desirable to obtain as good a grip as possible of the whole mass of the concrete, another method adopted is that represented in Fig. 175.

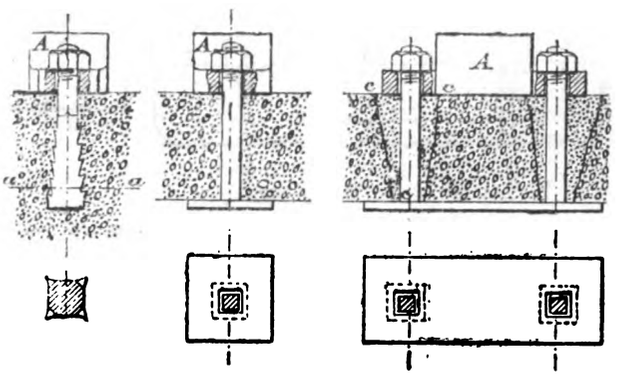

Fig. 174. Fig. 175. Fig. 176.

We here find that an iron or steel plate is put below the concrete, and then an ordinary bolt, having its head beneath the plate, securely connects the rail and concrete foundation together. The bolt and plate require holding in place before the concrete is put in, so that its position may be correct when the concrete has set. As may be seen in a book, "Electrical Engineering Formulæ," by Messrs. Geipel and Kilgour, the Brush Company use a jagged bolt whereof the section at the lower end is rectangular, the width of the section being $\frac{1}{8}$in. greater than the diameter of the bolt, and its length rather more than twice the width.

A convenient method, however, often adopted is indicated in Fig. 176, where also two bolts are shown with one plate. In this case, before the concrete is put down, each bolt, being already in place with the plate, is enclosed within a four-sided conical wooden box, having its small end downwards. The concrete is then put down, forming up to the outside of the boxes only. After the concrete has set the boxes are removed, when the bolts will be left each projecting up loosely within a conical hole in the concrete, as at *c c c* in the diagram. The rail being put over the bolts, an advantage now is that owing to the "play" allowed the bolts, the rail may with ease be accurately placed before the nuts are screwed down. After this grouting is poured into the holes, which finally fixes the position of the bolts. It is of course necessary to let the upper ends of the holes, *c c c*, be so large that the rail shall not cover them completely and prevent ingress of the grouting.

It is to be noted now that plates of wrought steel or iron are expensive. Not only is the material the reverse of cheap in the first instance, but there is the further expense of cutting them, and of drilling or punching the holes.

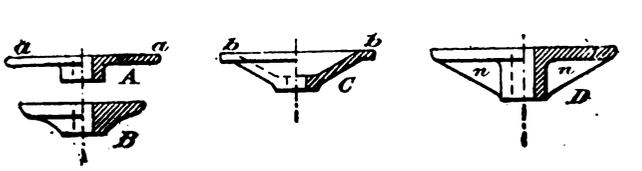

Fig. 177.

Especially when many are required alike, cast iron is, for these reasons, much to be preferred. For single bolts various shapes are shown in Fig. 177 herewith. The design lettered A looks simple: but the same weight of metal cast into forms B or C would be much stronger. With a central upward pressure the metal in the periphery at *a a* is practically idle; and the rim *a a* would deflect downwards. At *b b*, under the same conditions, the metal would be used, and would be in tension. In the case of form B the rim is prevented from deflecting downwards by the mass of metal beneath. For any design, however, much over 6in. or 9in. across, the form shown at D is preferable, wherein the

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deflection of the top plate is prevented by ribs, *n n*, beneath. The part plan of this latter is given at E (Fig. 178), where also a similar design for a pair of bolts is represented at

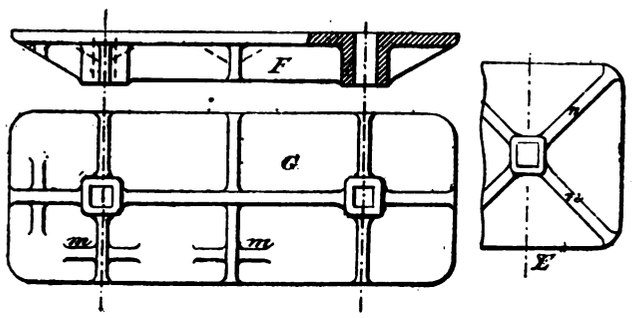

FIG. 178.

F and G. For large plates, say over 1ft. in width, subordinate ribs, *m m*, may be added, as shown.

(To be continued.)

THE BLACKBURN ELECTRICITY WORKS EXTENSIONS.

In few, if any, towns in England has the demand for electricity grown so fast in proportion to the size of the town as at Blackburn. It is a little over two years ago since the supply was commenced and we travelled to Blackburn to inspect the works then opened. The description of the plant will be found in our columns dated February 15, 1895, which forms an interesting comparison with the following *résumé* of progress. Perhaps the surest indication of the growth of the undertaking can be gathered from the financial aspects. The station was opened at the worst part of the year, and had to run the summer practically without load. Hence the first 10 months' working (ending December 31, 1895) did not result in sufficient balance to pay the capital charges. The gross income for this period was £1,216, and the total costs, including repairs, rates and taxes, and management expenses, came to £1,205. The

MR. E. M. LACEY, CONSULTING ELECTRICAL ENGINEER.

department was therefore debited with a loss of £1,865 due to capital charges up to date. Considering the fact that the first six months fell in such a bad part of the year from the lighting point of view, it is a credit to the engineers concerned that the outgoing expenses were met. For 1896, however, very different results were obtained, as can be seen from the balance-sheet and report at the end of this article. The gross income rose to £3,647, and the corresponding outgoing expenditure only increased to £1,928. This left a balance of £1,719, which is sufficient to meet all the capital charges for the same year. The shrewd Lancashire men forming the Electric Lighting Committee, under the able chairmanship of Alderman W. Thompson, soon gathered from the returns that they had got a paying department, and hence the extensions have not been stinted. These have been designed by Mr. E. M. Lacey, the consulting engineer responsible for the original station, and the carrying out

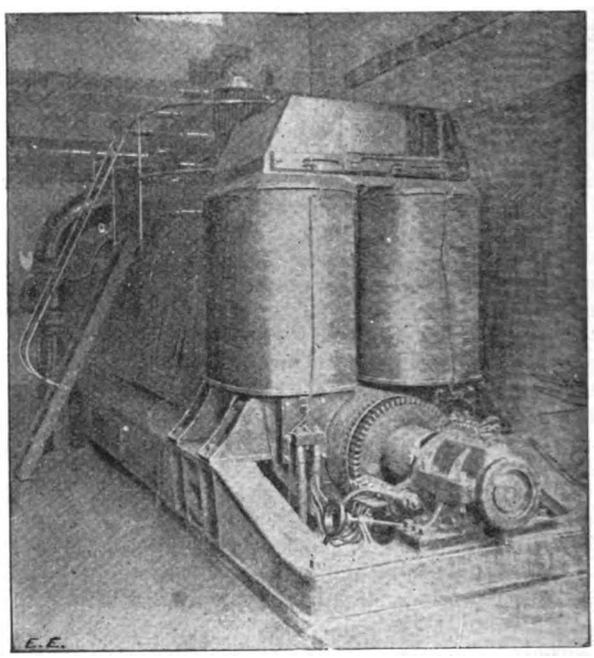

FIG. 1.—View of the Mather and Platt 225-kw. Dynamo and Belliss Engine.

of the same has of course been looked after by Mr. A. S. Giles, the borough electrical engineer. The first development required was the addition of a large direct-current generator to supplement the four sets at first installed. It was decided that a 225-kilowatt output should be asked for, and tenders to supply the same were accepted from Messrs. G. E. Belliss and Co. and Messrs. Mather and Platt, of Salford. The engine is of the Belliss high-speed

MR. A. S. GILES, BOROUGH ELECTRICAL ENGINEER.

self-lubricating type, with three cylinders, and has three cranks at 120deg. to each other. It is capable of developing 360 i.h.p. at 350 revolutions per minute with a steam pressure of 120lb. per square inch, non-condensing. The engine is of the closed-in type, as can be seen in Fig. 1, and has forced lubrication to all moving parts. The governor is of the throttle-valve type, which can be made extremely sensitive to small variations of speed, and is adjustable by hand whilst running. The guaranteed limits of control were within 2 per cent. between full load and half load, and within 5 per cent. between full load and no load.

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The dynamo, direct coupled to the above engine, is of the Hopkinson type, manufactured by Messrs. Mather and Platt, of Salford. The proportions of the dynamo can be seen in Fig. 1. The armature is drum wound, and so connected at the ends that the brushes collect the current on an horizontal axis of the commutator. The massive field magnets are shunt wound. The coils are so designed as to provide ventilation between the formers and the magnet. The output of the machine is 935 amperes at 240 volts, but the voltage is capable of adjustment by varying the field current between 225 and 250 volts at 900 amperes. When tested at the makers' works the combined set, engine and dynamo, was found to have an efficiency at full load of 88·4 per cent. The consumption of steam per electrical horse-power given out, when working non-condensing with 120lb. steam, was as follows:

At full load	26·03lb.	of water	per electrical	horse-power.
At ¾ load...	30·6lb.	,,	,,	,,
At ½ load...	33·46lb.	,,	,,	,,

The Alternate-Current Plant.

It was soon found that the direct-current system was not able to cope successfully with the demands for light from the out-lying residential districts. It will be remembered that the plans for the first station were not in the first instance prepared by Mr. Lacey, and that the town had been committed to a low-tension direct-current system before that gentleman was appointed as consulting engineer. Mr. Lacey, however, decided with promptitude that it would be false economy to strain the direct-current supply up to the requirements of the widely-scattered areas. Hence the centre of the town was left to the direct-current system, and high-tension mains and alternate-current plant were accordingly advertised for. The system of mains now completed is shown in Fig. 2. The districts served form practically the "West-end" of Blackburn, which is grouped along the Preston-road and the Corporation park. The fact that many of the large houses served are about a quarter of a mile from the main road emphasises the fact that a high-tension system must be used to give a satisfactory supply. Briefly, the new scheme is as follows: Two 60-kilowatt steam alternators are installed to take the load on the alternate-current network during the evenings, or when there is a good demand for current. These are supplemented by a motor-alternator having a normal output of 20 kilowatts. The motor of this set takes current from the 'bus bars of the direct-current system, and the energy so taken is transformed to high-tension alternate current to supply the network at light load. Thus even in the winter at present, the steam alternators are only required to be running for about six hours per day. During the remaining 18 hours the motor-alternator gives a continuous supply to the outlying districts. This part of the plant has its own switchboard, etc., but takes steam from the common steam-ring. The distribution is at present mostly effected on the house transformer system, but a section of low-tension distributors has been laid, and will be added to as soon as the number of consumers in any part of the district warrants the change. The present ground plan of the station can be seen in Fig. 3, which also shows the proposed traction extensions. The following are details of additions since the station was opened in 1895.

Boilers.

One boiler has been added to those previously in use. It is similar in every way to the two first fixed by Messrs. Yates and Thom, of Blackburn. It is of the Lancashire type, 28ft. long and 7ft. 6in. in diameter. Each internal flue is fitted with four Galloway tubes. The boiler, like the rest in the battery, is fitted with Proctor's mechanical stokers, which are driven by a small electric motor. The fuel used at Blackburn is small slack, costing only 6s. per ton, which greatly reduces the cost of production. It will be noted that the cost of fuel per unit generated at Blackburn this last year was only ·358d. The steam-pipes have, of course, been added to somewhat largely to make connection to the new machinery. The ring system is still followed out, as can be seen in the drawing, Fig. 3.

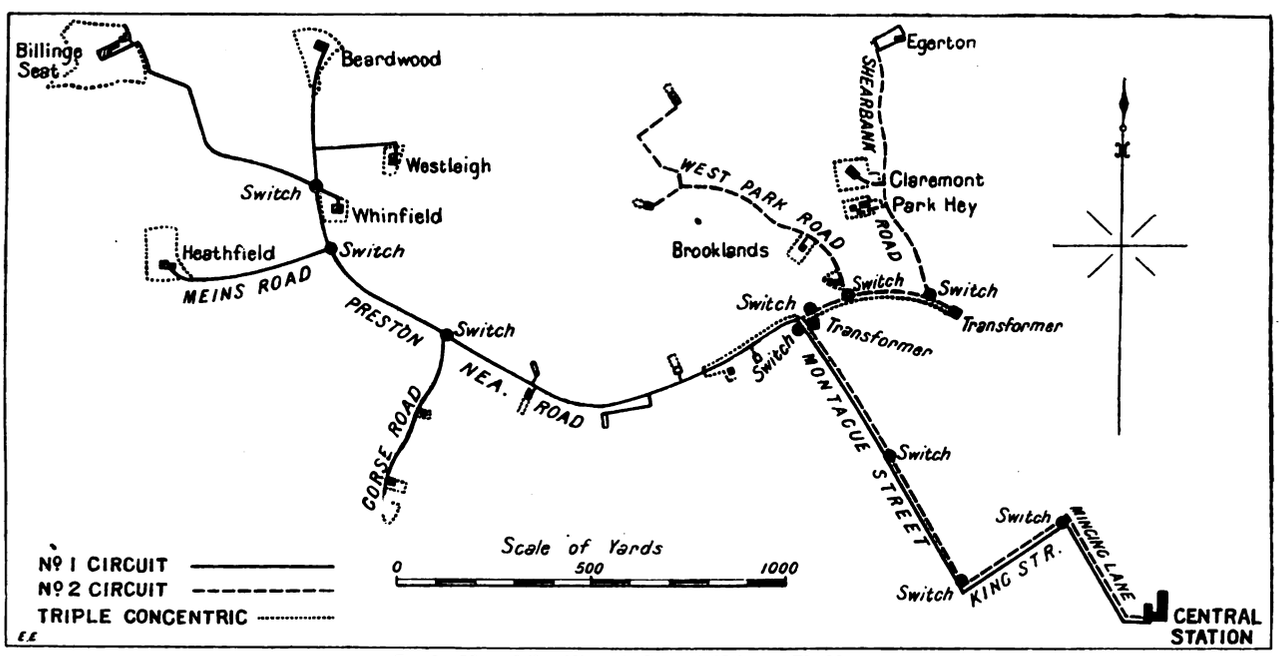

Fig. 2.—Map of the Alternate-Current Mains at Blackburn.

Steam Alternators.

The engines of these two 60-kilowatt units were supplied by Messrs. Willans and Robinson, Rugby. They are of the three-cylinder compound type, virtually consisting of three separate single-acting engines coupled on to three cranks at 120deg. These two engines are each capable of developing 110 h.p. at 450 revolutions, with steam at 120lb., when non-condensing. The governors are of the throttle-valve type, and hold the engines well under control for wide variations of load. The tests of these engines when coupled to the alternators are given below. The alternators were manufactured by Messrs. Siemens Bros., who had the contract for the complete sets. They are of somewhat novel construction, as can be seen from the illustrations, Figs. 4, 5, and 6. The first two illustrations give the details of the alternator, while Fig. 6 is a view of one end of the engine-room. In these machines the field-magnet system revolves. It consists of two claw castings set on the same axis, with the claws interspaced so as to form alternate poles. A single exciting coil is then sufficient to magnetise the complete system. The armature coils are wound flat, round a core of wood and then laid against a laminated iron core, as shown in the illustrations. The voltage of the machine is 2,000 and the frequency about 50 complete periods per second. The armatures being stationary allows of all the high-tension conductors being completely insulated, and hence tends to the safety of the attendants. These circuits were tested

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with 5,000 volts alternating to earth without any faults developing. In glancing through the specification of these machines we were glad to notice the following alternative clause: "Contractors are at liberty to quote alternative prices for different makes of engines or for standard sizes of steam dynamos working at a higher output or at a higher frequency (up to 75), and provided that such engines or sets comply otherwise with the terms of the specification, such alternative prices will be taken into consideration." On testing these sets at the engine-makers' works, a combined efficiency of 80 per cent. was found at full load. The following was the steam consumption at varying loads:

Full load ..... 37·5lb. per kilowatt-hour, non-condensing.
Half „ ..... 47lb. „ „ „ „

of giving continuously an output of 20 kilowatts. The exciting watts required by this machine are 320. The over-all efficiency of the transformation was found to be 79 per cent. on trial at full load.

SWITCHBOARD.

The switch-gear connected with this new plant has been supplied by Messrs. S. Z. de Ferranti, Limited, there being five panels—three panels controlling dynamos and two panels controlling circuits. The diagrams of the connections of the high and low tension portions are shown in Figs. 10 and 11. The switch-gear is of the well-known Ferranti type. All the fittings are carried on enamelled slate by means of porcelain insulators fastened into this slate (Figs. 12 and 13). There is nothing of an inflammable nature about any part of the gear, the slate slab on which

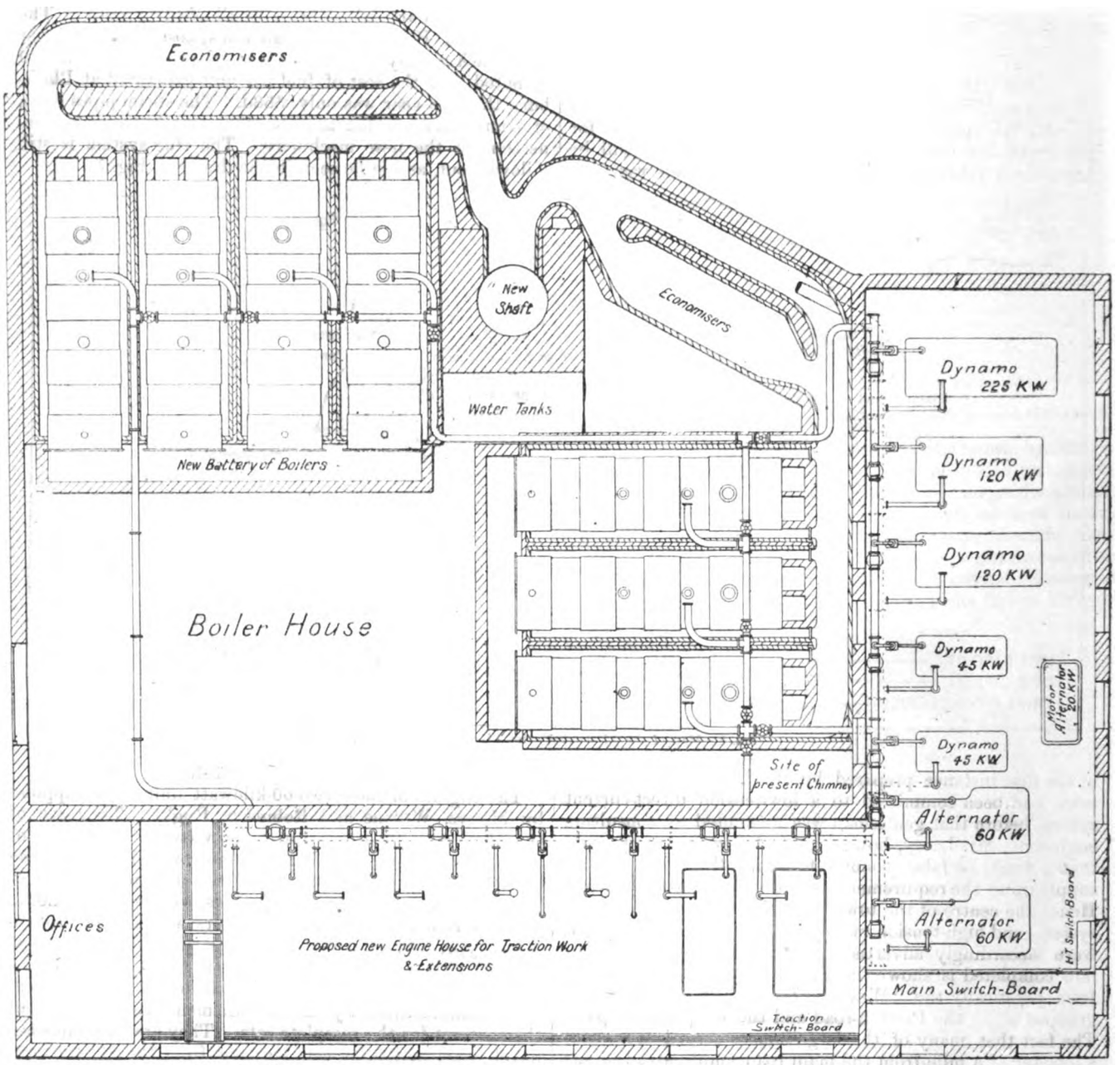

FIG. 3.—Plan of the Blackburn Central Station, showing the Proposed Arrangement of the Traction Plant and New Boiler-House.

The field coils require 600 watts to excite the magnets, equal thus to 1 per cent. of the full-load output. The temperature rise on the machine was under 50deg. F. The efficiency curve for these alternators is given in Fig. 7.

The motor-alternator, as mentioned above, is used to feed the high-tension mains at light loads. Figs. 8 and 9 give the general arrangement of this set, and also many of the details. The motor is of a type much used in the past by Messrs. Siemens Bros. The magnets are placed horizontally, with two limbs each side of the armature, thus requiring four magnet coils. These are shunt wound, and take about 350 watts for excitation. The alternator, direct coupled to this motor, is of the type described above, and is capable

the fittings are supported being secured into the wall of the station by means of cement. Each panel is distinctly labelled, showing dynamo or circuit it controls, and the switch, ammeter, and fuse belonging to each machine or circuit is in a perpendicular line. As each panel controls either one diagram or circuit the board shows its own connections, and is so simple in working that the switch attendant need only be possessed of ordinary intelligence. All the switches are constructed with ample contact surfaces to conduct the full current generated without heating, and the dynamo switches are fitted with synchronising contacts, which, when the switch is at half cock, make contact with the synchronising bar, which is

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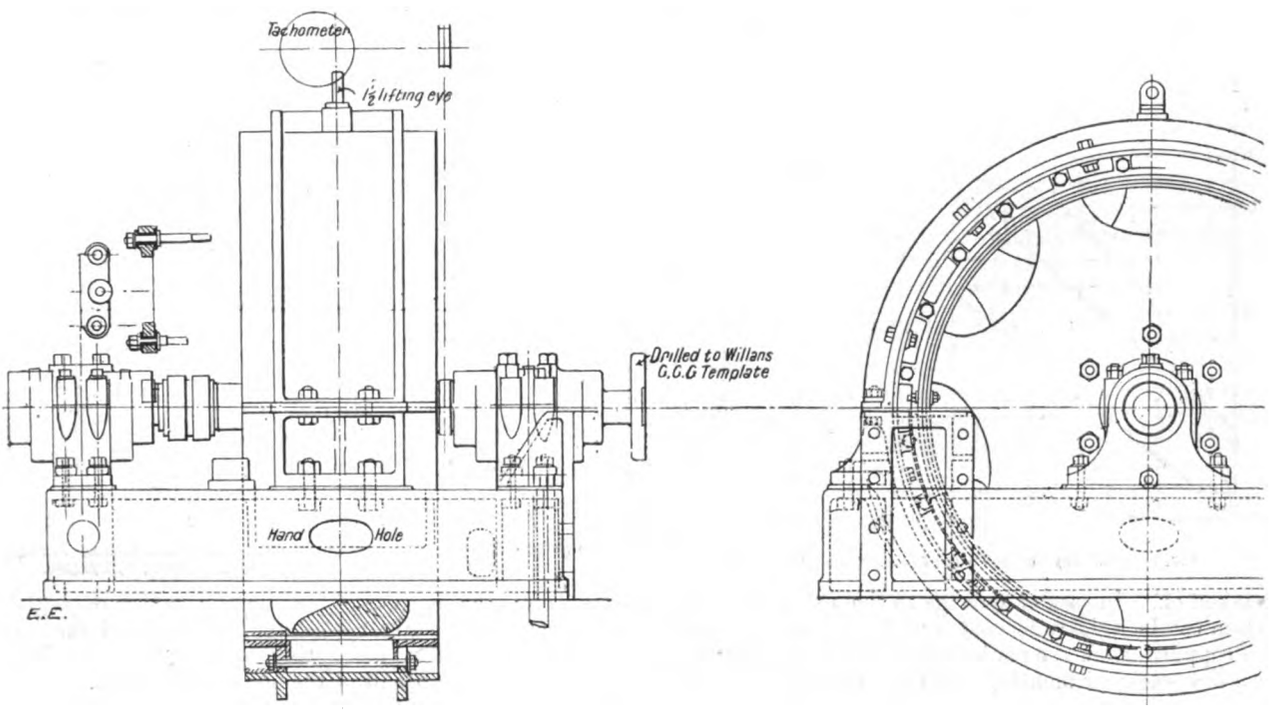
connected through fuses to the synchroniser and lamps. The switch-gear is designed specially for parallel running. With regard to the fuses, these are Messrs. Ferranti's well-known oil-break type, the fuse wire being held in constant tension. Should this wire be broken owing to an abnormal amount of current passing through it, the terminals to



FIGS. 4 AND 5.—Elevations of Siemens 60-kw. Alternator, with Revolving Field Magnets.

which the fuse wires are attached are buried in an oil bath, this entirely preventing the possibility of any arc maintaining when the fuse blows. Messrs. Ferranti have also got an improved arrangement in connection with this switch-gear, which greatly facilitates the working of the station, as by an arrangement of duplicate contacts a new fuse can be inserted without breaking the continuity of the supply,

the able hands of Messrs. W. T. Glover and Co., of Salford. The diagram (Fig. 2) of the work done shows how far the cables have been laid. Several novel and interesting features have been introduced in carrying out this work. From the switchboard at the generating station, two high-tension $^{19}/_{17}$ concentric cables (Fig. 14) are carried to the corner of Montague-street. From the corner of Montague-street one concentric cable is carried up Preston-road to Billinge, the other down Preston-road to West Park-road, Shearbank-road, etc. Down Montague-street, there are two feeders running side by side from the station for nearly a mile, and these are divided into five sections by four rotating switches of

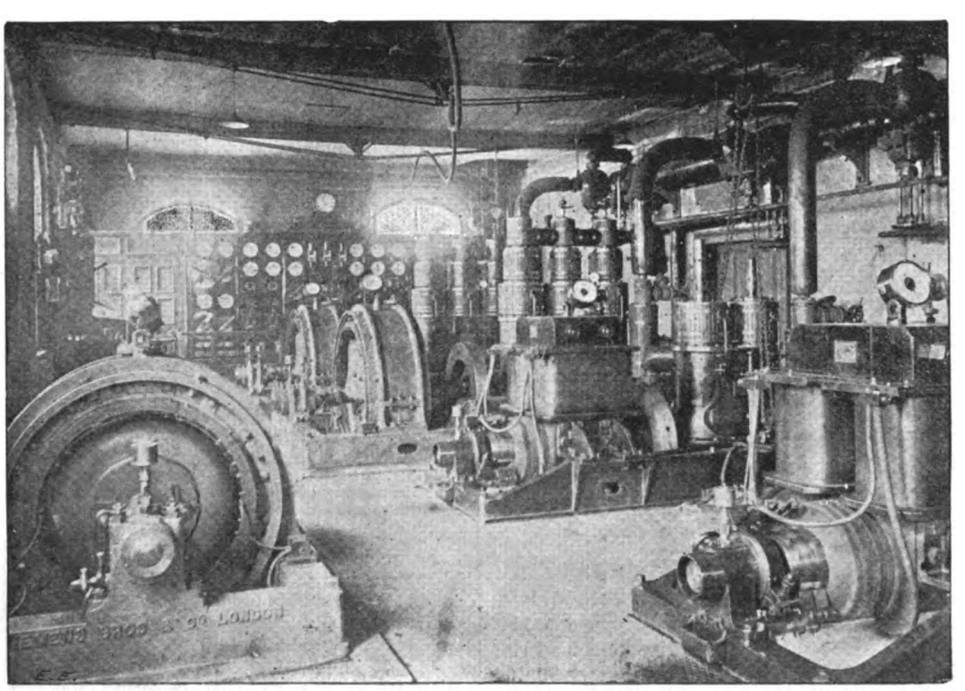


FIG. 6.—View of One End of the Blackburn Station, showing the Alternate-Current Plant. The Motor-Alternator is in the Foreground

and the working fuse can be withdrawn for cleaning or renewing the fuse wire. The regulating resistances controlling the supply of exciting current to the alternators are carried underneath the dynamo switch-panels.

DISTRIBUTION.

The contracts for the supply of the necessary cables, etc., for the alternate-current extensions were placed in

Glover's four-way type (Fig. 15 and 16). Ordinarily the mains are kept as two separate circuits, but if for any reason part of one requires to be taken off, say, to make a connection, it is effected by moving the disc of the switches at either end, shown in Fig. 17. The interruption of supply is thus limited to the section to be worked on. Long branches or services are controlled by Glover's three-way switches (Fig. 18), which act exactly in the same way as above.

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The introduction of these at junctions not only enables the branch to be disconnected, but also the main itself beyond the branch, or both branch and main beyond can

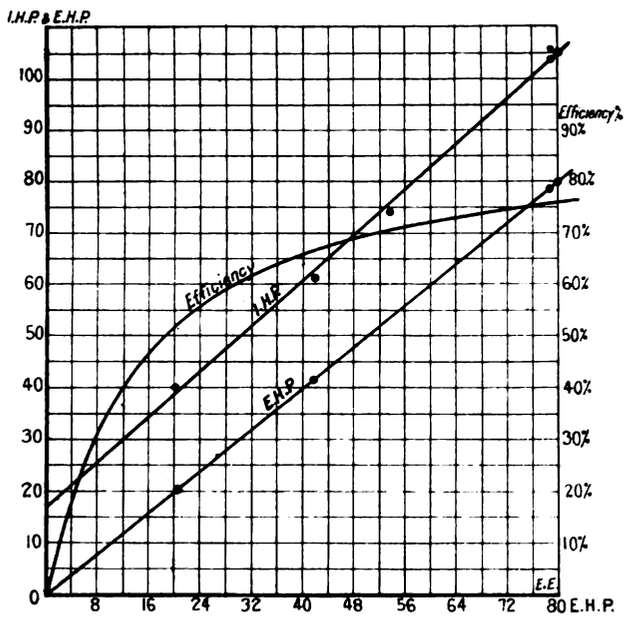


FIG. 7.—Efficiency Curves for the 60-kw. Steam Alternator.

be taken off. In case of damage to the cable the injured section can be quickly located, and if a big private installation supplied from the main is required to be shut down for a few weeks or months, it can be turned off or on in a few seconds. Again, these switches can be used where two parallel mains pass a transformer sub-station. By connecting both mains to a three-way switch and putting the transformer on the branch, it can be fed from either or both cables, or, when changing fuses or making alterations in the chamber, the current can be cut off altogether. All these arrangements are single-pole, all outer conductors of the concentric cables being earthed. The switches are in concentric cables, they will break current at 2,000 volts, and have been tested after fixing at over 4,000 volts. They are locked, so that only an authorised person can move them, and their operation is as simple as the turning of a plug water-cock.

The whole of the cables are of Glover's Diatrine type, and have given every satisfaction. They are concentric lead-covered and armoured cables, insulated with a non-hygroscopic insulation called "Diatrine" by the makers. The composition of this insulation is naturally kept a secret, but tests up to the present prove it possesses most valuable properties. One length of triple-concentric cable for a three-wire distribution at low tension has been laid as shown in the map. The sections of the cores are ·186 square inch, ·12, and ·186in. respectively. This cable is also lead covered and iron armoured, as shown in Fig. 22. The high-tension cables were tested with an E.M.F. of 5,000 volts inner to outer and 500 volts outer to lead. The low-tension cable was tested with 500 volts inner to middle, 500 volts middle to outer, and 500 volts outer to lead. Fig. 19 shows a cone grip for making connections to cables, much used in Glover's system of street boxes, and Fig. 20 is a draw-in box used on a length of pipe line laid in Montague-street. Figs. 21 and 22 show

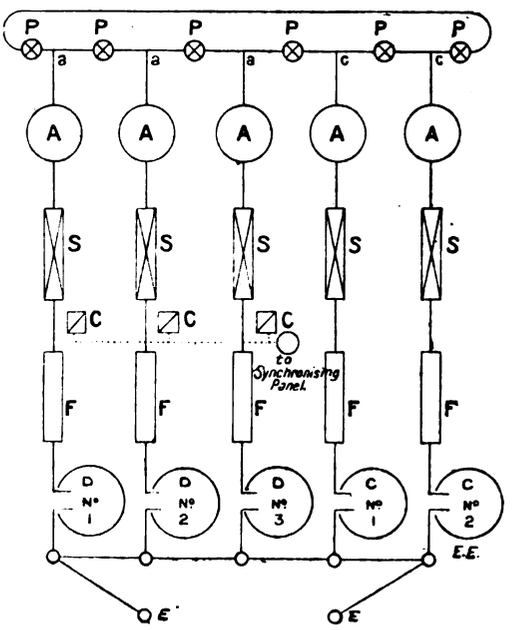
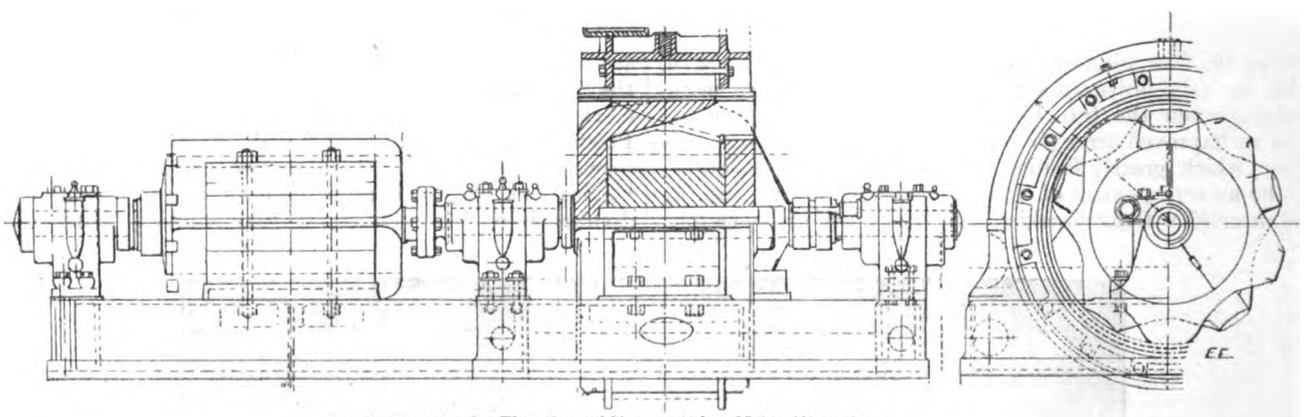


FIG. 10.—Diagram of Connections on the High-Tension Board. P, Plug; A, Ammeter; F, Fuse; C, Synchronising Contact; D, Dynamo.

details of the high and low tension cables respectively. The whole of the street work at Blackburn and the laying of the cables has been ably carried out by Mr. J. Hetherington on behalf of the above contractors.



FIGS. 8 AND 9.—Elevations of Siemens 20-kw. Motor-Alternator.

TRANSFORMERS.

These were supplied by Messrs. Siemens Bros. In the case of the low-tension distribution the following arrangements had been adopted: transformer boxes capable of containing 25-kilowatt transformers are placed under the

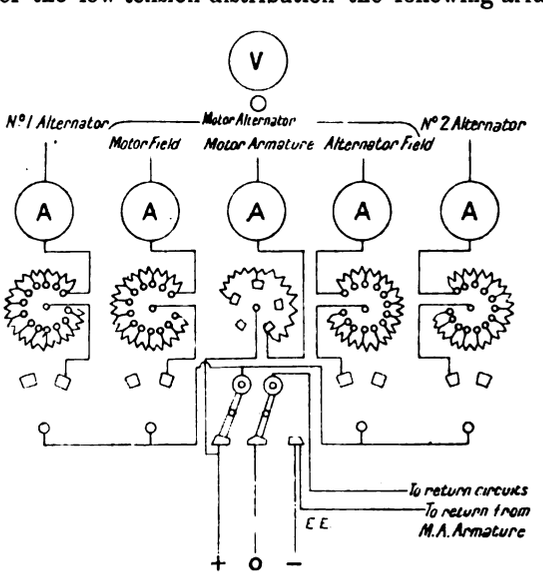


FIG. 11.—Diagram of Connections of the Low-Tension Board.

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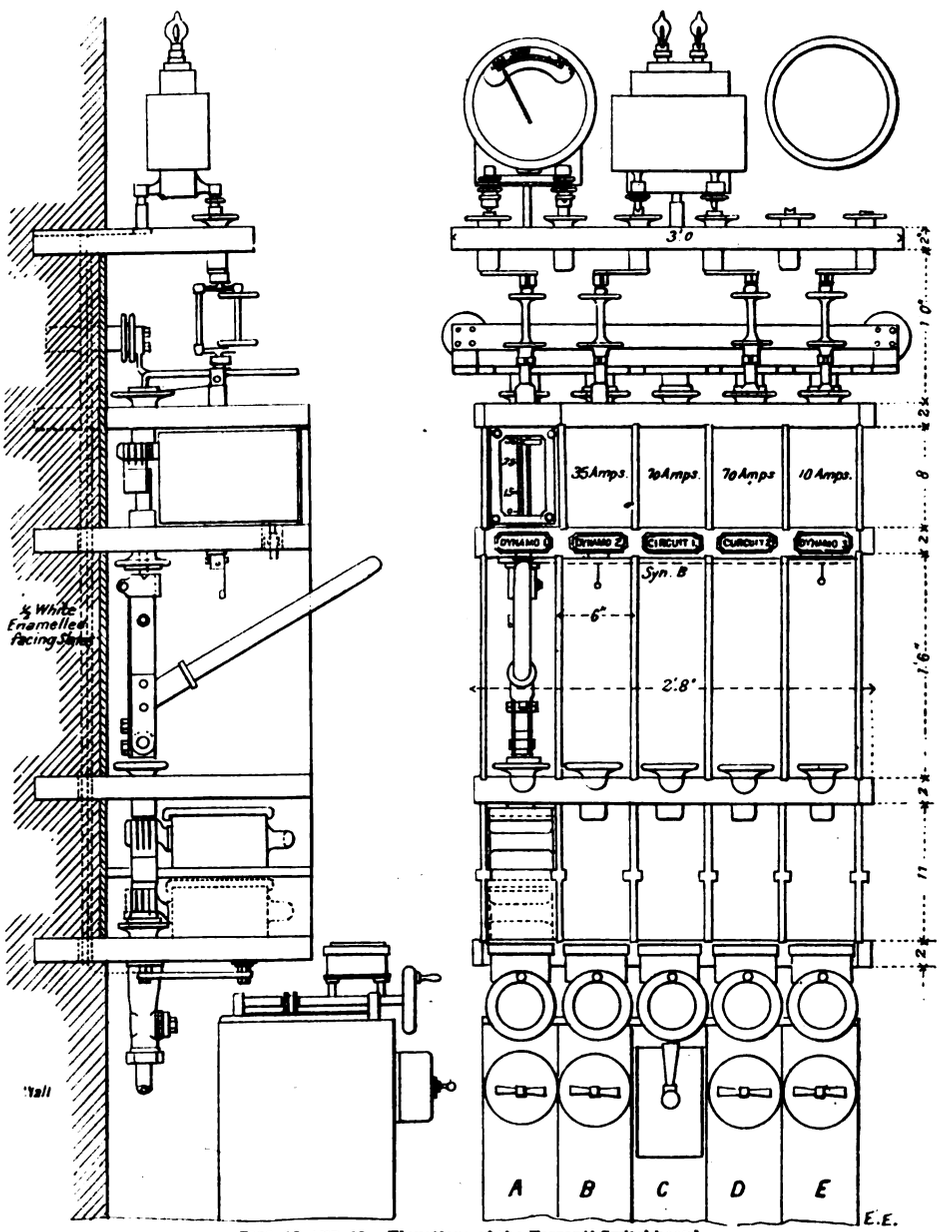
footways, and hence transformer-chambers in the usual sense of the word have not been used. At present



FIGS. 12 AND 13.—Elevations of the Ferranti Switchboard.

10-kilowatt transformers have been placed in these boxes. Owing to the scattered district served, the great majority of the consumers have their own transformers at present. Thus the contract quantities for transformers are as follows: 10 transformers for an output of 750 watts; five transformers for an output of 1,000 watts; 10 transformers for

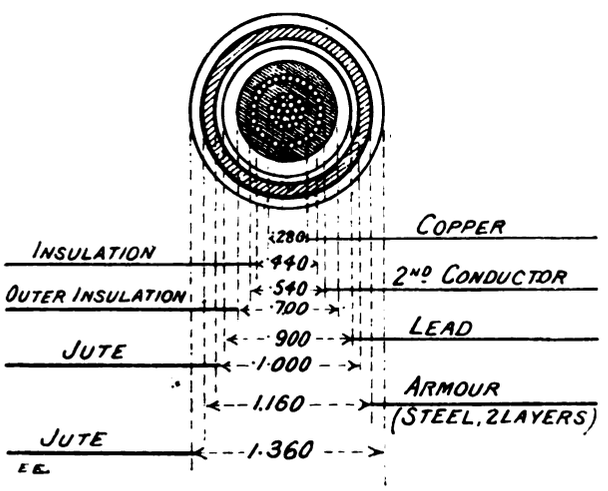
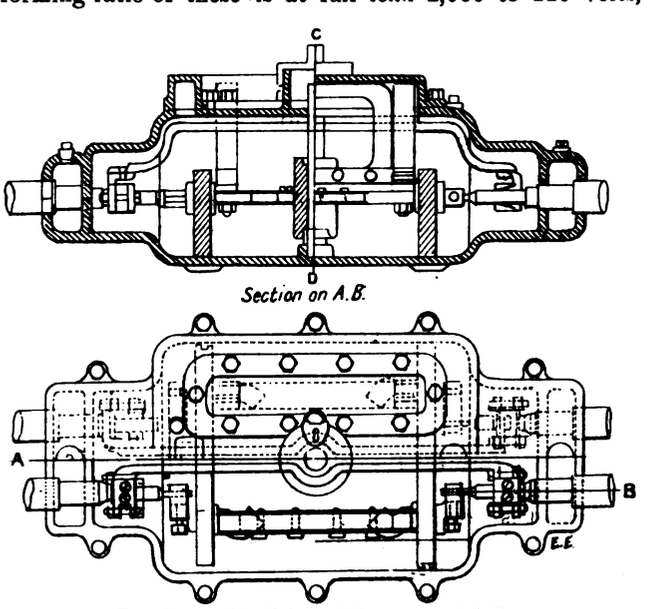


FIG. 14.—Section of the High-Tension Feeders.

an output of 1,500 watts; three transformers for an output of 2,000 watts; five transformers for an output of 3,000 watts; three transformers for an output of 4,500 watts; five transformers for an output of 6,000 watts; and three transformers for an output of 8,000 watts. The transforming ratio of these is at full load 2,000 to 110 volts,



FIGS. 15 AND 16.—Details of Four-way Switch-Box.

and the E.M.F. is guaranteed to be in no case more than 114 volts at no load, nor to be less than 109·5 volts at

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full load. The maximum drop allowed in any case was 3·5 per cent. The open-circuit losses allowed by the specifi-

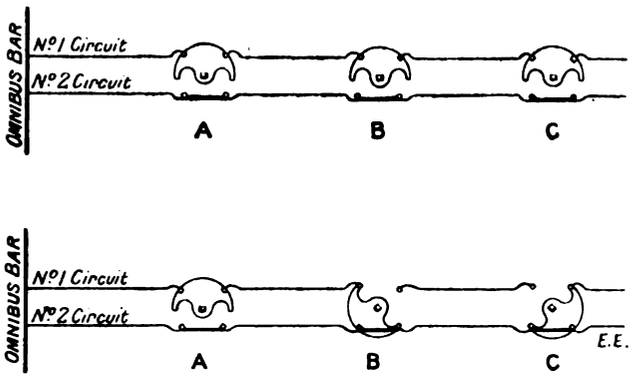

FIG. 17.—Diagram of Connections, showing method of Isolating a Faulty Section.

cation were limited as follows: for the 750-watt transformers, 22 watts; 1,000-watt transformers, 26 watts;

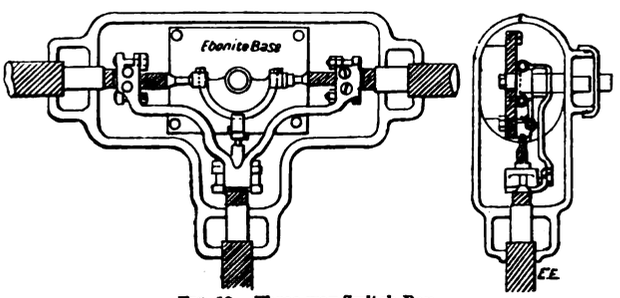

FIG. 18.—Three-way Switch-Box.

1,500-watt transformers, 30 watts; 2,000-watt transformers, 35 watts; 3,000-watt transformers, 49 watts;

FIG. 21.—High-Tension Cable.

4,500-watt transformers, 54 watts; 6,000-watt transformers, 60 watts; 8,000-watt transformers, 70 watts; and a deduction from the contract price of 10s. per watt over is to be made from the sums due to the contractor. We understand, however, that the transformers supplied were well within the above limits. This practically completes the description of the work actually carried out, but further extensions are now being advertised for.

TRACTION.

This time the departure is to be that of supplying power for traction purposes from the Corporation station. An arrangement has, under advice from Mr. Lacey, been entered into with the local tramway company. There are only two lines in Blackburn now worked by horse traction, and these are to be converted into electric street railways, to use a Yankee term. The basis on which the work is to be carried out seems to us to be fair to all concerned, and the Corporation has asked a reasonable price for the power afterwards. The line, with overhead work, poles, etc., is to be supplied by the Municipality, as is also the necessary generating plant. The company thus only require to furnish the electric cars, which are to be two-deckers. The charge per unit under a 21 years' agreement is arranged to be 2½d., of which it is assumed that the 1½d. represents the price of the power, while the other penny is to meet the capital charges and maintenance of the distributing system. The plant now advertised for, and for which tenders were received up to last Saturday, is, of course, liable to variation, but the following *résumé* gives an idea of the quantities. Two high-speed steam-engines are required, each capable of developing 200 h.p. at 350 revolutions, with steam at 115lb. pressure. These are to be controlled by throttle-valve governors. The direct-current generators, direct coupled to these, are compound wound, and the shunt coils may be excited from the 'bus bars of the lighting station. The maximum load on these is to be 220 amperes at 550 volts, and the average working load is expected to be about 140 amperes. The dynamos must, however, be able to stand a momentary load 25 per cent. above the maximum. Tenderers are asked to quote for machines with two armature windings

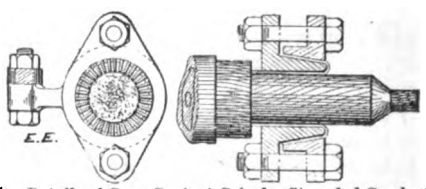

FIG. 19.—Details of Cone Contact Grip for Stranded Conductors.

and commutators which can be connected in series for traction purposes, and in parallel, if required, to assist the lighting circuits in the centre of the town. Three miles of roadway are being equipped; almost all have single tracks

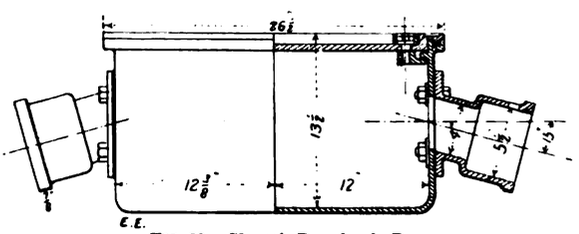

FIG. 20.—Glover's Drawing-in Box.

only, with turn-outs at intervals for passing. The first line runs from near the central station, up Jubilee-street, the

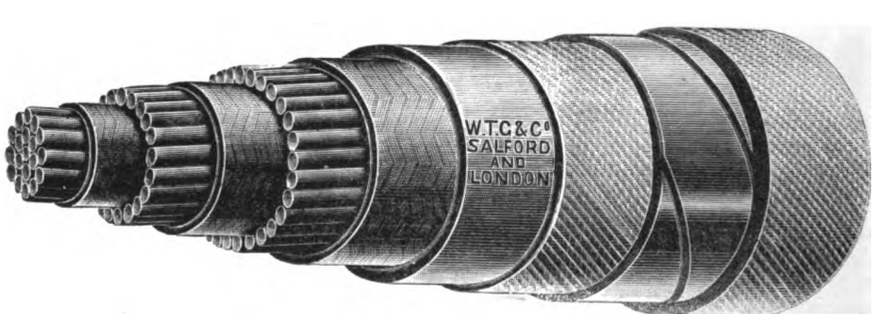

FIG. 22.—Triple-Concentric Low-Tension Cable.

Esplanade, Railway-road, through the Market-place, and along Preston New-road to Billinge End. The other line

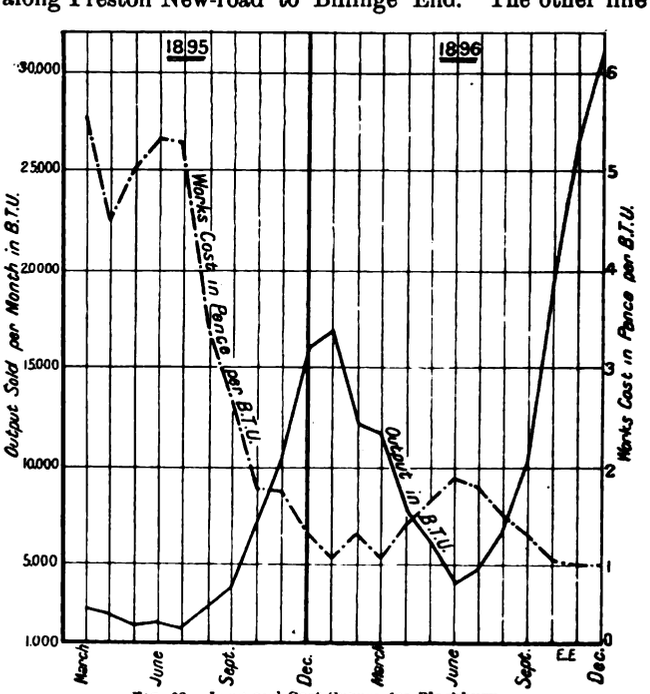

FIG. 23.—Load and Cost Curves for Blackburn.

runs down Peter's-street, King's-street, Whalley-bank, Bank-top, to Witton. There are two armoured feeders, of

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·150 square inch section, to the Preston-road section, where heavy grades have to be negotiated. Two trolley wires are to be suspended throughout the route—one for each direction of the service. The wire will be ·324in. diameter, and is to be suspended on poles not unlike those used at Bristol. On the double track central poles will be used, but elsewhere bracket poles. Lamps for street-lighting will be placed on nearly all these poles.

We must, in conclusion, acknowledge our appreciation of the high-class character of the electricity works at Blackburn, and of the excellent repair in which they are kept. The installation reflects great credit on Mr. E. M. Lacey, and we trust that the traction plant will be as great a success as the lighting has been. The upkeep of the station could not be left in better hands than those of Mr. A. S. Giles, whose report (given below) on the past year, recommending a reduced scale of charges, has recently been adopted by the Council. We also take this opportunity of giving the accounts for 1896, which are well accompanied by the curves of output and cost (Fig. 23), kindly prepared for us by the borough electrical engineer.

The following is the report of Mr. A. S. Giles to the Electric Lighting Committee, dated March 19, 1897:

The accounts of the electricity undertaking for the year 1896 are now before you, and we have made a gross profit sufficient to pay our interest and sinking fund charges for the year. There is a loss to date to be carried to next account, which approximately represents the deficit of the year 1895. As the result of the year's working for 1896 has shown that a revision of the tariff of charges for electricity can now be safely made, it may be well to briefly review the results obtained under the rebate system of charging adopted during the past half-year. The business has nearly trebled during the year 1896, and the rate at which new consumers have been connected in the last half-year has exceeded that period when the sliding scale was not in force by over 100 per cent. The object of the sliding-scale form of reduction was to increase the productiveness of the plant, and the benefits which it offered to the long-hour consumers have had the desired result of lengthening the average time during which the light is used. In 1895 (10 months only) we sold during the year 111 units per electrical horse-power, whereas in the 12 months ending December, 1896, we sold 340 units. Or, again, in the first half of 1896, when a uniform charge of 6d. was made, £3. 0s. 6d. was received as revenue per electrical horse-power, whereas in the second half-year, when, owing to the sliding scale, the average price obtained had fallen 8 per cent., the revenue per electrical horse-power was £4. 1s. 6d. The average number of units sold per lamp fixed has also largely increased since the sliding scale was adopted. This increased productiveness of our plant has enabled us to produce electricity in 1896 at a lower works cost than any figure yet published of any electric lighting station of the same output—viz., 1·26d. per unit sold—and a lower total cost on the first completed year's working of any municipal undertaking in the United Kingdom, except Edinburgh, which had an output five times as great as ours. In consideration of these exceptional figures obtained, and the percentage of increased revenue which we estimate for the year 1897, I am quite satisfied that the wisest form the revised tariff can take will be as follows: (1) to reduce the present two hours at 6d. per unit to one hour at that price, and to charge for all current after this time at 3d. per unit; (2) to give 5 per cent. discount for early payment at the Municipal Offices, Victoria-street, up to a specified date after presentation of the quarterly accounts; (3) the revised charges to date from July 1 next; (4) the 5 per cent. discount to be given on the quarterly account presented at the end of March next and henceforth. I am quite convinced, from our present customers' consumption, that this tariff will yield a large margin of profit in 1897.

(Signed) ALFRED S. GILES.

Dr. GENERAL BALANCE-SHEET, DEC. 31, 1896.	£	s.	d.
Capital account—amount received	29,950	0	0
Sundry creditors for coal and stores	849	13	2
Sinking fund account	1,781	14	3
Amount owing bankers, £8,419. 1s. 1d.; less in hand on sinking fund account, £1,781. 14s. 3d.	6,637	6	10
	£39,218	14	3
Cr.	£	s.	d.
Capital account—amount expended for works	35,266	11	1
Stores on hand: oil, waste, £29. 19s; general, £83. 6s. 9d.; electric cookers, £51. 13s. 6d.	164	19	3
Sundry debtors for current supplied to Dec. 31, 1896	1,550	7	9
Sundry persons for lamps and fittings	366	9	8
Net revenue account—balance at debit thereof	1,870	6	6
	£39,218	14	3

REVENUE ACCOUNT, YEAR ENDING DEC. 31, 1896.

Dr. Generation of Electricity.				£	s.	d.
Coke, coal, and all expenses of placing same on the works	£255	19	0			
Oil, waste, water, and stores	117	14	6			
Wages at generating station	380	8	4			
				754	1	10
Repairs and Maintenance.						
Buildings	0	13	0			
Boiler-house, machinery, tools	26	7	7			
				27	0	7
Repairs and maintenance of mains	46	17	10			
Repairing meters	1	4	6			
				48	2	4
Lamps, carbons, and fittings				209	0	3
Rates and Taxes.						
Rent of works	75	0	0			
Ground rent	74	0	4			
Income tax	26	13	4			
				175	13	8
Management Expenses.						
Salaries of engineer and assistants	388	6	8			
Office clerks' wages	83	9	2			
Stationery and printing	46	11	8			
General establishment charges and advertising, and commission on loans	118	5	5			
				636	12	11
Royalty				16	0	
Insurance				63	17	6
Bad debts				12	13	6
Total expenditure				1,927	18	7
Balance of revenue account				1,719	2	5
				£3,647	1	0

Cr.	£	s.	d.	£	s.	d.
Sale of current	2,268	12	6			
Public lighting	1,103	14	8			
	3,372	7	2			
Less discount	34	9	1			
				3,337	18	1
Rental of meters				77	16	5
Sales of lamps and fittings				231	6	6
				£3,647	1	0

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC.

Quantity generated in B.T. units		171,299
Quantity sold { Public lamps	33,884	157,000
Quantity sold { Private consumers by meter	123,116	
Quantity used on works		4,972
Total quantity accounted for		161,972
Quantity not accounted for		9,327
Number of public lamps		18
Total maximum supply demanded (kilowatts)		261

FORTHCOMING EVENTS.

The following are some of the announcements for the forthcoming week:

TO-DAY (FRIDAY).—Royal Institution (Prof. J. J. Thomson on Cathode Rays), 9 p.m.—Institution of Mechanical Engineers (Fans and Electric Motors, by Mr. Walker), at the Civil Engineers, 7.30.—Also at Newcastle, meeting of the North-East Coast Engineers (Gravitation Stamp Mills).

TO-MORROW (SATURDAY.—Royal Institution (Dr. J. P. Mahaffy on the Greek Theatre), 3 p.m.; also at 5 p.m., annual meeting.—Institution of Junior Engineers' visit to Blackwall Tunnel works; train leaves Fenchurch-street at 2.40 p.m.

MONDAY, MAY 3.—Society of Arts (Cantor lecture, "Design in Lettering," by Mr. Lewis Foreman Day), John-street, Adelphi, 4.30 p.m.—Royal Institution (monthly meeting), 5 p.m.—Society of Engineers (United Services Institution, Gas Station Governors), 7.30 p.m.

TUESDAY, MAY 4.—Royal Institution (Dr. Tempest Anderson, B.Sc., on "Volcanoes." The Tyndall lecture), 3 p.m.—Society of Arts ("The Arctic and Antarctic," by Mr. Aubyn Trevor-Battye), 4.30 p.m.—Institution of Civil Engineers, 8 p.m.

WEDNESDAY, MAY 5.—Society of Arts ("The Railway to India," by Mr. C. E. D. Black), 8 p.m.—Crystal Palace Wednesday lecture, 8 p.m.

THURSDAY, MAY 6.—Royal Institution (Prof. Dewar on "Liquid Air as an Agent of Research," Lecture II.), 3 p.m.—Society of Arts ("Kafiristan: Its Manners and Customs," by Sir George Scott Robertson, K.C.S.I., late British Agent at Chitral. Lord Roberts will preside), 4.30 p.m.—Chemical Society (Burlington House), 8 p.m.

FRIDAY, MAY 7.—Royal Institution (Mr. "Anthony Hope" on "Romance), 9 p.m.—Institution of Junior Engineers (Mr. Ferriera on Electrical Railway Signalling), Westminster Palace Hotel, 8 p.m.—And at Paris, meeting of the Ingénieurs Civils de France.

SATURDAY, MAY 8.—Royal Institution (Dr. Mahaffy on the Greek Theatre), 3 p.m.—Also at Nottingham, Chesterfield and Midland Engineers' meeting, 3 p.m.

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THE

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TO CORRESPONDENTS.

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All communications intended for the Editor should be addressed C. H. W. Biggs, *139-140, Salisbury Court, Fleet Street, London, E.C Anonymous communications will not be noticed.*

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DEFENCE, NOT DEFIANCE.

The news that the Queen has approved the formation of a new volunteer corps, to be called "The Electrical Engineers, Royal Engineers (Volunteers)," will be pleasing to all of our readers. The idea of forming such a body of electrical engineers originated from Dr. John Hopkinson during the early months of 1896, when the Venezuelan dispute was before the country. His words in introducing the subject to the members of the Institution of Electrical Engineers are worth reproducing at this distant time. They were addressed to brother electrical engineers, and were as follows: You possess aptitudes which might be of great use, particularly for purposes of defence, in the unhappy eventuality of war. If you think of the use of electricity for military purposes, for telegraphs, search-lights, the training of guns, submarine mines, and so on, I think you will agree that if we were properly organised our technical knowledge must be very useful indeed." It is also announced that Dr. Hopkinson is to be appointed major of the corps. No one could be found more suitable for the post. It is also expected Lord Kelvin will be honorary colonel. The Secretary for War has made arrangements to establish a training station at Tilbury. This will be a convenient point to many, as a number of large electrical firms have their works in that district. From an interview with Major Hopkinson we gathered that full details of the duties of the new volunteers are not yet to hand from the War Office, but that they are expected to be issued shortly. Those engineers—numbering about five hundred—who sent their names in as wishing to join, will then be communicated with as to whether they will be required to sacrifice this year's holiday for their country's good. We wish the new corps every success, and trust that in case of need they will, in contradiction to their usual vocation, demonstrate how destructive electricity can be.

"COMING EVENTS CAST," ETC.

"Coming events cast their shadows before," is the full quotation; and the remarks of the chairman to the shareholders of the Eastern Extension Company are certainly indicative that at last the inevitable is to be faced. For more years than we care to remember we have strenuously advocated, from an Imperial point of view, the necessity of cable connection with our Colonies passing only through our own territory. The existing companies naturally see only trade competition in Pacific cables, and did as they were bound to do in their own interests—oppose all such schemes. When, then, the chairman of the company most nearly concerned practically admits that the competition will have to be faced, we may be sure that the competition will not long be delayed. Gratuitous advice is seldom palatable, and the following remarks will certainly not commend themselves to the "powers" of the companies interested. Practically, the group of Eastern, Eastern Extension, African, etc., companies are one going concern. They are carried on under different

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directorates, or the same men posing as directors to the different companies, for no purpose that we can see other than paying a larger number of men. It is human, so far as directors are concerned, but it is not to the shareholders' interest that combination has not long since been the order of the day. Now competition is coming, subsidies that have been paid will be dropped; and in order to economise and continue the moderate dividends hitherto paid, would it not be well to amalgamate all these separate interests, get rid of a few directors, and a great number of "fees" of directors? Begin the economical tactics from the fountain-head, where the guinea-pigs do congregate, rather than, as may be the case, with members of the staff who have never suffered from plurality of holdings or munificence in salaries. The time has not come yet to enter into detail into this question, but it will have to be faced; and the shareholders must not be permitted to suffer because there is a good deal of human nature in man—especially in man when he spells his name "director." Probably we shall ere long have to record not only one, but a couple, if not more, of Pacific cables, and then what really might have been a commercial success must depend upon subsidies. One cable properly laid and conducted with the co-operation of the Mother Country, Canada, and the Australasian Colonies might have been successful commercially as well as Imperially; but when England has laid one, when the United States have followed, and France comes in a good second or third, then the "paying" is not so easily seen.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

GAS TRACTION AND THE SHEFFIELD TRAMWAY REPORT.

SIR,—In that part of the above report which relates to Milan and other places, reference is made (p. 525 your last issue) to the gas system of traction at Dessau. As I have had to pay some attention to the gas traction question, perhaps you will permit me to draw attention to the misleading remarks made in the report on this subject. Firstly, as to the cost of running, which it is said is unsatisfactory. The gas traction line in Dessau was opened in November, 1894, with nine cars on the Luther system, the arrangement of the gas-engine and gearing of which has since been much improved for the cars more recently made. These cars, however, worked so well and economically that a public demand arose for lines on the same system connecting other parts of the town, the whole of the capital being subscribed in the town of Dessau. The year's working to the end of 1895 proved that the whole cost of the gas for traction and compression was under 1d. per car mile with gas at 2s. 11d. per 1,000 cubic feet. In Dresden the system was put into operation in 1895, and the accounts of the Dresden Tramway Company, using the three systems of horse, electric, and gas haulage, showed that all costs for haulage, including driver, were 5¾d. by horses, 4¼d. by electrical means, and 3¼d. by gas means per car mile.

On the Blackpool, Lytham, and St. Annes, where the system has been at work with great success since July, 1896, the whole cost of running for gas per car mile with 40-passenger cars and gas at 3s. per 1,000 cubic feet has fallen as low as 1·005d. in wet weather, and was only 1·25d. per car mile when the line was new and with rail grooves partly filled with tar and sticky in dry weather. What the writers of the Sheffield report can mean, therefore, by "unsatisfactory as to cost," I cannot understand.

With regard to vibration, that difficulty has been practically overcome. When I inspected the Blackpool, Lytham, and St. Annes cars the running of an engine in a standing car was imperceptible from without, and would pass unnoticed by anyone within not expecting it. In the earliest cars run on the Dessau lines experience had not shown the way to realise this very smooth running. Now, however, the two gas-engine cylinders make perfect balancing and smooth running easy, and either one or both cylinders automatically come into action, according to the load and road.

The Sheffield report says the vibration was observable "even when standing," as though the writers would expect to find it less then than when the car was running. That there is some smell resulting from the running of a gas-engine cannot be denied. There is also a very objectionable smell from the rear of a horse sometimes, only it is a different smell, but quite as disagreeable to a motorman. The gas-engine smell has, however, been reduced by the recent arrangements, by means of which the lubricating oil feed is made intermittent with the explosions, so that no unburnt oil products are exhausted, and also by the exhaust-box and pipe arrangements. Engines are now being made for the purpose by the largest makers of gas-engines in England, and the objections referred to will be even more completely removed. Considering the extent of tramway in this country earning no dividend, and the number of lines on which electric haulage is not yet likely to be adopted, it is important that any misleading statements concerning a system which is exceedingly economical in working and capital expenditure, and is eminently suitable for many places, should not pass unnoticed.—Yours, etc.,

W. WORBY BEAUMONT.

Outer Temple, London, W.C., April 29, 1897.

THE TIVOLI-ROME POWER TRANSMISSION.

We have just received the following communication from Mr. Henry Edmunds, who is interested in this country in Prof. Mengarini's system for the utilisation of alternating currents for charging accumulators or driving tramcars, which has been working so successfully for the last few years at Rome. We understand that there are already several corporations in this country considering the adoption of this system for their work.

At Tivoli, 18 miles from Rome, about 2,000 h.p., obtained from a cascade with a fall of 50 metres, is now at work. Machinery is also being erected to utilise another fall, which will give 2,000 h.p. in addition, and will be at work in 1898. Single-phase alternating current is used, at a pressure of 6,000 volts, which can be increased to 7,000 volts when required. The tension at Tivoli is varied, so as to deliver at Porta Pia, in Rome, a constant pressure of 4,100 volts under any load. The loss of energy in the line is somewhat less than 18 per cent. If there was no impedance in the line, a pressure of 5,000 volts at Tivoli would be sufficient to give 4,100 at Porta Pia instead of the 6,000 to 7,000 volts actually necessary; but this higher voltage does not mean any additional loss of energy, as the higher pressure necessary to overcome the impedance does not increase the actual watts used. The power delivered at Tivoli, measured with a recording wattmeter, is 18 per cent. more than the power received in Rome, measured in the same way.

At Porta Pia the current from Tivoli is divided into three circuits, corresponding to the three different purposes for which it is used, and requiring three different sets of apparatus:

1. *Current for Private Illumination.*—This is obtained by reducing the current coming from Tivoli from 4,100 to 2,000 volts by a bank of transformers. The current is distributed at 2,000 volts to a number of sub-stations, which feed a network of low-tension concentric cable, aggregating 80 kilometres at a pressure of 100 volts. To this network are connected arc and incandescent lamps and motors.

2. *Current for Public Illumination.*—This is obtained by transforming the current coming from Tivoli at 4,100 volts to 500, 1,000, 1,500, and 2,000 volts for various circuits

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by means of step-down transformers. The current is kept constant at 14 amperes by means of the Blathy system of automatic resistances. Thus they can feed the arc lamps for street illumination in a number of series circuits. In some cases 50 lamps are run on one circuit.

3. *Motive Power for Tramways.*—The current for tramway work is transformed into direct current by the intermediary of rotary transformers up to 60 kilowatts and motor-generators above that power. For the rotary transformers the current is reduced in tension from 4,100 volts to 400 volts and then rendered continuous. The rotary transformers raise the tension from 400 to $400 \times \sqrt{2}$—that is, 566 volts. The motor-generators consist of a synchronous alternating motor for 4,100 volts coupled direct to a direct-current shunt dynamo delivering 550 volts.

An accumulator battery of 304 Tudor cells is in parallel with the direct-current side of the converters or motor-generators. The charging current is 545 amperes, and discharging 621 amperes for three hours; or, at an emergency, a discharge of 1,738 amperes can be obtained for a short time. The battery has 1,864 ampere-hours capacity, and we can go three and four hours without recharging. The capacity of the battery could be reduced if it were required to run the tramways with the battery alone.

Forty cars (Thomson-Houston), with two 25-h.p. motors per car, have been in use since the beginning of April.

SHEFFIELD.

REPORT ON TRAMWAY TRACTION.

(Continued from page 525.)

DESSAU.—Population, 42,000.

The following information has been obtained with reference to the gas-engines at Dessau, but the deputation have not seen the system in question: The engine in these cars is placed under one seat. There are two cylinders—one on each side of the driving shaft. The access to the engine is entirely from the outside, and, as it is cut off from the inside, there is said to be no smell of gas. The noise, too, is said to be very slight. The gas is at a pressure of 90lb., and the tanks hold sufficient for a journey of about six miles. The refilling only takes a very short time. Part of the apparatus consists of a large cooling-tank, and the water in this becomes so warm that it can be used for heating the inside of the car. The car is said to be under the fullest control, and can be stopped in a very short space. The engine power required for the compressing is very slight. The gas cars as at present designed will not mount a steep gradient.

BRUSSELS.—Population, 482,000.

In Brussels the deputation had interviews with the Secretary of the British Legation, the Deputy Burgomaster (the Alderman de Mot), the Baron de Jamblinne de Meux (city engineer), the general director (M. Janssen), the general secretary (M. Janssen's son), and the engineer-in-chief of the Brussels Tramway Company (M. d'Hoop), and the engineer-in-chief of the branch establishment in Brussels of the Union Company.

The boulevards along which the electric tramways run are very wide, the width of some of them being as much as 230ft. Many of the streets traversed by the horse cars are also wide, but some of them are narrow; the gradients in some cases are very steep, being as much as 1 in 16 for 330 yards (on one of the electric tram routes), and the radius of certain curves is only 64ft. At present the steam tramways only enter the city for one short length, but in some of the suburbs there are steam tramways on a large scale, in streets of medium width, often with steep gradients and quick curves. In streets where there would not be sufficient room for a vehicle to stand between the rail and the kerb at least on one side, only those cars which are constructed to run either on or off the rails are allowed. In narrow streets where the line is single cross-overs are provided, and where double the lines interlace, or "bend," so that cars can avoid standing vehicles, etc. The paving is generally of granite, sandstone, or basalt. The rails (Phœnix section) weigh about 85lb. to the yard.

The total length of the lines of the Brussels Tramway Company is about 30½ miles, only about 1½ mile being single line. Originally nearly all the lines were single, but where the streets were of sufficient width they have been doubled in order to enable the cars to run to time. About eight miles are worked by electricity (principally overhead) and 22⅓ miles by horses. Both narrow and wide gauges (3ft. 3in. and 4ft. 8½in.) are laid, the latter being more general, but a very long line is now being laid on the narrow gauge. The tramways in Brussels are in the hands of several companies. The National Company has local and suburban railways in all parts of Belgium, the others are local companies. The capital and obligations of one of the companies amounts to about £800,000.

There are four systems of tramway traction in Brussels—viz., (1) horses, (2) steam, (3) electric overhead, and (4) electric conduit (in construction). Accumulators have been used and abandoned, but they are to be experimented with again. The advisability of adopting gas traction has been considered, one of the companies having made enquiries as to its working. They also sent an engineer to Paris to inspect the Serpollet system. The result, however, was not satisfactory for various reasons, amongst others being the expense of working, cost of repairs, etc. The lines of the National Company were originally built for steam, which to a certain extent is now superseded by overhead electricity. The lines of the other companies were built for horse or electric traction.

The horse cars are worked by from one to four horses, the company having a stud of about 1,000 horses. The cars have no top seats. In addition to the ordinary tram-cars, there are cars and omnibuses provided with a small flanged guiding wheel, so that they can use the tramlines or not according to circumstances. Some of these cars run along streets with gradients as steep as Snig-hill. All the steam tramways are to be transformed into electric tramways within 15 months by arrangement with the Municipality. Steam trams are considered by the company to be much more costly to work, although coal for the steam trams costs only about 6s. as against 8s. 8d. per ton for coal used in the production of electricity, and this is one reason why they are being discontinued.

The earliest electric line has been in use since May, 1894. The lines (both overhead and conduit) were and are being equipped by the Union Company of Berlin under a guarantee as to cost of working. On the overhead lines, however, the cost came out at even less than the guarantee, and the company were relieved of their responsibility before the term of their guarantee had expired. The guarantee was 2½d. per car mile. Where possible, the companies prefer the overhead system, and the conduit will only be used in the centre of the city and on the best streets, where the municipal authorities will not allow overhead. The suspension of the wires is by means of the usual poles and rosettes (a detailed description of which appeared in the Hamburg section—*vide E. E.*, March 12, 1897, p. 322, *et seq.*), and there does not seem to be any objection to these on the ground of appearance. This applies especially to the streets or boulevards flanked with trees, where the wires, etc., are scarcely noticeable. A view of one of the finest boulevards traversed by the electric tramways is given herewith. In some of the suburbs the lines are cheaply built, the rails are light, and the poles are of wood. These lines, however, are not satisfactory, and the rocking of the cars is very unpleasant. At present the overhead poles, etc., are not used for electric lighting, but there is a possibility of their being utilised for this purpose. The deputation inspected a long length of conduit line which was being constructed by the Union Company, and were informed the cost was £19,600 per mile on double line, including everything, and at this price the line was to be handed over by the constructors to the company ready for service. Altogether about seven miles of conduit lines are in course of construction. The gradients of some of the electric lines are about as steep as those of Angel-street

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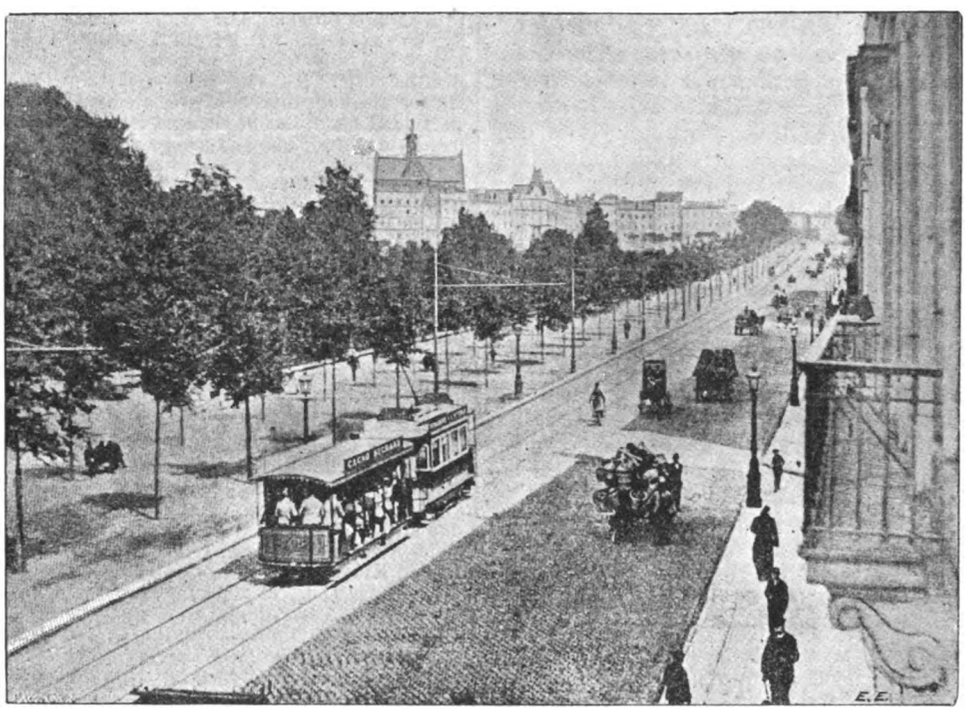
and Burngreave-road. A car with a trailer attached ascended the steepest of these with ease. On one part of the tramway route there are overhead wires and two of the companies crossing one another, but they are kept apart by insulators, and no difficulty is experienced in their use. The cost of the overhead electric lines is stated to be about £1,400 per mile for the line proper, £1,150 per mile for the electric apparatus, and £2,860 per mile for engines, cars, etc., but no buildings; altogether about £5,410 per mile. The cost per mile run, including electricity, repairs, general charges, staff management, and interest, is said to be about 4½d., but the receipts cannot be given. As previously mentioned, the cost of working was guaranteed for a certain period not to exceed 2½d. per car mile.

The present horse-power used for tramway traction is 900 indicated, 750 effective, of which two-fifths is reserve, 200 amperes, 500 kilowatts. Very large additions, however, are being made, and by May 1 next four new multipolar dynamos and a compound tandem horizontal condensing steam-engine (Corliss-Bonjour) of 2,500 h.p. is to be added. Three Babcock and Wilcox boilers are in use, which are stated to be satisfactory, but Galloway boilers would be preferred for heavy and regular traffic if space admitted. The number of boilers is to be increased to five. The current is direct, and the maximum voltage permitted is from 500 to 600. There are no accumulators at the power station. Machinery is provided for supplying compressed air to the Westinghouse and other brakes. The power station is considered to be too far from the centre of the tramway system, the furthest point being 4½ miles away. Its cost was about £12,000.

(To be continued.)



Brussels—View of Overhead Electric Tramways (Thomson-Houston) in one of the Boulevards.

MECHANICAL PROPULSION ON CANALS.

BY LESLIE S. ROBINSON.

The following paragraphs are extracted from the paper on the above-named subject read before the Institution of Mechanical Engineers on Wednesday last.

Electric haulage on a chain has lately been started upon the Bourgogne Canal, and has given complete satisfaction up to the present time. It was designed by M. Galliot, ingénieur des Ponts et Chaussées, under the direction of M. Fontaine, chief engineer of the Bourgogne Canal, and was approved by the Minister of Public Works on February 8, 1893; the work was immediately begun, and was finished on July 15 following. The reach of canal upon which the system has been applied is 3¾ miles long, and includes a little over two miles through a tunnel; the width of waterway is about 23ft. in the open and about 20ft. in the tunnel, while the depth varies from 7ft. 4½in. to 7ft. 10½in. From 1867 to 1883 barges were towed by a steam-tug hauling on a submerged chain; the plan worked well, but was dear, the cost of maintenence being high. In 1888, the old tug-boats being no longer serviceable, it was decided to utilise the waterfall at the canal locks for driving turbines to generate electricity, and to work this reach electrically. The ground having been surveyed, it was decided to make a fall of 23ft. at Pouilly at the Seine end, and another of 26¼ft. at Escommes at the Saône end. The available water power at Pouilly is 20·7 h.p., and at Escommes 11·8 h.p., making a total of 32½ h.p. Two dynamos are used, which are shunt-wound Gramme machines, connected in series; that at Pouilly is constructed to supply a normal current of 30 amperes at 370 volts, and the other at Escommes furnishes 30 amperes at 280 volts. A conducting wire running along the canal bank joins two opposite poles of the machines; and from each of the two remaining poles a separate wire runs along the same bank parallel to the first wire and below it; by means of the two lower wires the current is conveyed to the motor. When the turbines are running at their normal speed, the total E.M.F. is 370 + 280 = 650 volts; the resulting current does not generally reach 30 amperes, but varies between 12 and 25 amperes, according to the cargo towed; for a current of 25 amperes the loss of power is 180 volts. The motor is capable of absorbing a maximum of 18½ h.p.; it is rarely, however, that such a high power is required. The mode of connection by the wires presents the advantage that the length of conductor traversed by the current remains always the same, on whatever part of its journey the tug-boat may be. The switchboard on the tug has a rheostat of 180 ohms for admitting the current gradually to the motor. The governor regulating the admission of water to the turbines is worked electrically; it allows a variation in voltage of only 10 per cent. when a tug is starting, and normally a variation of only 2½ per cent. A battery of accumulators is connected in parallel with the conducting wire, and works simultaneously with the dynamos; the connection is continuous, so that the accumulators act as equalisers. The battery working alone is sufficient for two journeys in each direction; it is placed in the cellar of the resident engineer's house.

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The accumulators have been found, however, to be of but little use; and M. Galliot states that, if the work were to be done over again, he should dispense with them, and should also use series-wound dynamos, instead of shunt-wound as at present. The total length of circuit traversed by the current being about 7½ miles, the resistance is 3·9 ohms. In ordinary working at 600 volts, with a current of 20 amperes, the efficiency is 87 per cent. The three wires of the line are so arranged as to occupy in section the corners of an isosceles triangle 3·9in. high, the two lower wires being those along which the current travels to and from the motor. For keeping the wires in their required position, insulators of a special form are used. The line so constituted forms an open circuit; to close the circuit, it is only necessary to place the two lower wires in contact with the poles of the motor, which is done by means of two trolleys carried by the boat. As on American tramways, the trolleys are composed of two long jointed arms, each terminating in a small roller, which travels along the conductor on the bank of the canal, and conveys the current to the motor that leads through the arms. At the end of the arms of the trolleys the conductors are connected to the switchboard, and thence to the poles of the motor. The latter is a series-wound Gramme machine, which on a brake trial at 900 revolutions per minute, with 30 amperes and 550 volts, gave 19 b.h.p.; the mechanical efficiency was 85 per cent. The motor receives a greater or less supply of power in proportion to the trains it has to tow; it works well with different cargoes in tow, and is remarkably free from sparking. It is connected to the chain drum by means of belting; the pulley of the motor is 11·8in. diameter, and the flywheel on the chain drum 5ft. 10½in., or six times the pulley. The boat is geared for two nominal speeds of 1·79 and 3·13 miles per hour; the actual speed, of course, varies largely with the weight of cargo towed. The tug is 49ft. 2½in. long, 10ft. 6in. wide, and 3ft. 11¼in. deep, with a draught of 1ft. 5¾in. Fore and aft she is covered with fluted sheet iron, and a length of 26ft. 3in. amidships carries a cabin of thin sheet iron to protect the machinery from the weather. In order to prevent the chain from bespattering the boat, it is entirely enclosed in a U-shaped trough, which is covered by a half-round lid of thin sheet iron. The chain enters and leaves the boat through two holes similar to those on river steam-tugs. There are two rudders, one at each end, and each connected to a wheel placed at the opposite end, so that the boat can be steered from the forward end both up stream and down stream. In the tunnel the boat is lighted by electricity. The total cost of the arrangement was about £5,400, including £400 for the accumulators and £200 spent on unsuccessful trials, which latter, of course, could now be avoided. With the advantage of present experience, the electric haulage at Pouilly could now be carried out for about £4,800, exclusive of the accumulators, which are of little use, so that the cost per mile would be about £4,800 ÷ 3·75 = £1,280. The saving in cost over the old steam-tugs is considerable. During a period of six months the cost of transport over the length of 3¾ miles was 0·68d. per ton by electric haulage, as against 0·99d. by the old method, or a saving of a little over 30 per cent. The time taken is also slightly less.

INSTITUTION OF MECHANICAL ENGINEERS.

At the meeting of the Institution of Mechanical Engineers on Wednesday evening, the chairman, Mr. E. Windsor Richards, was very brief in his opening remarks, stating that he would reserve all reference to the progress of the institution until the anniversary meeting at Birmingham on July 26. Particulars as to that would be circulated shortly. It was intended to issue some debentures in connection with the providing for the expenses of the new building, and it was hoped the debentures would be distributed widely among the members. The Secretary then read Mr. Robinson's paper on "Canal Traction," some notice of which will be found above and on preceding page.

INSTITUTION OF ELECTRICAL ENGINEERS, April 22.

Sir Henry Mance (president) in the chair.

After formal business, the **Chairman** announced that, following the example of all other learned societies in this country, the Institution would present an address to the Queen on the occasion of her Diamond Jubilee.

The discussion of Mr. Baylor's paper was then resumed.

Mr. Wallis Jones said the magnetic brake described in the paper was an excellent example of American practice in the devising of efficient apparatus which could be worked by absolutely unskilled labour. Electric welding of rails was a matter which would come prominently forward. The greatest difficulty had been in the unreliability of the weld. This had been remedied by the system of snap welding, which he illustrated with an example. Assuming a variation of temperature of 100deg., the strain in an ordinary type rail would be about 157,000lb., but the maximum strain for the rail would be 350,000lb., so there would be a large margin of safety. In the "snap" welded joint he showed, which had been tested to destruction, the breakage had taken place 6in. from the weld.

Mr. Stephen Sellon thought that the paramount importance of good bonding had not been properly appreciated by English engineers. Until they had settled that, it was waste of time discussing whether one dynamo was better than another; because if they got leakage and electrolysis of the gas or water pipes of the municipal authorities, it would simply prove a death-blow to the introduction of electric tramways. They should profit by the experience of America in the matter. In a bond adopted by one firm here in England, the electrical connection was from an iron bolt to a steel rail. It was good enough when it was laid down, but would anyone call it good electrical connection after six months' use? He was convinced that the importance of the matter was not properly appreciated. He was no advocate of any particular bond, but he thought it would be a very great hardship if the amount of time and money which had been devoted to the promotion of tramway enterprise in this country were jeopardised by neglect to adopt proper and known efficient methods of bonding.

Mr. Holroyd Smith thought the title of the paper was wrong so far as it promised to be about "recent developments." Series-parallel control was not new, and equally good results could be obtained in a simpler manner. Neither was braking by making the dynamos act as a motor new. He thought the members of the Institution were entitled to more information as to how the idea was carried out. A trolley wheel labelled "provisionally protected" resembled something described in a paper read before the Northern Society of Engineers in 1895.

Mr. Preece, in reference to the remarks of one or two of the speakers, said it was of little importance who it was invented a thing. If there was one thing about the electrical confraternity it was that they did not care whether a good thing came from England, or America, or Germany, or Kamstchatka. He had visited America when there was only one experimental electric line in that country—at Cleveland. Now in the town of Cleveland alone there were as many miles of line as in the whole of the United Kingdom, and the total mileage in the United States did not fall far short of 20,000. There was, in fact, nothing more wonderful and startling in their profession than the growth of the electric traction industry in the United States in the course of such a short period, and they were therefore much indebted to Mr. Baylor for summarising for them the experience derived from across the Atlantic in the manner in which he had done in his paper; and that experience was not confined to America, but related also to what had been done in Germany. It had been fully brought before them, and should be received in a proper spirit. When it was said that there was no need to tell English engineers that they should use direct connection, could anyone point out a traction plant in this country where it had been used? Only now on the City and South London were they acquiring the experience which led them to adopt direct driving. It was a mistake to suppose that there was no mischief from leakage in England. Although it was by some supposed that they were under the grandmotherly government of officials in the matter, no one could say that he had been ground down by the Post Office in the matter in the pure spirit of officialism. The Post Office had suffered from leakage from the South London line at Clapham, where 30 paper-covered wires had been broken down by the piercing of their lead covering through electrolysis, in a manner Mr. Preece illustrated on the blackboard. On the City and South London the rails were not bonded, and the tunnel tube was assumed to be a complete return conductor. As a matter of fact it was not, and he anticipated trouble in consequence at Stockwell and Clapham, and on a smaller scale at Liverpool. All this was, however, remediable, as with a proper bond on a sufficient return conductor there was no outside leakage, and he did not fear any trouble from the newer railways if they would profit by the experience to be derived from the United States.

Mr. Gadsby thought the electrical brake was a product of the high speed and heavy cars used in the United States, and that there would not be much application for them in this country until the Board of Trade speed limit was raised. One matter in connection with them not brought out in the paper was the dissipation of the energy in heat in the form of C^2R losses in the armatures of the motors. In reference to bonding in Fig. 10 in the paper, the ends should be turned over to the web of the rail, and not in the way shown.

Mr. Grove said, as he understood it, the substance of the objec-

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tions to the three-wire system was the difficulty of balancing the current on both sides of the system. He did not think, however, that it should be allowed to be laid down as a canon that the proper way of dealing with long lines was by alternating currents and converting to continuous in sub-stations. There were at present schemes for the construction of several underground electric railways in London, and his work in connection with some of these had led him to an opinion opposed to that of the paper. There had just been submitted designs for the Central London. The engineers merely specified the weight of the trains and the speed, and so on, and this brought the two systems into competition. The company he (the speaker) represented had worked it out on the three-wire system, for which the line seemed specially adapted. There were two tunnels, a seven-mile length of line, with the generating station at one end—in fact, the very case for a three-wire system. You could feed down the line with bare copper feeders, and the rails would be the neutral conductor earthed and carrying only the balancing current, so there would be no danger from leakage. The dynamos would be arranged to work in pairs at 500 or 600 volts apiece, that being a convenient voltage for multipolar machines with bar armatures, and a simple arrangement of switches would make it possible to throw a machine over from one side to the other. Local differences would be dealt with by motor-transformers at the stations, and in that way an ample margin was provided for local irregularities due to the different weight of the trains and the starting of them. Now, if instead of this an alternating-current system were used, there was the loss in the static transformers and the rotary converters, for they had been told that these were better than motor-generators, though Prof. Mengarini, at Rome, who used them, said it would be impossible to do so with large machines because of the sparking. With 5,500 kilowatts the increased cost of the alternating-current machines over the continuous dynamo was a matter to be considered, and then there were the static transformers and the rotary machines. Altogether, at the ordinary market rates of the price-lists it would come to something like £45,000 worth of machinery more than would be required for a continuous-current plant. Added to that the loss in the static and rotary transformers when expressed as an increase in the coal bill and the increased works costs should be capitalised to compare the two systems, and as a result he did not think that there could be other than a big balance against the alternating-current system. It must be remembered that if more money was spent than was wanted to obtain an efficient system, that money was absolutely thrown away and wasted, and was a loss to the world which could not be justified.

Mr. Parshall said there were certain features in the statements as to the Central London Railway and the three-wire system which should be put right. These remarks were based upon pure theory without experience. The three-wire system had never been made a success for traction, and he (Mr. Parshall) did not believe it ever would be. For lighting systems it was quite different, for if the voltage dropped the resistance of the lamps increased immediately, but with a traction system it was just the reverse, as the carmen had a schedule to run to. On a rectilinear system like the Central London, there might be one train out of balance which would absorb one-third of the normal output on one side of the system, and to keep up to the Board of Trade regulations that current must be transferred from one side to the other. The arrangement described involved machines with a core loss of 6 per cent. of the output, and there was a transmission loss of 4 per cent. Practice had shown that the neutral had to be as large as the outside conductors, and that it was never "neutral." The system would not compare with three-phase transmission. What Prof. Mengarini had said as to sparking related to single-phase machines, the principle of which was absolutely opposed to commutation. The proper reference was to the three-phase machines at Niagara. Moreover, the cars would be run on a fixed schedule, which must be maintained, and therefore there would in the three-wire system be a large amount of power simply lost in the rheostat. Suppose the voltage loss in transmission was 10 per cent.—that is, 20 per cent. at the end—and a constant speed schedule. That meant 500 volts at one end of the line, and the difference between 500 volts and 600 volts, or 20 per cent. loss to keep the speed constant at the other. In any event this matter must be considered in reference to the efficiency of the motors.

Mr. Preece asked whether Mr. Parshall or anyone else could give them any information as to a way of working the three-wire system which had been tried somewhere, in which each car was its own equaliser, taking current from each side with a double trolley.

Mr. Parshall said that had been tried in the United States, but it had been found practically impossible to provide against the liability to short-circuits which the system involved, and it had been given up on that account.

Mr. Mordey was called upon by the president, but declared he had nothing to add to the discussion.

A communication was received from **Mr. Geipel,** who considered that we were on the verge of a great development of electric traction in this country. He (Mr. Geipel) had been especially interested in what Mr. Baylor said on the welding of the rails together, but observed that no mention was made of the cost either by the cast welded method or by electric welding. There could be no doubt that for good conductivity the electrical method was far away better than the casting method; in fact, it was doubtful if in the case of the latter method it would be safe to do without other bonding to assist. Mr. Baylor referred to the mechanical difficulty of getting electrically-welded joints to stand, but with the enormous strain set up by temperature differences in long lengths some part of a long continuous rail was bound to give way. In 1,000 yards there was a difference in length of 2ft. for a temperature difference of 100deg. F., which was not an outside limit of temperature variation on the surface of the ground. If the continuous lengths were made shorter by introducing a small percentage of fishplates and bonded joints, this difficulty might be overcome, while the number of loose rail joints which strained the car equipment would then be considerably reduced. But the difficulty which occurred to the contractor was the expense of providing the necessary electricity for the welding during the time of installation, for at this time current was not usually available from the central station. If Mr. Baylor would tell them how they got over this difficulty in America, and what they found the cost to be of electric welding per joint, it would be of much interest. As to the series-parallel method of control, there was no doubt that with high-speed heavy cars this system was necessary; but for small light cars running at a low speed, it was quite a matter for consideration whether one motor was not sufficient. Firstly, there was, owing to the reduced range of speed, less possibility of effecting a saving with the series-parallel control; and, secondly, the first cost and the cost of maintenance was considerably less with one motor. At Hamburg, for example, where they have some 300 cars they have adopted the single motor for as many as 250 cars, while they use the two-motor series-parallel control on 50 cars only. The power consumed at Hamburg is under 800 watt-hours per car mile. The most interesting point in Mr. Baylor's paper was his description of the electric brake. The curves showing the braking effect of the eddy currents were most instructive. As to difficulty with residual magnetism, there would appear to be various well-known and obvious ways of overcoming this, perhaps with less complication than in those that have been adopted. The description of the switchboards was useful, although the panel system had been adopted for years past in this country; but if Mr. Baylor, instead of illustrating his paper by means of pretty pictures. had made use of diagrams of connections, it would have been still more useful. And the same remark applied to the dynamo, of which there were given four outside views, but not one section. As to the laxity of specifications of dynamos in this country, it was his (Mr. Geipel's) misfortune or otherwise to have to wade through numbers of long-winded specifications almost daily, and he could assure Mr. Baylor that our consulting engineers covered the points to which he referred, and a good many more. One of the latest tests which machines had been specified to stand was that the armature shall be dragged round by the scruff of its neck whilst the magnet is fully excited, and that under these most uncomfortable circumstances it must not grunt. Mr. Baylor might rest assured that our consulting engineers required no pricking by the contractors to induce them to specify fully what the dynamo should or should not do.

Mr. E. Scott said that one could not but be struck by the weight carried by the cars in the form of motors, and by the fact that two 15-h.p. motors were required for a two-horse tramcar or a car that at most took three horses on a hill. He suggested that economy might be effected by a combined system in which there would be a cable electrically worked to take the cars over a place of steep gradient. That would apply to many towns where, as at Leeds, you had to climb a hill to get out of the town. Mr. Scott also suggested that weight might be saved by making some of the outside portions of the motor of aluminium.

Mr. Raworth said it might save some time to Mr. Baylor in his reply if it was mentioned that a system on the principle suggested by the last speaker had been worked out by a gentleman at Leeds, and was the subject of a patent.

Mr. Baylor said the speakers had so dealt with the points raised in the discussion as to leave him little to answer. For the information of Mr. Jones, he might say that they had come back to the type of welding suggested by Prof. Thompson. He agreed with Mr. Sellon that the question of the return was most important. As to the three-wire system, in theory there was very much to recommend it. He (Mr Baylor) could only say that wherever it had been advised it had been found after actual trial inapplicable, and had been discarded. That was certainly a strong ground to go upon. In reference to the title of the paper, he was perfectly well aware that much of the matter in his paper would be by no means new to the eminent engineers who had heard it, but, at the same time, what he had done was to endeavour to represent the latest practice in the States as he knew it. As to electric traction in England, he could only speak of what he found in practice. As to direct-coupled generators, the only plant—whether American or English—in the United Kingdom so run was, he believed, the remodelled Bristol trams, which gave great satisfaction, and those machines, he need not say, were imported from America. He was highly gratified at the number who had been present to hear or discuss his paper, as he thought that it showed that he had dealt with a subject which was of some interest.

The **President** said this was the three hundredth meeting of the Institution, and he trusted that when their four hundredth meeting came they would have as good a discussion as they had had that evening. One thing that had struck him was that throughout the discussion the word "battery" had never been mentioned. In reference to combined systems, he thought the combination of the battery with the overhead trolley was one that would have to be considered in special cases. He would sit rather later than usual that evening in order to allow Mr. Raworth's paper to be read.

The following is the paper alluded to,

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THE GENERATION OF ELECTRICAL ENERGY FOR TRAMWAYS.

BY J. S. RAWORTH, MEMBER.

The development of the dynamo-electric machine and its gradual adaptation to new purposes have provided engineers with a series of interesting, but extremely puzzling, problems. The first problem was to drive the dynamo; the second, to drive it an even speed; the third, to drive it economically at full load; the fourth, to drive it economically at light load. In 1880 almost any engineer would have tackled the whole four with that lightness of heart which many possessed who took on only one at a time, and found to their sorrow that the infant dynamo, like other young persons, could set them questions which they could not answer. By slow and painful processes these four problems have been wholly or partially solved; and although we cannot certainly say that the dynamo has no terrors in store for us, yet we feel that we can now approach him with some of the confidence of the lion-tamer, who at least knows the exact moment when to get outside.

My attention has been directed to this question of electric traction by certain articles in the American Press, by some events which I have observed in this country, and by the fact that some central-station engineers have evinced a very strong desire to supply current for traction at the modest price of 3d. per unit, "to improve their load-factor"—a very happy thought—possibly too happy for this world. The principal object of this paper is to show that a suitable and paying price for the supply of electric energy for tramway purposes, under reasonably favourable conditions, is 1d. per unit, and that the said supply will reduce the cost of the lighting current by an amount which, though small, is definite.

It is necessary at this point to turn back to the year 1891, when, during the discussion on Mr. Crompton's papers on the generation and distribution of electrical energy, Mr. Willans told us what no living man previously knew—that the curve of total steam consumption of a constant expansion engine is practically a straight line, and consequently the most economical

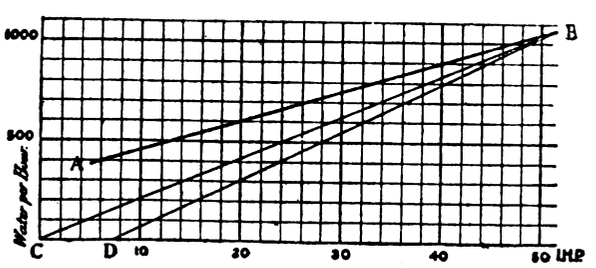

FIG 1.

load of such an engine is its full load. He also showed us that the steam consumption at no load of such an engine, non-condensing, is about one-third of its full-load consumption. These were very awkward facts. The only pleasant thing about the Willans diagram is that, as the line is straight, one can draw it with a ruler; but it was not Willans's fault that the line was straight, and we are under great obligation to him for having called our attention to it, and for having, as it were, planted a lighthouse on a submerged rock. The immediate outcome of this discovery was that engine cylinders were made smaller; no margin was left for fall of boiler pressure or for overload, simply because any such margin would obviously entail waste of steam. The effect of the straight-line diagram is shown in Fig. 1, where the indicated horse-powers are abscissæ and the steam consumptions ordinates. The Willans line is shown at A B. The line C B is drawn from the origin to meet the line A B at the point B. Vertical measurements from the base line to the line C B are proportional to the indicated hore-power. The loss therefore at any given power is shown by the distance between the lines A B and C B. Indicated horse-power, however, to the electrical engineer is but a stepping-stone in the path to his goal, which is electrical horse-power. For his benefit, therefore, we must draw another line, D B, the distance C D representing the indicated horse-power necessary to drive the dynamo magnetised, but without external load; the vertical distances between the lines A B and D B represent the losses at various powers per electrical horse-power. As Mr. Willans pointed out, they are terrible; for instance, in an engine taking 23½lb. of steam per electrical horse-power at full load—that is to say, about the best commercial result obtainable—the consumption at half load is 32lb., and at quarter load 52lb. These are all well-known and thoroughly established facts; the question for us is: "Can they be ameliorated or cured?" The answer is, "Yes"; or, more precisely, they can be ameliorated considerably, and to some extent cured. The first method of amelioration is shown in Fig. 2, in which everything remains as in Fig. 1, except that by increased efficiency in the engine and dynamo, the toe of the electrical horse-power line has been moved back from D to E; the line E B is thereby made more nearly parallel to the Willans line, A B, and the losses therefore reduced. The prospect of improvement in this direction is small, but we may possibly get 3 or 4 per cent. The next step is to apply a condenser to the engine: the effect of this is more strongly marked, as it raises the base line to the position X Y, and from the point F, vertically above the point E, we draw the line F B. The new base line is nearer to the Willans line at all points than the original base line, and the lines A B and F B have become more nearly parallel. The effect of the use of a condenser, as compared with the non-condensing example quoted above, is to reduce the full-load consumption per electrical horse-power from 23½lb. to 20lb., the half-load from 32lb. to 24lb., and the quarter-load from 52lb. to 33lb. In both these examples there is considerable loss by working much below full load; and this fact has been so fully realised by electrical engineers, that great care has been exercised by those responsible for the design of electric lighting stations to sufficiently subdivide the plant, and by those who superintend the working thereof to make use of that subdivision so that there may be very little loss due to working engines under-

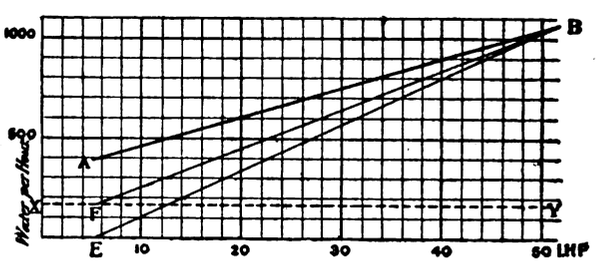

FIG. 2.

loaded. But even the subdivision cure has brought with its own peculiar disease—namely, complication of pipes and valves, involving much constant waste in condensation; and, worse still, the necessity for skilled supervision to make those constant changes in the plant which we all recognise as necessary to secure economical working.

The bearing of all this on the traction question is that some engineers, fully realising that they cannot by any possibility change their engines as quickly as their load changes, have come to the conclusion that a unit of electrical energy, generated under the conditions attending the transmission of power for traction purposes, will cost as much as, if not more than, the unit now costs them for lighting. We shall see. If we had no better prospect before us than that which is set forth in the gospel of straight lines, which has sunk so deep into the minds of electrical engineers that the limitation of it to constant expansion—that is, to throttle-valve engines—appears to be entirely overlooked, then our Diagram No. 2 would form the basis of the best results we could expect under present conditions. But automatic expansion introduces an entirely new feature: the straight line of Fig. 2 becomes the curved line of

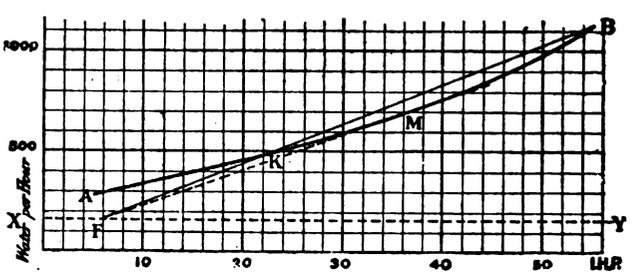

FIG 3

Fig. 3, which, it will be observed, from the point of maximum load, B, down to the point K—which represents about one-third load in electrical output—shows everywhere a gain instead of a loss of steam per unit of energy generated; and even below the point K, down to no load, the losses are much less than in Fig. 2. The most economical load is indicated by the point M, where a line drawn from the point F touches the steam curve tangentially.

In an automatic expansion engine working with a constant boiler pressure the mean pressure referred to the low-pressure cylinder, or, in other words, the horse-power developed, is an index of the point of cut-off—that is to say, a high mean pressure means a late cut-off, and a low mean pressure an early cut-off; therefore to get a fairly high—that is, an economical—ratio of expansion, the mean pressure must necessarily be much lower than the practical maximum, which is about 50lb. per square inch. From an electrical engineer's point of view the engine must be underloaded. The practical application of this ancient and approved theory to electric traction work is as follows: In the first place, as the average load remains fairly steady throughout the day, and the momentary variations are as

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erratic as they are great, there is obviously no advantage to be gained by subdivision of the plant; the problem therefore approaches that of factory or mill driving, and the solution will probably be similar—viz., by one engine large enough to do the work and one man to oil it. There must, of course, be a spare engine and dynamo, but there is no necessity to keep the engine under steam, as the conditions of traction service in respect of absolute continuity are not so rigorous as those of electric lighting.

Assuming for the moment that this solution be adopted, I propose to prove that by it, whether it be the best solution or not, electrical energy can be supplied at the terminals of the generator, as stated previously, for less than 1d. per unit. Take as an example the case of a comparatively small tramway requiring 1,000,000 units per annum. The tramway day is 16 hours, with about 14 on Sunday, making 110 per week, or 5,720 per annum. The average load to produce a total of 1,000,000 units per annum is 174·82 kilowatts. The actual ascertained load-factor during the working hours (varying according to circumstances) appears to be about 60 per cent., but I prefer to err on the safe side, and to assume only 50 per cent., which brings out the plant capacity at 350 kilowatts, or 470 e.h.p. The total indicated horse-power to be provided is therefore

Electrical horse-power	470
$\frac{6}{94}$ loss in dynamo	30
$\frac{10}{90}$ loss in engine	55·5
Total indicated horse-power	555·5

Quite a small engine compared with the ordinary run of cotton-mill engines. The low-pressure cylinder need not be larger than 30in. diameter, working with a maximum mean pressure of 43lb. The average indicated horse-power would be :

$470 \times \frac{50}{100}$	235	e.h.p.
Loss in dynamo	30	
Loss in engine	55·5	
Average	320·5	i.h.p.

which is equivalent to a mean pressure of 25lb. per square inch referred to the low-pressure piston. This mean pressure, with boiler at 150 and a 27in. vacuum, corresponds approximately with 20 expansions, and is as nearly as possible the mean pressure adopted in modern cotton-mill engines. The usual ascertained consumption of steam under such circumstances is 14½lb. per indicated horse-power, and of coal 1·7lb., corresponding to an evaporation of 8½lb. of water per pound of coal.

In the paper on cheap steam power which I had the honour to read in November, 1896, before the Northern Society of Electrical Engineers, I raised this figure to 2lb., to cover all incidental losses, and was informed by several speakers that I was much outside the actual results obtained. Nevertheless, I propose to adhere to the 2lb. Thus we get our cost made up as follows :

$$\frac{320{\cdot}5 \text{ h.p.} \times 5{,}720 \text{ hours} \times 2}{2{,}240}.$$

1,636 tons, at 10s.	£818	0	0
Engine-driver, in two shifts, at 36s.	187	4	0
Sunday work, one-sixth	31	4	0
Stoker, in two shifts, at 24s.	124	16	0
Sunday work, one-sixth	20	16	0
General man, at 24s.	62	8	0
Oil, waste, etc.	52	0	0
Net cost per unit, 0·311d.	£1,296	8	0

We now come to capital and incidental charges. Taking the value of the plant in duplicate, including cost of land and buildings, at £17,000—of which £11,000 stands for plant and £6,000 for land and buildings—we have—

Rates and taxes					£125
Repairs,	2½	per cent.	on	£11,000	275
,,	1	,,	,,	5,000	50
,,	0	,,	,,	1,000	0
Depreciation,	5	,,	,,	11,000	550
,,	2	,,	,,	5,000	100
= 0·264d. per unit.					£1,100

We have only one other item to consider—that is, management. At the outset it would appear that the plant would require no more management than the steam plant of a cotton mill, but as I am extremely anxious to find good berths for my numerous friends, I provide for one engineer-in-charge at £300 per annum and £100 for office expenses—total, £400 = 0·096d. per unit. Our total expenses now stand thus.

	Per unit.
Generation	0·311d.
General charges	0·264d.
Management	0·096d.
Total	0·671d.
Balance	0·329d.
Selling price	1·000d.

Our total profit is, therefore, 1,000,000 units at 0·329d. = £1,370. 16s. 8d., or 8 per cent. on £17,000. This result is arrived at by taking commonplace figures, with, in every case, a margin on the safe side, and with a clear reserve of 100 per cent. of power over mean load. There is actually a much larger reserve, for I have taken the maximum pressure at 43lb., whereas 48lb. would be still a safe figure. Incidentally it is worth remarking that the limitation of the working plant to one engine and dynamo is an extremely economical arrangement, because it reduces the switching gear to one large change-over switch, which may be worked by an ordinary reversing lever standing out of the floor, and the services of a switchboard attendant can be dispensed with. On the other side of the engine, the simplification of pipes and valves is equally noticeable.

The next subject for consideration is the effect of an electric traction load on the load-factor of an electric lighting station. It is obvious at the outset that the mere fact of the traction load-factor being higher than the lighting load-factor cannot be taken as influencing the result; for the unit of output for traction purposes, by reason of the higher load-factor, will command a lower price—the price, in fact, at which it could be produced independently of a lighting station. The question still remains, What influence will the presence of a traction contract have on the cost per unit? In the first place, it would increase the load-factor of the chief engineer; and if he did not at the same time demand an increase of salary, the effect would be appreciable. I suggest that a corporation possessing specially benevolent sentiments might raise him £100 a year, thus saving £200 of the £300 which I have allowed for. Further, one spare boiler might possibly be dispensed with at a saving in capital of, say, £1,000, the charges on which are worth £120 a year. Further, it would probably be possible and convenient to take steam for the day-load lighting plant from the traction boiler, thus saving one stoker on one shift, say, £60 per annum. Beyond these three, I cannot find any openings for further savings. They therefore stand thus :

Manager	£200
Boiler	120
Stoker	60
Total	£380

Quite a considerable sum, but small in comparison with some people's expectation. It is sufficient to raise the profit on the traction plant from 8 per cent. to 10 per cent., or to reduce the price of the unit from 1d. to 0·918d. In all the above calculations as to the cost of generating power for electric traction commonplace efficiencies are taken, such as any engineer will freely guarantee; the boiler is only called on to evaporate 8½lb. of water per pound of coal, and a very considerable margin is allowed for banking fires and other incidentals. The cost of coal is taken at 10s. per ton, which is higher than the usual price in Midland and Northern towns.

A paper dealing with the generation of power for electric traction would not be complete without a special reference to the problem of engine construction which is supposed to hang round the neck of this young daughter of electrical science. In the technical journals articles on this subject constantly appear, and as constantly terminate without saying one single word of any value to anybody. They tell us that direct coupling is more economical than belt driving, that it is desirable to have a condenser, that the use of compound engines is becoming common; and they might add with equal truth that Queen Anne is dead. I have not yet seen any reference to the necessity for automatic expansion which was explained and insisted on by Captain Sankey in his paper on the governing of steam-engines, read before the Institution of Mechanical Engineers in April, 1895. No pretension was made by the author to originality in his treatment of the subject, but it was, nevertheless, so elegant and so perspicuous that I have no hesitation in saying that it ought to be assimilated by every electrical engineer, and particularly by those who have any interest or duties in connection with electric traction. Further, the aforesaid articles, whilst they omit all reference to automatic expansion, and to average or maximum mean pressure, all agree in giving special prominence to an idea, which may be most easily explained by the following quotation from the paper of Mr. Richard McCullock on the modern power-house : "The main objection which was urged against the direct-

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connected generator was the fact that the shocks resulting from overloads were thrown directly on the engine, and that there was none of the cushioning effect that a belt connection might supply. While this is undoubtedly true, the best argument which may be submitted against it is that none of the installations of direct-driven generators can trace any trouble to this source." Thus we find American practice refuting American theory. The theory, however, is not "undoubtedly true," but undoubtedly erroneous, as will be evident from the following considerations: (*a*) In an automatic expansion engine the maximum initial pressure on the high-pressure piston is attained every stroke, at any load, from quarter to full; (*b*) the size and strength of the parts of the low-pressure engine are always made equal to those of the high-pressure; (*c*) the maximum stress on the valve gear occurs at light load, not at full load; (*d*) inertia stresses are reduced by reduction of speed. The torque on the crankshaft is undoubtedly increased by increased mean pressure; but as crankshafts are built to withstand the strain caused by water in the cylinder, the steam pressure never troubles them. I have myself seen cylinder covers torn off, pistons broken, and even cylinders lifted off their standards by water, without any damage to the crankshaft.

Electric traction involves sudden variations in load, but, barring short-circuits, there is no difficulty in arranging the power plant so that in no case shall the maximum load exceed the power of the engine; therefore neither the strains nor the wear due to such causes will ever exceed those which are daily dealt with in electric light stations, for it must be remembered that electric light engines are quite commonly, even usually, built to work with a mean pressure of 42lb. per square inch, and do so work without distress or trouble of any kind. Should, however, some person imagine that varying loads are more trying to steam-engines than a constant full load, then this little island of ours will provide them with any number of examples of steam-engines driving rolling-mills in which the fluctuations of load are more violent than any that can be found in connection with electric traction. The effect of short-circuits, which used to be serious, is now minimised by automatic circuit-breakers, which amply protect the dynamo. On the question of governing, it is unnecessary to say anything. With slow-speed engines and relay governors a large flywheel may be necessary; but with high-speed engines fitted with automatic shaft governors acting directly on the high-pressure eccentric, special flywheel power is certainly not required. The rapidity and precision with which shaft governors perform their functions are so remarkable that I hesitate to describe them without the support of a demonstration, but, following the example of George Stephenson, who said that his locomotive could run 16 miles an hour, I may say that the total variation in speed may easily be covered by 2 per cent.

JUBILEE ILLUMINATIONS.

There seems to be no end of the designs for decorations for the forthcoming Jubilee celebrations, and it is wonderful what variation both in effect and workmanship is to be noticed in the resultant electric fittings compared with the gas-pipe with leaks up it previously used. The illustrations below show two designs made by the General Electric Company. These are a marked contrast to many we have seen, in that they are not of a temporary character. The whole of the framework is heavy and substantial, so that the fitting could be used year after year. In cases, of course, the inscription would want changing; but we trust that the "V.R." will hold good for many years. The first design (Fig. 1) consists of wreaths of flowers. The foliage is of metalwork, suitably coloured. The flowers have incandescent lamps as centres, while the surrounding petals are of coloured glass variously tinted. The letters "V.R." in the centre are brightly gilded, and the flowers round it cause them to stand out well when the design is lighted up. The complete arrangement extends about 6ft. in each direction. The total number of lamps on the design is 34, and, as a rule, they will be of 16 c.p.

The larger decoration (Fig. 2) measures about 8ft. in height, and is nearly 6ft. broad. It is more elaborate in detail, and consists of a strong wrought-iron framework made hollow to receive the bulk of the lamps. The fronts of these frames are covered by a fast-coloured fabric, or by celluloid or glass, on which designs are worked representing the "Royal arms," with suitable inscription below. The floral wreath is constructed on the same principle as the design above, with metal foliage and glass letters. The crown above all is illuminated with small lamps of many colours to represent jewels, an oval in white lamps surrounds the coat-of-arms. The whole design takes about 20 small 10-volt lamps and 80 100-volt lamps of 16 c.p. Besides these two designs the General Electric Company have prepared many others rather more simple in detail. They consist of letters, crowns, stars, etc., formed by rows of lamps or of the usual crystal letters backed by electric lights, etc. These can be worked up to inscriptions to the fancy of the purchasers. Another novel feature is the use of lamps the upper zones only of which are dipped in coloured varnishes. The lamps are then placed in metallic shades of the same colour, only tinted more lightly. The uncoloured portions of the lamps then reflect light on these shades, and give on the whole a gradation

FIG. 1.—Floral Design by the General Electric Company.

of colour which is very effective. These shades can also be arranged in the form of letters. The use of lamps in coloured celluloid spheres is also being pushed, and these give pleasing

FIG. 2.—Design by the General Electric Company for the Diamond Jubilee.

effects. From the above firm, and from others we have seen, we gather that the central-station engineers will have no reason to complain of want of load on June 21, 1897.

BIRMINGHAM TRAMWAY TRACTION REPORT.

The Public Works Committee of the Corporation of Birmingham decided on February 22 "that a sub-committee should be appointed to visit such places where electrical or other motive power for tramways is in operation as they may think desirable, and to report upon the merits of any motor which they may consider adapted for use in Birmingham." A sub-committee of four was accordingly selected, and they, in company with Alderman Pollack, Mr. John Price (the city surveyor), and Mr. Arnall

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(superintendent of the mechanical and electrical department), visited the following towns: Bristol, Blackpool, Paris, Rouen, Brussels, Vienna, Budapest, Dresden, Berlin, Hamburg, and Bremen. The report as to what was in each town is most interesting reading, but we regret that in this issue we can only find room for the following summary, which gives the committee's conclusions:

It will be convenient to make a general summary before drawing conclusions as to what would be proper for application to Birmingham. As to mechanical traction, there are (*a*) steam locomotives, (*b*) fireless locomotives, (*c*) Serpollet motors, (*d*) compressed air, (*e*) gas motors; in electric traction, there are (*f*) overhead wires, (*g*) underground conduit, (*h*) combination of overhead wires and underground conduit, (*i*) combination of overhead wires and storage batteries, (*j*) surface contact. The mechanical motors do not call for any further remarks than those which have been made in the descriptive portions of the report.

As to electric traction, discussion will be chiefly centred upon the overhead wires and the conduit. The introduction of storage batteries into a system partly worked by overhead wires is only, at present, commercially practicable upon lines where the storage batteries have to work over the level sections of the route. The engineers consulted on the matter agreed in stating that the gradients over which the batteries have to work should not exceed 2 or 3 per cent.; steeper gradients could be worked, but only at an excessive cost, and as many of the gradients in the Birmingham streets are above this limit, it must be concluded that Birmingham is not a suitable town for such a system. These remarks are of course intended to apply to the present time only; it may be that before long some new discovery will be made, or some new form of battery invented, which will overcome existing difficulties, but at present there is nothing of the kind in sight. Many eminent engineers are, however, at work upon the problem, and success may not be far off.

In comparing the overhead wire with the conduit system, one of the first questions that arises is that of the comparative cost, and here your sub-committee have not been able to get definite figures. In some cases there seems to be an effort to magnify the cost of one and to minimise that of the other. One engineer, who is an undoubted authority on the matter, tells us that the cost of the conduit is four or five times that of an overhead wire. Another engineer, of equal reputation, says that the difference in cost between a conduit and a well-constructed overhead wire is but small. Both agree that when once constructed one is worked as cheaply as the other so far as cost of electricity, labour, etc., is concerned, but they differ again as to cost of maintenance and keeping the conduit cleaned out.

Your sub-committee believe that these differences in opinion as to cost arise in a large degree from different works being included, and they think rough general statements of this kind can be of but little value. The comparative capital expenditures of two companies incurred in setting up installations of each kind can only be compared when proper weight is given to the elements of locality, prices, costs of concessions, commissions, patent royalties, nature of contracts, and modes of payment, whether in "cash" or "paper," and many other considerations and sources of expense which may be included in one case and excluded in the other. A fair comparison can only be made by obtaining the actual cost of the works in the streets belonging to a conduit, and comparing this with the actual cost of an overhead wire with its poles, span wires, and other necessary apparatus, but omitting all questions of ordinary tramway rails and paving, generating stations and machinery, underground feeders, and such other items as are common to both systems. The prices taken in such an estimate should only be such as a corporation or a substantial company could get the work done for by competent contractors, who are paid for their work on a cash basis. Taken in other ways, it seems possible to make the difference between the costs of the two systems appear as great or as little as may be desired.

The sub-committee have already some guide in the cable tramway, which cost for conduit alone about £5,000 per mile of single line. A tube such as that proposed by the engineers to the company would cost more than this, and one such as those your sub-committee have seen at Budapest and elsewhere would cost less. From this amount would have to be deducted the cost of the poles, the span, pull-off, and guard wires, and other apparatus peculiar to an overhead wire system, and the balance only would represent the legitimate difference in the costs of the systems. Your sub-committee do not believe that this difference would be a large proportion of the cost of reconstructing and re-equipping the tramways on any electrical system, or even a large proportion of the cost of the street work alone; and they do not think such a sum would have any material influence on the success or otherwise of the company.

From a public point of view, and apart from the question of first cost, there does not seem to be much doubt as to which system is the better one. The overhead wire gives reliable and efficient service, but the underground conduit is equally capable of doing the same. It has been in successful use at Blackpool and at Budapest for several years, often under more adverse circumstances than would be met with in Birmingham. The only point against it is that its construction is said to involve a more prolonged disturbance in the streets, but your sub committee do not think this argument is of much weight, and especially if its depth is only such as has been found sufficient in other places, no great disturbance of gas or water pipes need be anticipated. When the work is done there is no room for doubt as to the appearances of the streets as presented by the two systems. In the one case the appearance, whatever it was, remains unaltered; in the other case, we have a number of poles and overhead wires, which, wherever seen, can be considered nothing but a disfigurement. Your sub-committee saw these wires under all conditions; perhaps at their best in the boulevards, where the poles and brackets were partially hidden by the trees, and at their worst in crooked streets and at junctures of branch routes. The least conspicuous of all was in certain narrow streets, with high houses on each side, and the span wires attached to rosettes fixed to the walls; but there are no streets like this in Birmingham, and even if there were these wires would still be objectionable.

It is not only the wires necessary for working the tramway that have to be considered. Where telephone or telegraph wires cross over they have to be protected by additional guard wires, suspended several feet above and parallel to the tramway wire; or otherwise such wires are protected by fixing to them wooden covering pieces carried on little brackets or pillars soldered to the tops of the wires. It is not easy to say which has the most unsightly result. In the one case there is the additional network of wires, and in the other the overhead wire itself is made to look like a heavy bar. That some such precaution is necessary is shown by the general adoption of either the one method or the other, and the probable results, if it is omitted or imperfectly done, are illustrated by an accident that happened in Brussels on the 18th of last month. A telephone wire gave way, and in falling made contact with the tramway wire. A two-horse van passing by came in contact with the broken wire, the driver received some severe shocks, and both horses were killed on the spot. A similar accident recently occurred in Calais, and two horses were killed in this case also.

Another very objectionable feature in all overhead wire systems is the return current being taken by the rails, with its accompanying danger of electrolysis of gas and water pipes by the stray currents. We are assured that the Board of Trade rules are sufficient protection; but these rules seem, to some extent, permissive in their application; and even if they are complied with in the first instance, there is no certainty that compliance will not become increasingly difficult, and perhaps impossible as time goes on, and deterioration sets in in the underground and inaccessible parts of the return circuit. That this danger is not an imaginary one is shown by the elaborate nature of the bonding of the joints of the tramway, provision of supplementary feeders, and other devices adopted to avert it by the tramway company. At Rouen your sub committee found the road being opened up and the joints examined, not that there was known to be anything wrong, but to ascertain whether there was or not. The best kind of bond at the joint does not yet seem to be settled; three different kinds have been used or proposed by the City of Birmingham Company already for use on the tramways—viz., the "Chicago bond," a strong copper wire or bar; the "cast welded" bond, a mass of cast iron run in a molten condition into a pair of clamps fixed to the rails, and said to weld the whole into one continuous length; and thirdly, the "plastic bond," a little pellet of a plastic amalgam squeezed in between the rail and fishplate. This last-mentioned bond is only to be used provided experiments now in progress in America as to its conductivity are satisfactory. These things tend to show that although the overhead wire system has been the longest in the field, and has by far the greatest share of experience connected with it, such an important matter as proper provisions for the return circuit are not yet out of the experimental stage. To the Corporation, as owners of the gas and water mains, this is a most important matter, and your sub-committee are very strongly of opinion that this is not a thing that should be left to chance, but that the system to be adopted should be free from any suspicion of mischief arising from such a source.

The underground conduit, as carried out at Budapest and at Berlin, appears to your sub-committee to be the only system (apart from accumulators) which affords this assurance. Both conductors are contained in the tube, and neither the rails of the tramway nor the general body of the earth forms any part of the circuit, and there is consequently no tendency to electrolysis of underground pipes. As carried out at Blackpool the rails form the return portion of the circuit, and this subsequently is no better in these respects than the overhead wire. Another great advantage of the conduit is that there is no sparking at the wheels, which must always occur when the rails are used as the return. This feature of some systems of electric traction is not often referred to; on a clean road and with damp or wet rails, it is not, perhaps, enough to give rise to complaint, but on a dusty road it is a great objection, and in the crowded streets of such a town as Birmingham would certainly be the cause of many accidents.

Your sub-committee would point out that the unsightliness and otherwise objectionable features of the overhead wire system are recognised in many of the places they have visited. The municipal authorities at Paris, Vienna, and Berlin stated that in no case would they permit overhead wires in the central portion of those cities. At Brussels several miles of conduit are being laid to avoid them; at Dresden and Budapest they are not allowed in the principal streets, and even in some of the outer districts, where permission has been given, it is conditional, and the wires have to be removed upon notice being given. At Hanover they are not allowed in the principal streets, and the tramcars are worked through the town by accumulators. At Bremen they have had overhead wires through some of the principal streets for several years, but the present authorities refuse permission for them to be extended into some of the side streets, which are still being worked by horses. Even in New York the company of which Mr. Pearson is engineer is this year going to lay down about 50 miles

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of conduit, because permission for overhead wires cannot be obtained.

The conclusion to be drawn from this enquiry has been a matter of anxious consideration to your sub-committee. They recognise that it is not merely a matter of the cheapest form of traction to be used on some of the present tramways, but a much larger one, affecting in many ways the best interests of the whole town. Due weight has been given by them to the considerations that should enter into such an important question, and they strongly recommend that no consent be given for the erection of overhead wires in any part of the city. They believe that less objectionable and equally efficient methods of applying electricity to the working of the tramways are available and at a reasonable cost.

(Signed) WILLIAM COOK, FRED E. HALLAM, H. BISSEKER, HOWARD LANE, } Members of the Sub-Committee.

I entirely concur in the description of the different systems of the tramways seen by the sub-committee and in the conclusions of the sub-committee. (Signed) MAURICE POLLACK.

I was present at a meeting of the sub-committee on tramway traction last Tuesday. I have read the report, and particularly considered the conclusion at which the sub-committee has arrived—viz., that in such a city as Birmingham an electric tramway in which the conductors are entirely underground is much to be preferred to any overhead system. With this conclusion I heartily agree. The greater cost of the former system, though by no means negligible, is very small compared with the advantage gained in so populous and wealthy a city as Birmingham.

(Signed) J. HOPKINSON.

PROPOSED ELECTRIC TRAMWAYS FOR BIRKENHEAD.*

A special meeting of the Town Council was summoned for four o'clock on the afternoon of April 22 to take into consideration and determine upon the following subjects—namely:

1. The following communication, addressed to the town clerk from James Ross, Esq., of Birmingham:

2. To authorise one of the standing committees of the Council, or, if thought desirable, to appoint a special committee to consider and report to the Council their views and recommendations in regard to the several matters referred to in the above communication.

"Birmingham, April 10, 1897.

"Alfred Gill, Esq., town clerk of Birkenhead.

"Dear Sir,—With reference to the informal conversation which Mr. Cunningham, acting for me, has had with you and some members of your Council in your town hall, and to my own interview with you to-day, I now beg to lay before your Council the terms and conditions under which I would be prepared to install a system of electric traction for the tramcars of your town.

"The proposition on our part is as follows: We will form a new company, embracing the two companies now operating in Birkenhead and Wirral, and will at once proceed to lay down and construct an electric system covering, in the first place, all the existing routes on the system of the overhead wire, it being understood that on the present lines, or on such new lines as may be projected, your Council will permit us to employ double tracks where streets are wide enough to permit double tracks, or in narrow streets enough passing places as will enable us to furnish a proper and efficient service of cars. We will lay new rails throughout of a section similar to that in use in Montreal and Toronto (drawings enclosed), and to the lines and levels to be supplied by your surveyor, with all the necessary frogs, switches, and turn-outs, and proper deep-grooved rails on curves, and erect iron poles on either side of the street and at distances apart of about 120ft., to carry the span wire from which the trolley wire is supported at a height of about 20ft. above the rail level, and put in the necessary feed-wire cables to supply the current to the trolley wire where necessary at our own cost and charges. And in doing this work we will take up and hand over to you to remove all the rails, etc., at present in the streets which are your property, and will relay the pavement disturbed in the above work in the same manner as we found it and to your satisfaction, using therefor the material that we take up from the street that is not broken or destroyed in the taking up, and supplying such new material as may be required to replace that which may have been broken or destroyed; and will, on the completion of the work, leave the pavement in practically the same condition as that in which we found it before disturbance. We will further maintain the rails, frogs, turn-outs, etc., and the poles, span wire, trolley wire, and feed wire in repair, and from time to time, as may be necessary, renew the same during the currency of the lease or franchise from your Corporation to our company. And if and whenever in this repairing or renewing we break or disturb the pavement or roadway, we will at our own cost make good the same and put the pavement or roadway in practically the same condition as before the disturbance took place.

"The Corporation on its part to grant to our company a lease or franchise of the tramways for a period of 21 years, to date from one year after the date on which we are put in possession of the streets and enabled to commence the work of construction. And if at the end of the said period of 21 years arrangements satisfactory to the Corporation and our company are not made for a new lease of the tramways, then the Corporation shall pay to the company the then value (without any allowance for goodwill) of the tramways with the rails, equipment, plant, and assets generally of the company provided and used in connection with the tramways, as such value may be determined by mutual agreement or (upon failure to agree) by arbitration.

"Under the above proposed arrangement the Corporation will be relieved of all expense of maintenance, repair, and renewals to the rails, which I understand is a considerable one, and is at present borne by the Corporation. We should be prepared, however, in lieu of the present rent, which comprises such maintenance, repair, and renewal, to make to the Corporation an annual payment not exceeding £1,000 per annum during the currency of the lease.

"If an arrangement is to be entered into between the Corporation and our company, it is very essential to the giving of a thoroughly good system and the most efficient and beneficial service for the public, that there should be a harmonious understanding and agreement in regard to extensions of the track along new streets. Birkenhead's population requires considerable more mileage than at present exists in order to give good service; some districts are not served at all; in others the route is so circuitous that the service is necessarily poor and inefficient. Wherever existing tracks are relaid or new tracks constructed, they should be double tracks, but where the streets are too narrow to allow of this, single tracks with passing places sufficiently close should be put in to give a proper service of cars. In laying double tracks or on passing places the space between tracks should not be less than 4ft. Therefore I would ask as part of my proposal that it should be understood that the necessary powers are to be obtained (either by the Corporation or the company as may be agreed) to enable the company to construct and work (on the same system as that proposed for the existing lines) tramways on the following streets—viz., (1) starting from the Borough-road, on Argyle-street South, Hinderton-road, Queen-street, Old Chester-road, Downham-road, Elm-road, North-road to the Borough-road again, with extension as far as the traffic requires it on the Old Chester-road from Downham-road—this is in order to form a belt line and serve the Clifton and Egerton Wards; (2) from the Borough-road on Ball's-road East, Ball's-road, and Shrewsbury-road; (3) from Conway-street on Claughton-road to the present track at the park entrance, double track except that part of the Claughton-road between Conway-street and Camden-street, where there would be single track with a return single track on Camden-street, between Claughton-road and Conway-street—this would bring the cars in quickly from the Claughton Ward and give easy access to Grange-road, where there are many shops; (4) extension on Egerton-road and Tollemache-road; (5) extension on Conway-street, Park-road North, Upton-road, or Bailey-street. The three first mentioned are the more important, and should be proceeded with as soon as powers can be obtained. There are probably other extensions or modifications of the above which the Council would suggest which would be of benefit to the public. It would, I think, be an advantage to have a connection from Dock-road to the corner of Park-road and Conway-street.

"A clause should be inserted in the lease setting forth that the Corporation will not encourage or aid any other tramway company to construct in the town. As the company do not in any way use the roadway, but run simply on the metals, no part of the cost of road maintenance would fall on the company, but it would naturally be done by the Corporation. The speed at which cars should be run should be eight miles per hour in the central parts of the town and 12 miles per hour in the suburbs, subject, of course, to the Board of Trade regulations in force for the time being. The company would undertake to start cars early in the morning so as to accommodate working-men. The company should be allowed—if it were found expedient to do so—to run first-class cars in addition to the regular cars, or to run cars with first-class compartments if it were found more suitable, and to charge an extra fare for the same. Also to be allowed to hire out special cars at special rates, and to run cars after midnight and charge double fare between midnight and 5 a.m. The company of course to supply all power required for its system. In the work of construction, in order to secure an expeditious changing over of the system, the company would rely upon the Corporation to receive fair treatment and not to be held back in its work by unreasonable restrictions. It is only by the two bodies working harmoniously together that rapid work can be done. The obligations which your Corporation have come under at the instance of the Wirral Tramways Company in connection with your Ferries Bill of this session might, in case this arrangement goes through, be considered as abrogated.

"In order that the Corporation may form an idea of the class of work that the company purposes to do, and the appearance and character of the system when completed, I indicate the system of Rouen in France as the standard. The system that we would put in in Birkenhead would be similar to, though not identical with, that at Rouen, and on wide streets we would, at the option of the Council, put in centre-pole constructions as at Rouen, instead of side-pole.

"In the event of an arrangement being come to, the new company, on being placed in possession of the existing lines, will deposit with the Corporation the sum of £2,000 as a guarantee of good faith in the execution of the agreement, the same to be forfeited in the event of the company neglecting or refusing to carry out the work, but to be repaid to the company by the Corporation whenever the horse trams cease to be operated in the town and the lines are worked by electricity.—Yours respectfully,

"(Signed) JAMES ROSS."

* From the *Birkenhead Advertiser*.

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COMPANIES' MEETINGS AND REPORTS.

EASTERN EXTENSION TELEGRAPH COMPANY.

The half-yearly general meeting of the Eastern Extension, Australasia, and China Telegraph Company, Limited, was held on Wednesday at Winchester House, the Marquis of Tweeddale presiding.

The **Chairman**, in moving the adoption of the report, said that the increase in expenditure was exceptional in character, largely due to the duplicating of cables and the providing of machinery at Singapore for the renewal of cables on the spot. Comparing the figures of 1896 and 1895, the receipts amounted in the former to £649 319, being an increase of £63,599. Seeing that during 1896 there had been a great reduction in the charges for through rates, the increase of revenue was most gratifying. The large increase in the revenue was in the main due to the extraordinary development of gold mining in West Australia. There would be further reduction in the through rates to China. The general reserve fund has been increased to £729.193, and the whole was invested in securities of the highest class. Several of the old cables were showing signs of weakness and rendered it necessary that renewals should be made during the next two years. Since the close of the year they had come to an agreement with the Spanish Government for a cable in connection with the Philippine Islands, which would include the towns of Iloilo and Manilla. The three short sections between Luzon, Penay, Negros, and Cebu had long been wanted by the Government and the commercial community, and they would be of great advantage to the Spanish Government, would bring a considerable amount of traffic to the Company's system, and would, he believed, lead to further extensions in the Philippine group, which the Spanish Government were very anxious to see carried out. The Company had also arranged to supply the Dutch Government with two short cables in the Java seas, which they trusted would also bring additional traffic to their cables. A further drawing of their 5 per cent. Australian subsidy debentures took place on the 5th inst., when these debentures, which originally amounted to £640,000, were reduced to £125,700. At their last meeting he referred to the subject of cable communications between Canada or the United States of America, or both, and Japan, China, and Australia. The Imperial Commission to consider the laying an all-British cable to connect Canada with China and Australia had not yet made public its report, but it would be assumed that the report would announce that no insurmountable difficulties stood in the way of carrying out the undertaking. Two Bills had been introduced into the United States Congress having for their object the laying of a cable from San Francisco to Hawaii, with extensions to Japan and Australia. Neither of these Bills became law, but it was certain that either or both of them would be introduced into Congress again as soon as it reassembled. The establishment of telegraphic communication between North America and China and Australia might be regarded as within measurable distance of realisation, and would lead to a diversion of traffic. It was a matter which the directors had regarded with considerable anxiety, and they would do all that could be done to safeguard the interests of the Company. They had subscribed £500 on behalf of the Company to the Indian Famine Relief Fund. The current half-year had commenced very satisfactorily.

Mr. Francis A. Bevan seconded the resolution, which was carried unanimously.

On the motion of **Mr. M. Davis**, seconded by **Mr. John Newton**, a resolution was also passed voting 100 guineas to the Prince of Wales's Hospital Fund.

LIVERPOOL UNITED TRAMWAYS COMPANY.

A Wharncliffe meeting of the Liverpool United Tramways and Omnibus Company was held on Saturday at the Company's Offices, Liverpool, Sir David Radcliffe presiding.

The **Solicitor** explained the provisions of the Bill for transferring the undertaking of the Company to the Corporation at a price equivalent to £12. 15s. per share.

The **Chairman**, in a speech of considerable length, explained the negotiations that had taken place with the Corporation, and the reasons which had influenced the directors in coming to the arrangement embodied in the Bill. He then proposed a resolution approving the Bill, which was seconded by **Mr. James Richardson**, and unanimously approved by the shareholders.

A vote of thanks to the chairman and directors and the officials of the Company was proposed by **Mr. C. Birchall**, seconded by **Mr. Waterhouse**, supported by numerous shareholders, and cordially approved.

It was explained that the transfer would be completed on August 31, and in the meantime the Company would be entitled to pay its shareholders a dividend at the rate of 5 per cent. per annum, free of income tax.

INDO-EUROPEAN TELEGRAPH COMPANY, LIMITED.

The annual meeting of this Company was held on Wednesday at Winchester House.

Mr. J. H. Tritton presided, and moved the adoption of the report, recommending a dividend for the second half of the year of 17s. 6d. per share, making, with the interim dividend previously declared, 6 per cent. for the year, together with a bonus of 20s. per share, making a total distribution of 10 per cent., and carrying forward £7,704. Having expressed regret at the loss to the telegraphic world sustained by the death of Dr. von Stephan, Secretary of State for the German Empire, and the more immediate loss to the company of the late colleague, Major-General Tremenheere, who had been with them from the very commencement, the Chairman went on to say that there were no great vicissitudes or changes in the undeviating and quietly prosperous condition of their affairs, their expenses and receipts for 1896 being almost identical with those of the previous year. Nothing had occurred at the Budapest Conference to interfere seriously with their revenues. Certain concessions favourable to those using the wires had been made, which would no doubt be satisfactory, while well within the means of the Company. In fact, the reductions of rates made at former conferences were so drastic and far-reaching that the necessity for repose and gradual recoupment was forced upon the attention of all those interested. They had introduced into use a high-speed Wheatstone mechanical transmitter, which, with the duplex arrangements already in use, should enable their wires to deal with any increase of business that might be likely to arise. The total sum available for distribution was £60,204, out of which £10,000 was placed to the reserve.

Mr. C. Holland seconded the adoption of the report, which was carried, and a sum of 100 guineas was voted towards the Prince of Wales's Hospital Fund.

ORIENTAL TELEPHONE AND ELECTRIC COMPANY, LIMITED.

The third ordinary general meeting of this Company was held last Tuesday at Cannon-street Hotel, Mr. W. Addison in the chair.

The **Chairman** said that after paying a dividend of 5 per cent. they were able out of the revenue to write off £1,427. 5s. to the credit of the Colombo suspense account, this leaving only £1,000 to the debit of that account, while they carried forward £629. But for the arbitrary action of the Ceylon Government in appropriating their business without adequately compensating them, even for the capital expended, not to mention the goodwill, the Board would have been able to apply nearly £1,500 to the establishment of a reserve fund, such as they had in the old company, which was available for the equalisation of dividends and other purposes. The reserve fund existing could now only be applied to capital purposes. The electric light business had still resulted in a loss. However, the outlays at Bombay, Madras, and Rangoon in connection with negotiations for business would, he hoped, eventually be to their advantage. The severe suffering in India for months past from famine and plague had greatly interfered with business. As the Company had so large an interest there, the directors had thought it right to contribute 50 guineas to the Lord Mayor's Indian Famine Relief Fund.

He then moved the adoption of the report.

This was seconded by **Mr. T. Lloyd**, and carried unanimously.

Mr. H. Grëwing and Mr. W. Addison were re-elected directors, and the auditors, Messrs. Deloitte, Dever, Griffiths, and Co., were also re-elected.

MANCHESTER CARRIAGE AND TRAMWAY COMPANY.

The half-yearly meeting of this Company was held on Tuesday, in the Memorial Hall, Albert-square, Manchester. Mr. Alderman J. King presided. The balance-sheet showed that the receipts from all sources were £245,646. 16s. 7d., as compared with £242,091. 5s. 10d. in the corresponding half-year of 1895-96. To the net profit of £22,820. 1s. 1d., the report stated, there must be added £9,046. 6s. 4d., the balance from last year, making a disposable sum of £31,866. 7s. 5d. This will provide for a dividend of 2½ per cent. to the preference shareholders, and one of 5 per cent. for the six months to the ordinary shareholders, and will enable the directors to set aside £2,500 for the reserve fund, and to carry forward a balance of £9,267. 7s. 5d. to the next half-year.

The **Chairman**, who moved the adoption of the report, said that it was very satisfactory, as it showed that the traffic had increased to the extent of about £3,000, and the expenses had been so regulated that they were enabled to pay the same dividend—5 per cent.—as was paid in the last half-year. Their horses had increased from 4,891 to 5 071, as shown in the report, and their tramcars from 494 to 507. The directors had observed that there was talk of electric traction in the air, and they would give all the necessary attention to improvements of that kind, so that, if necessary, they would be able to move with the times.

Mr. Turton, who seconded the resolution, remarked that he thought much of the talk about electric traction was mere rumour. He hoped that before anything of the kind was undertaken by the Company, the directors would be satisfied that it was a paying matter.

The resolution was adopted.

On the motion of **Mr. Adam Murray**, seconded by **Mr. R. Falkner**, it was resolved to increase the annual remuneration to the directors from £2,000 to £3,000.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

West Ham.—The Council invite tenders for pipe work, feed pumps, feed-water tank, etc. Tenders to be sent in not later than 4 o'clock on May 11. See advertisement.

Liege.—Tenders will be received by the Provincial Government of Liège on May 3 for the construction, maintenance, and working of an overhead electric tramway from Grivegnée (Bonne-Femme) to Chênée.

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Dusseldorf.—Proposals will be received by the municipal authorities of Dusseldorf up to May 20 for the conversion of the horse tramways of Dusseldorf to electric traction.

Arnay-le-Duc (France).—The municipal authorities of Arnay-le-Duc, in the Côte d'Or, have advertised that they are prepared to consider propositions for the electric lighting of the town. No date is specified.

Bucharest.—The Roumanian Government will want tenders on August 20 for the supply of 55,000 porcelain insulators (double bell), and other porcelain telegraphic fittings. Application should be made to the Direction of Posts and Telegraphs at Bucharest.

Manchester.—The Electricity Committee invite tenders for the purchase and removal from their electric light station Dickinson-street, of certain plant, which is being disposed of in consequence of the committee having decided to put down larger plant. Full particulars are given in our advertisement columns.

Spandau (Germany).—Tenders will be considered on June 22 for the supply of 900 incandescent electric lamps, and on May 25 for the supply of arc light carbons for the arsenal. Particulars are obtainable for 75pfg. (9d.) from the Königl. Direktion der Gewehrfabrik, Spandau, and samples should be sent in by May 11.

Santiago de Chile.—The Chilian Government Telegraphic Department will receive tenders on June 19, at Santiago, for the supply of galvanised iron wire, insulators, Morse instruments, paper for same, etc. Particulars (a summary only, and in Spanish) can be consulted at the Musée Commerciale, Brussels; otherwise application is to Santiago.

Paris.—The French Telegraphic Authorities (Paris, Rue de Grenelle 103) will receive on May 11 tenders for the construction and fitting of a central telephone office in Paris. Application should be made by May 6. Also on May 20 tenders will be received for 19,100 telegraph posts and for wood fibre for packing. Application should be made before May 10.

Bath.—Tenders are required for the supply of two electroliers, to be fixed in the Roman Promenade, adjoining the Grand Pump Room. Design can be inspected at the office of the Architect, 77, Newman-street, London, or at the Town Clerk's Office, Guildhall, Bath, between 11 a.m. and 4 p.m. Sealed tenders, properly endorsed, and addressed to the Chairman of the Baths Committee, to be delivered by May 6 at the Town Clerk's Office.

London, E.C.—The Great Eastern Railway Company invite tenders for the supply of stores and materials—including telegraph materials. Forms of tender may be had on application to the Secretary's Office Liverpool-street Terminus, E.C., on and after May 6. The patterns may be seen at the Company's Stores, Stratford, between 10 a.m. and 4 p.m from May 6 to 12, inclusive. Tenders, endorsed "Tender for Stores," to be forwarded by post in the envelope provided by the company to Mr. W. H. Peppercorne, secretary, Liverpool-street Terminus, London, E.C., by 10 a m. on May 13. (See advertisement)

Dundee.—The Gas Commissioners are prepared to receive tenders for the supply of (*a*) arc lamps and accessories, (*b*) arc lamp pillars, (*c*) Lancashire boiler and fittings, (*d*) high-speed steam-engine and dynamo, (*e*) accumulator battery and switching gear. Specifications and forms of tender may be obtained on application to Mr. Walter H. Tittensor, city electrical engineer. Applications for sections (*c*), (*d*), (*e*) must be accompanied by a deposit of 10s. for each section, which will be refunded on receipt of a bona fide tender. Sealed tenders (marked on the outside) must be deposited with Sir Thomas Thornton, LL.D, clerk to the Commissioners, City Chambers, Dundee, on or before May 12.

Wakefield.—The Guardians invite tenders for the following work at the new infirmary: (1) electric lighting plant, combined steam-engine and dynamo, belt-driven dynamo, motor-dynamo, motor, switchboard, storage cells, etc.; (2) complete system of wiring for the electric light, also bells and telephones; (3) vertical steam-engine, feed-water heater, tank, pumps, and pipe work, etc. Contractors wishing to tender for any of above sections must forward to Messrs. Shepherd and Watney, engineers, 71, Albion-street, Leeds, a deposit of £1. 1s. for such section, which will be returned on receipt of a bona fide tender. Specifications will then be forwarded to such applicants on or about May 13. Tenders must be delivered to Mr. H. Beaumont, clerk, Union Offices, Tetley House, Wakefield, in sealed envelopes, endorsed "Section No. 1, etc.," by noon on June 2.

Belfast.—The Electric Committee are prepared to receive tenders for the supply and erection of the following plant: Section B 3—Boilers, mechanical stokers, coal-conveying plant, economisers. Section B 4—Storage batteries Section B 7—Overhead traveller. Section B 8—Underground cables, pilot wire. Section B 9—Laying cables. Section B 10—Cast-iron work. Section B 11—Roadwork, laying conduits, pipes, and building junction boxes. Section B 12—Earthenware conduits and earthenware junction boxes. Specifications and conditions of contract may be obtained from the Electrical Engineer, Central Station, Chapel-lane, on payment of £1. 1s. per copy of each section, which sum will be refunded on the return of the specification with a bona fide tender. Sealed tenders, endorsed "Tender for ——," be lodged in the office of Sir Samuel Black, town clerk, not later than noon on May 6.

Blackburn.—The Corporation are prepared to receive tenders for the supply and erection of electric tramway equipment as follows: two steam dynamos, switchboard, instruments and connections, steam and exhaust pipes, valves, etc., posts and bracket arms, etc., overhead line equipment, underground cables, pilot wires, etc., section boxes, etc., railbonding, etc. Tenders, in conjunction with the above, are also invited for street-lighting—both arc and incandescent. The specifications and plans, with conditions and forms of tender, may be obtained at the offices of Mr. E. M. Lacey, the consulting engineer to the Corporation, 10, Delahay-street, Westminster, S.W., on payment of £7. 7s. for each copy, which sum will be refunded on the return of the specification filled up, with bona fide tenders. Tenders, sealed, and endorsed "Traction," to be delivered to Mr. Robert E. Fox, town clerk, Town Hall, Blackburn, on or before Saturday, May 8 next.

Valletta (Malta).—Sealed tenders will be received at the office of the Receiver-General and Director of Contracts, Valletta, until 11 a.m. on May 4 for supply, either separately or jointly, of any or all of the following: (1) a 200-kilowatt steam alternator; (2) a steam-engine, to drive directly the 200-kilowatt alternator; (3) a water-tube boiler and accessories, to evaporate 6,000lb. of water an hour at 150lb. of pressure from 60deg. F. Tenderers in England not having a representative in Malta are to deposit with the Crown Agents the sum of £200, to be forfeited in case of non-compliance with any of the provisions of this notice, or with any agreement consequent thereon. Tenderers in Malta are to deposit a similar sum at the office of the Director of Contracts. Tenderers are to undertake to deliver at Malta, on the wharf, to erect and to allow and cause to be tested all or any of the above before October 1, and to contract to pay, as liquidated damages, ½ per cent. per diem on the contract price for each day of delay up to final completion. Tenderers are also to state the earliest date on which they can deliver on the wharf at Malta, and the abatement in the price tendered, which they would be willing to allow in case the Government of Malta undertakes to erect the plant at the expense of the Government. Particulars, specifications, etc, may be obtained on application to the Superintendent of Public Works in Malta, or to the Crown Agents for the Colonies, Downing-street, London.

RESULTS OF TENDERS.

Braila (Roumania).—The electric tramway concession for 35 years has been given to the Helios (Cologne) Company on the basis of the payment of 3 per cent. of the gross revenue and 35 per cent. of all profits above 6 per cent. on the capital. Schuckert and Co., (Nuremberg), Singer and Co. (Berlin), and Lindheim and Co. (Vienna) also tendered, but the first two of these did not deposit the necessary guarantee.

Bath—The Corporation have received the following tenders for the extension of the buildings of the electric light works at Dorchester-street:

Hayward and Wooster Bath (accepted)	£2,327
Hughes and Weeks, Bristol	2,730
W. Webb, Southgate-street, Bath	2,659
J. Tong and Son, Railway-road, Bath	2,387
S. Ambrose, Railway-road, Bath	2,684

West Ham.—The following tenders have been received for the erection of sewage pumping engine and boiler-house and electric lighting buildings at the Abbey Wharf, Stratford, London, E., by the West Ham Town Council:

Portland stone.

J. Jackson, Plaistow	£50,097
Shillitoe and Sons, Bury St. Edmunds	45,530
Munday and Sons, Trinity-square, E.C.	44,939
B. Cooke and Co, 16, Victoria-street, S.W.	42,240
Chessum and Sons, Haggerston	40,981
G. Sharpe, Stratford	39,945
C. G. Hill, London	38,600
Gregar and Son, Stratford	35,747

Artificial stone.

J. Jackson	47,157
Shillitoe and Son	44,530
Munday and Sons	43,561
B. Cooke and Co.	41,116
Chessum and Sons	39,208
G. Sharpe	38,260
C. G. Hill	36,300
Gregar and Son	33,747

BUSINESS NOTES.

Norwich—The Town Council have adopted a resolution in favour of the light railways and electric tramways scheme.

Appointment Vacant.—The Electrical Committee of Bristol desire applications for the post of charge engineer. Salary £2 10s. per week. See advertisement.

West India and Panama Telegraph Company.—For the half-month ended April 15 the receipts were £2,710, as against £2,803 for the corresponding period of 1896.

Ealing.—The Electric Lighting Committee reported at the District Council meeting that the proprietor of the King's Head Hotel, in the Grove, had applied for electric lights equivalent to 160 8-c.p. lamps.

Boxhill.—At the Urban District Council meeting Mr. Cooper moved that the Electric Lighting Committee be composed of the whole body, and that they have power to act. Mr. Young seconded, and it was carried.

Electric Soldering Pots.—The American Electric Heating Corporation, of Boston, announce as ready for market electric solder pots in two sizes, one to hold 4lb. using 1¾ amperes at 110 volts; a larger size holds 10lb.

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Clerkenwell.—The Clerkenwell Vestry have agreed to refer to a special committee for early consideration and report the question of the advisability of the Vestry applying for a provisional order for lighting the parish with electricity.

London.—At the meeting of the Commissioners of Sewers, a letter from the City of London Electric Lighting Company relative to the claim of the Commission to be reimbursed the expenses of the electrical inspector, was referred to the Streets Committee.

Bristol Tramways and Carriage Company, Limited.—The traffic returns for the week ended April 23 were £2 963. 9s. 10d., compared with £2,077. 3s. 6d. for the corresponding period of last year (including Easter week) being an increase of £886. 6s 4d.

Electric Supply Corporation, Limited.—This Company has been registered, with a capital of £5,000 in £5 shares, to carry on the business of an electric light and power company in all its branches, and as electricians, mechanical engineers, suppliers of electricity, etc.

Plumstead, Limited.—This Company has been registered with a capital of £2,000, in £1 shares, to acquire the business of an electrical fittings manufacturer as now carried on by F. Plumstead at 44A, Whitfield-street, Tottenham Court-road, and to develop and extend the same.

Ipswich.—The Ipswich Tramways Company have accepted the offer of the British Gas Traction Company to purchase their undertaking for the sum of £12,000 in cash, payable by instalments, and £5,000 in 1,000 fully paid-up shares in the British Gas Traction Company, Limited.

A Danish Cable Steamer in the Tyne.—The Danish cable steamer "H. C. Orsted" visited the Tyne at North Shields last week, taking on board a supply of bunker coal. She has recently been engaged at the repairing of the telegraph cable between Newbiggin and the Danish coast.

City and South London Railway.—The returns for the week ended April 25 were £928 compared with £889 for the corresponding period of last year, being an increase of £39. The total receipts for the half-year 1897 were £17,612, compared with £16,149 last year, being an increase of £1,463.

Electricity in Calcutta.—It would appear as though the question of converting the Calcutta tramways into a concern worked by electric traction has been dropped, and *Indian Engineering* says that the public will have to endure, for a still further period, the horrors of the present system.

Birmingham Motor Omnibus Company, Limited.—This Company has been registered, with a capital of £10,000 in £1 shares, to carry on the business of motor and other omnibus builders, tramcar, carriage, cab, and van builders, engineers, machinists, fitters, millwrights, founders, etc.

Book Received.—We have received a book from the American Impulse Wheel Company, of New York, entitled "The Perfect American Hurdy-Gurdy in the Light of Modern Hydraulics," which is a description of the Gazin power wheel. We may have some remarks to make about this in a future issue.

Times Electric Lamp Company, Limited.—This Company has been registered, with a capital of £100,000 in £1 shares, to carry on in all or any of their respective branches the businesses of manufacturers of and dealers in primary and other batteries, electric lamps and apparatus, as electricians and electrical engineers, etc.

Chester.—At the Town Council meeting Alderman Churton asked when they were to have the electric current in the Groves. He understood there were two electric launches waiting to be charged. The Town Clerk said it was a question whether the distributing cable could be put down with or without an arc light cable.

Theatre Lighting.—In Her Majesty's Theatre, which has just been opened, there is an elaborate system of warming and ventilation with fans worked by electric motors. For lighting Mr. Tree relies on electric light alone. The theatre is fitted with reproductions of the Fontainebleau candle brackets, electric light being substituted for candles.

Western and Brazilian Telegraph Company, Limited.—The directors have decided that after placing £5,000 to the reserve fund they will, subject to audit, recommend at the forthcoming meeting a dividend at the rate of £2 per cent. per annum (3s. per share), free of income tax, for the six months ended December 31 last, carrying forward £6,406.

Lighting in France.—The Electric Lighting Company of Nancy (Meurthe-et-Moselle), who have established very large works for lighting and motive power, have again decided to make an extension, and will shortly install two units of a power of about 400 kilowatts each, continuous current. The work has been entrusted to the firm of M. Fabius Henrion, of Nancy.

Newcastle.—At a meeting of the Lighting Committee an arrangement was made that as many members as can make it convenient should go to Southport and Bolton for the purpose of examining the system of electric lighting in those towns. It was further arranged that the survey should be made on Wednesday, May 12. The members will proceed to Southport first, and then to Bolton.

Underground Telephone Wires.—The Forfarshire Road Board have refused an application by the National Telephone Company, Dundee, for permission to lay underground wires from Dundee burgh boundary to Strips of Craigie. Mr. J. G. Soutar remarked that the Dundee District Committee had refused to allow the wires to be laid in their roads. There was nothing to prevent their being laid in the fields adjoining.

Taunton and West Somerset Electric Railways and Tramways Company, Limited.—This Company was registered on April 9 by Milner and Co., 1, Great Tower-street, E.C., with a capital of £600 in £1 shares. Object sufficiently indicated by the title, and to enter into certain agreements. Table A mainly applies. Registered office: 3, Hammel-street, Taunton.

Telephone Charges.—Following the example of New South Wales, the Postmaster-General of Victoria has decided to reduce the charges for telephones in the capital by about 25 per cent. Mr. Duffy has great misgivings as to the financial result of the step, and officers of the telephone department estimate that the reduction will result in considerable loss. In Sydney, however, the lowering of the rates has had no such effect.

Electric Rudder Motors—A syndicate has been formed for the purpose of putting on the market an invention which it is claimed will prove of great value to shipowners, marine engineers, yachtsmen, and those interested in the shipping trade and boating generally. Boats fitted with electric rudder motors will be seen on the Mersey on Tuesday next. The invention is the property of the New-Mayne Electric Rudder Motor Syndicate, Limited.

Bristol.—A few evenings ago a slight accident happened on the electric tramway. About a quarter to eight one of the Eastville cars had got to the first point at the West-street junction, when the trolley at the end of the connecting rod at the top of the car suddenly came off, and the tram, after going a few yards, stopped. Some excitement was caused amongst the outside passengers by the way in which the wires at the junction swayed up and down.

A Motorcar Explosion.—The boiler of a motorcar, which was being worked at Charing, Kent, by William Brakefield, an engineer, who had manufactured it, exploded on Wednesday. Brakefield was struck by portions of the machinery, and sustained terrible injuries. His skull was fractured, laying open the brain, and no hopes are entertained of his recovery. The explosion was caused through the compressed air failing to escape while the car was being driven.

Search-Light.—Experiments have been carried out at Sheerness to test the efficiency of the electric search-light arrangements in connection with the defence of the entrance to the River Medway. The gunboats "Bustard" and "Bouncer" and three War Department steamers were ordered to steam into Sheerness Harbour under cover of darkness, but by the aid of the lights the vessels were kept under observation until they had rounded Garrison Point Fort.

Grimsby.—The Street Tramways Company have been successful in their application to the Board of Trade for a provisional order empowering them to extend their system into Cleethorpes town, and the order has been issued accordingly. To meet an objection raised by the Grimsby Corporation, it is stipulated that the company, whilst being given power to use electrical traction, shall not use the same within the borough of Grimsby without the consent of the Corporation.

The Brush Electrical Engineering Company.—We have received from this Company a handsomely printed and bound catalogue, illustrations, and particulars of engines, etc., manufactured at the Falcon Engine and Car Works, Loughborough. We notice that the Company do not confine themselves to electricity, for, judging by the illustrations, they also turn out some very useful-looking locomotives, passenger and light railway carriages, wagons, etc., electric and horse cars, omnibuses, etc.

Fire at Electrical Works—Fire broke out on Tuesday afternoon in the machine-room on the fifth floor of the premises occupied by Messrs. Allen and Adamson, electrical engineers, 88 and 90, Tabernacle-street, E.C. Appliances were promptly got to work by the firemen, and a good supply of water being available the flames were confined to the room in which they broke out, but, in addition to the complete destruction of its contents, much damage was caused to the valuable stock in the floors underneath by water and dirt.

Bray.—A deputation, consisting of Messrs. Liller, Ryan, and Isaac Molloy, solicitor, waited on the Township Board at the last meeting for the final decision of the Commissioners with reference to the promenade pier scheme. The clauses of the agreement submitted by the Commissioners were further considered and slightly amended, and subsequently accepted by both parties. The promoters of the pier and electric tramway schemes have to lodge £2,500 in each matter to the credit of the Commissioners by July 31 as guarantees for going on with the projects.

Colombian Indiarubber Exploration Company, Limited.—This Company has been registered, with a capital of £300,000 in £1 shares (100,000 preference), to adopt and carry into effect an agreement between the Colombian Syndicate, Limited, and R. B. Alena, as trustee for this Company, for the acquisition by purchase or otherwise of a concession granted by the Colombian Government and of a freehold property situate in Colombia, to carry on the business of tree growers, indiarubber manufacturers and merchants, to construct, maintain, and work rail and tram roads, telegraph lines, etc.

The Isle of Man Tramways.—The Manx Legislative Council at their last meeting considered the Laxey and Ramsey Electric Tramway Bill. Several postponed clauses were amended and a new clause added providing that the governor should appoint the arbitrator to settle any difference which might occur between the company and the Ramsey section of the shareholders with regard to working expenses or the effective working of the line. The Bill was then read a third time and passed. It is intended to proceed at once with a new electric tramway from Snaefell to Sulby Glen, the Manx Switzerland.

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Patent Designs.—The number of designs applied for at the Patent Office during 1896 amounted to 21,738, exclusive of 1,111 "sets" of designs, as against 20,507 single designs and 910 "sets" in the previous year. The term "set" includes any number of articles ordinarily on sale together, irrespective of the varieties of the size or arrangement in which the particular design may be shown on each separate article. During the year 1,269 applications for registration of designs were objected to by the comptroller, and of these 524 were refused on account of their similarity to designs already registered, while the remainder were objected to chiefly on account of want of subject-matter or of substantial novelty.

Fire at Ponders End.—We understand that the fire brigade organised in connection with the Edison and Swan United Electric Light Company's works at Ponders End had a special holiday outing at Easter. On the Thursday before Good Friday a serious fire broke out at the works of the Corticine Company, Limited, at Ponders End. The outbreak was noticed between five and six, and in the race for first place the Ediswan brigade came in a good second. The fire gave work to nearly a dozen engines before it was got in hand. We understand that the electrical fire brigade stood by the ruins till Saturday evening. We trust the services thus rendered will be suitably acknowledged by the fire insurance authorities.

Birkenhead.—A special meeting of the Town Council was held last week to consider the question of introducing electric trams into the borough. After a very full discussion an amendment was carried that a special committee be appointed to consider and report to the Council their views and recommendations in regard to the introduction and adoption of electric tramways by the Corporation or any other body of persons, and several matters referred to in the communication of Mr. Ross; and that the committee consist of the Mayor, Messrs. Deakin, Singleton, Getley, Shaw, John Laird, Cook, B. Jones, Rees, Gamlin, Oates, Price, Kelly, Mason, and E. P. Smith.

Brighton.—In a few days the Brighton and Rottingdean seashore electric tramway will be in working order again. The car, which was wrecked in the great gale last autumn, is now stronger than ever, and the new landing-stages and passengers' waiting-rooms will be so situated as to be safe from future gales. A harbour of refuge for the car is being made. At the meeting of the Board of Guardians, Councillor Dewe asked leave to mention that it had been decided that it was desirable to have the new sanatorium on the hill lighted by electricity, and he thought it was a fitting opportunity to consider the advisability of laying the light on at the workhouse. Councillor Swift rose to a point of order, as the matter was not on the agenda, and the subject therefore dropped.

The Dublin Tramways.—On Wednesday, the 21st inst., application was made by the Dublin and Lucan Steam Tramway Company to the Grand Jury of the County of Dublin, under the Tramways (Ireland) Act of 1860, for permission to erect the necessary poles and wires, and to work their line by electricity, the name of the company being also changed to the Dublin and Lucan Electric Railway. Mr. H. J. Fuller, the company's engineer was in attendance and gave evidence as to the method of traction—the single-pole side-wire system—to be employed. Sanction was given to the proposals of the company, which expects to commence the works in June or July next. The line is in reality a railway, laid with steel Vignoles rails upon timber sleepers, and is the first of its type in the country.

Lift Fatality at the Central London Railway—At the Paddington coroner's court last week, Dr. G. D. Thomas held an inquest respecting the death of William Joseph Hughes, aged 29, a bricklayer. The deceased, who resided at 91, Westmoreland-place, City-road, was employed by Messrs. Walter Scott and Co., contractors, at the Marble Arch Station of the Central London Electric Railway, now in course of construction. The men were working at the bottom of a 90ft. shaft, and to reach their work were lowered in a cage or lift. As the cage was in motion deceased rushed to get into it, and one of his legs was crushed against the framework. The right thigh was severely fractured, and he died from hæmorrhage in St. Mary's Hospital. The jury returned a verdict of accidental death.

Electrical Printing.—Mr. J. J. Reifgraber, of St. Louis, Mo., has invented and patented an apparatus by which typographical composition can be simultaneously reproduced electrically in as many newspaper offices as are connected with the transmitting wire. The device consists of a combined typewriter and perforating machine, by which the operator not only prints the respective characters represented by the various keys, but produces a strip of paper upon which are perforations for every key pressed. This perforated slip is inserted in an electrical transmitter, and through identical machines at other and distant points this perforated slip is inserted into another little instrument attached to the Mergenthaller linotype machine, thereby automatically operating the same and setting up the matter in type, in any number of places.

The Accident at Bristol.—At the Bedminster Police Station on Tuesday the city coroner, Mr. H. G. Doggett, resumed the enquiry into the circumstances attending the deaths of Francis Stone, aged 37, of 8, Adelaide-place, Upper Easton, and John Reynolds, 38, of 70, Luke's-crescent, Totterdown. The deceased were formerly in the employ of Mr. C. A. Hayes, contractor, and on April 13 they were engaged upon the works in progress in connection with the extension of the Bristol central electrical station, when they received injuries by the fall of a pile-driving machine, to which they ultimately succumbed. The enquiry was watched by Mr. J. S. Maitland, H.M. inspector of factories; Mr. W. Brown, representing Mr. Hayes; and Mr. Robinson (Wansbrough, Dickinson, and Co.) appeared for the relatives of the deceased. After hearing the evidence, the jury returned a verdict of accidental death in each case.

European Electric Railways.—Some interesting statistics of the electric railways in Europe are to be found in a recently published American consular report. In mileage of electric railways Germany is foremost among European nations, having 252 miles of lines; then follow France with 82 miles; Great Britain and Ireland, 66½ miles; Austria-Hungary, 44 miles; Switzerland, 29 miles; Italy, 24¾ miles; Servia, Russia, Belgium, and Spain have from 6·21 miles to 18·64 miles. Of the 111 lines of electric railways in Europe, 91 are worked on the overhead trolley line system, 12 on the underground system, and eight by means of accumulators. Berlin, which has hitherto been almost entirely dependent on the old horse tramway and omnibus service, is just about to introduce general electric locomotion in its streets, while Hamburg and Leipzic have their electric street railways nearly completed.

Rathmines.—A special meeting of the Commissioners has been held "for the purpose of considering and of expressing approval or disapproval of the scheme of the tramways extension and alterations put forward by the Dublin United Tramways Company and embodied in their memorial to his Excellency the Lord-Lieutenant in Council." Mr. G. Collins, solicitor (Messrs. Casey and Clay), was present on behalf of the tramway company. Mr. Shannon, solicitor to the Commissioners, was also present. Mr. W. Dickeson, C.E., engineer to the township, reported on the scheme, and pointed out the amendments that would be required to safeguard the interests of the Commissioners. After some discussion it was decided "that the consideration of the said application of the tramway company be adjourned until May 5, to prepare and submit the draft proposed order in accordance with the terms of the agreement dated February 27, 1897, and to comply with the other provisions of said agreement."

Rowley.—At the District Council meeting the General Purposes Committee reported having received a letter from the manager of the Birmingham, Wolverhampton, and District Tramways Company stating that the Bill promoted for the extension of tramways had been abandoned, but the matter would be brought up in a fresh form. A communication was received from Mr. S. Morse, solicitor, of London, enclosing a form of agreement with respect to the intentions of the British Electric Traction Company to purchase certain existing tramways in Dudley and other districts, and to obtain an order authorising light railways under the Light Railways Act of 1896, which in certain districts would be worked by means of electricity. The committee were unable to make any recommendation, but they were impressed with the idea that the Light Railways Act would not authorise the carrying out of the proposal as made. They directed the clerk to communicate with the company's solicitor upon the matter.

The Telephone in Fife.—On the Post Office taking over the telephone some months ago, great dissatisfaction with the service was expressed by the Chief Constable of Fife, and on the matter being brought before the County Council, negotiations were entered into with private contractors for the erection of wires and instruments for the exclusive use of the county officials. The cost was found to be heavier than the County Council felt justified in incurring, but at a meeting at Cupar of the Road Board on Wednesday it was reported that the National Telephone Company had agreed for £72. 13s. 6d. per annum to perform the telephone work of the county, supplying instruments for the following nine stations: Cupar police office, the chief constable's house at Cupar, Newport, St. Andrews, Leven, Dysart, Burntisland, Cowdenbeath, and Dunfermline. Besides the above sum, the county would have to pay the Post Office between £24 and £30, so that the total outlay would be about £100 per annum. The Board approved and adopted this report.

Edinburgh.—The Electric Lighting and the Cleaning and Lighting Committees have framed their provisional estimates for the year from May 15, 1897, to May 15, 1898, and directed them to be submitted to the Treasurer's Committee of the Town Council. In the case of the Electric Lighting Committee the total estimated expenditure is £19,730, as compared with an estimate of £10,730 last year. It is estimated that the receipts on account of the expenditure will be £33 050, as against an estimate last year of £23,850. The committee estimated its total capital expenditure for the year at £46,900. The Cleaning and Lighting Committee estimate their ordinary expenditure in the lighting department at £32,720, as against an estimate last year of £29,730. The receipts on account of that expenditure are stated at £25, against £6,560 last year, the difference being largely due to the change by which the cost of lighting the common stairs is now assessed for. In the cleaning department the expenditure is estimated at £48,935, as against an estimate of £45,235 last year. The receipts on account are stated at £2,000 as against £2,040 last year. The capital expenditure is estimated at £48,000.

Llandudno.—A letter enclosing plans was read at the Urban District Council meeting from Mr. Webb, on behalf of the Colwyn Bay and Llandudno Light Railway Syndicate, showing the proposed new route, and intimating that another application would be made for powers. Mr. J. O. Thomas characterised the application as the very acme of cheek. It was the sixth application in two and a half years. He moved that they do not entertain the idea at all. Mr. John Owen seconded. He thought it was quite time the Council gave these gentlemen to understand that they did not mean to have anything to do with them; such repeated

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applications were out of place. Mr. Bevan moved that the application be referred to the Electric Lighting Committee. Mr. Sarson seconded. He did not know of any law of courtesy or rule of etiquette to prevent repeated applications, and they were not an insult to the commonsense of the Council. He thought a courteous application should be received in a courteous spirit, and not with inflated epithets such as "cheek." Mr. Bevan's resolution was carried, and a resolution from Colwyn Bay Council suggesting co-operation between the two authorities in tramway matters was referred to the same committee.

B. Groote, Nuremberg.—We have received from this firm a circular showing that the Germans have no objection to participating in the Jubilee boom in electric light in England. The circular says that "the 'Jubilee' electric illumination lamp can be fitted to the wires or taken off after use at any moment, without tools, one man being able to fix up to 300 lamps an hour; can be placed at any distance from each other; can be lighted all at once; no danger of fire; does not drop and soil your cloth; does not want refilling; does not smoke; does not smell; stands well stormy weather; manufactured in all colours of glasses; electric current absolutely harmless; lighting power costing about half price of candle, oil, or other kind of light; expenses for installation reduced by three-quarters." The system consists of making the lamp and fitting in one. The fitting consists of two clips on an insulated base, which fit over two bare wires 2in. apart. The inventor says, "While using the boards for straight lines generally we have also constructed a system allowing the formation of devices of all kinds. This was done by fixing the blank copper wires to isolators." We are afraid the stubborn English fire insurance inspectors will have something to say in the matter.

Hampstead.—At the meeting of the Vestry, the Lighting Committee recommended that a 32-hour alternating arc lamp be erected and lighted near the urinal at the junction of Fairfax-road with five other roads, to replace seven existing gas lamps, at an estimated cost of £30. A memorial, forwarded by Mr. Corbet Woodall, of 69, Fitzjohn's-avenue, was received from owners and occupiers of houses in that road, stating that they had heard that a proposal for lighting Fitzjohn's-avenue with electric arc lamps was before the Vestry, and representing, for reasons stated that such a system of lighting would be inappropriate and objectionable for a road of that character. A letter was received from the Board of Trade, forwarding, for the observations of the Vestry thereon, a copy of the report by Major Cardew, R.E, after an investigation of the circumstances connected with the fatal accident on March 6 to H. White, an employé of the Vestry, in one of the electric lighting sub stations. Mr. Newton asked why the report had not been placed before the members of the Vestry, whose only information on the subject had been obtained through the Press. Mr. Reed, chairman of the Lighting Committee, said that committee had the matter under consideration, and would report in due course. The report was adopted, and the memorial was referred to the Lighting Committee.

Stafford.—The report of the Gas and Electricity Committee was presented at the Town Council meeting by Mr. Alderman W. H. Peach. The committee recommended the following scale of charges for electricity: 7d. per unit on an average maximum demand of one hour per day, and 3d. per unit for the excess; not exceeding 2,000 units, 7d. per unit per annum; exceeding 2,000 units and not exceeding 4,000 units, 6½d. per unit per annum; exceeding 4,000 units and not exceeding 6,000 units, 6d. per unit per annum; exceeding 6,000 units and not exceeding 8,000 units, 5½d. per unit per annum; exceeding 8,000 units, 5d. per unit per annum. In moving the consideration of the report, Mr. W. H. Peach stated that since the committee met the year's accounts had been made up, and were eminently satisfactory, the profit balance, after paying all expenses for engineer, wages, distribution, rates and taxes, management, and in fact, everything except interest and repayment of loans, was £601. 4s. 9d., the receipts having been £1,215. 1s. 6d, and expenses £613. 16s. 9d., leaving a net profit as stated. This year the interest on loans amounted to £479. 4s. 5d., and the item for repayment £423. 15s. 2d., making £902. 19s. 7d. in all, so that deducting the profit they were only £301. 14s. 10d. short of paying their way. As they carried forward nearly this amount last year, they might say that they had paid their way. They should not ask the Finance Committee to find them the £902. 19s. 7d., but hoped by increased trade to repay them and pay their way. The second year of the working of the electric station had shown an improvement, and the amount of current sold was 2½ times as much as in the previous year.

St. Pancras.—At a meeting of the St. Pancras Vestry, held on Wednesday, the Electricity and Public Lighting Committee presented their accounts for the year ended December 31 last. These showed a revenue of £23,133. 16s. 2d. from the Regent's Park station, and a net profit of £2,816. 4s. 5d. To this was to be added £1,149. 6s. 7d. brought forward from 1895. The entire profit derived from the working of this station was thus £3,965. 11s. On the other hand, the King's-road station accounts, which from the beginning covered only a period of 15 months, disclosed a loss of £4,766. 3s. 7d. In explanation of this it was stated that up to the time when the station began to supply electric current nearly £1,650 was spent in paying instalments and interest on loans and in meeting salaries, wages, and other working and standing charges. The demand upon the station was small when it commenced to supply, while the working expenses and standing charges were almost as high as when the station was delivering a large output. Of the £3,824 obtained from the sale of current, £1,670, or 43 per cent., was in respect of the last three months' working. The net result of the two stations' work was a loss of £807. 12s. 7d. Exceptional charges, however, had to be met during the year for compensation and law charges in connection with explosions in the culverts which occurred in February, 1895; and the large expenditure involved for repairs to the arc lighting mains owing to the breakdown of the public arc lighting in August, 1896. But for these accidents, and in spite of the loss in respect of the King's-road station, the year's working as a whole would have shown a profit instead of a loss. The accounts were adopted.

Newmarket—At the Urban District Council meeting a notice of motion stood on the agenda in Mr. Carr's name, that the Council should abandon their application for an electric lighting provisional order. The Chairman ruled that this, as virtually a negative motion, could not be brought forward unless the Council resolved that the matter was one of emergency. Mr. Sheppard urged that as, if they waited another month or six weeks, the Council would incur a further expenditure of £25, he moved that the matter be treated as one of emergency. Mr. Carr seconded the motion, and it was carried. Mr. Carr then moved that the application for an electric lighting provisional order be abandoned. He pointed out that at the recent election the public feeling on the electric light question was unmistakably shown, and the sooner they disposed of the matter the better. Mr. Sheppard seconded the motion, and spoke of the strong public feeling against the Council undertaking an electric light supply. Mr. Dearsley expressed the feelings of the working classes against the electric light, and Mr. Rodrigo also supported the motion. Messrs. Westrope and Segrott opposed the motion. They pointed out that the Council had already virtually expended £235 in applying for a provisional order, and that even if they expended another £25 in getting the order, they might be able to dispose of the order for as much or more than it cost them, and so save the town £235. A letter from the Edison-Swan United Electric Light Company, enquiring whether the Council, if they obtained a provisional order, would be prepared to dispose of it was read before a vote was taken. Upon the motion being put to the meeting, Messrs. Carr, Sheppard, Hammond, Dearsley, Rodrigo, W. Westley, and S. Westley voted for, and the Chairman and Messrs. Westrope, Segrott, Carter, and Cottrall against. The motion was declared carried.

The Reduction of Metals.—Letters patents have recently been granted to Mr. H Maxim for improvements in processes and apparatus for reducing metals from their ores, and for obtaining carbides, acetylene, cyanogen, cyanides, nitrides, and for fixing nitrogen. The principle involved is that of subjecting the materials to be treated to the action of a gaseous heating medium, which derives its heat from ordinary combustion and the heat of electrical energy. If desirable, the electrical superheater can be made to revolve. The primary heater is a circular flue fixed in a furnace heated by the combustion of solid or gaseous fuel. Leaving this furnace, the heated reaction gases pass through the electrical superheater, which consists of two vertical chambers, packed with carbon blocks, fireclay, or other suitable materials. These are heated to a very high temperature by the passage of the electric current introduced through poles at the top and bottom of the heater. The reaction gases passing over the same are heated to the required temperature, and are ready to pass to the small furnace of the blast-furnace type which forms part of the plant. These heated gases are introduced through a tuyere at the bottom of the furnace, into the top of which the material to be acted on is fed through a hopper and worm. Any excess of the reaction gas and the gaseous products of the reaction escape by a pipe to a holder, and when of a suitable character are drawn from thence as gaseous fuel for the primary heater. The blast furnace is charged with lime, carbon and potash, magnesium, etc., according to the desired product. The reaction gases are also varied accordingly. Thus to make illuminating gas and carbide, steam and hydrogen or a hydro-carbon are used, the oxygen of the steam forming CO, and the hydrogen combining with the electrically-heated carbon to form acetylene. For cyanogen compounds nitrogen is employed, or, in conjunction with air, used to form nitrides. For treating ores a reducing gas—such as carbon monoxide—is produced. In making calcium carbide limestone is used, and carbon in sufficient excess to convert the CO_2 as liberated into CO.

Bath.—At the meeting of the Baths Committee, the Chairman said before the Town Council passed its resolution the other day he asked Mr. Brydon to get tenders from two London firms and one at Frome. Those tenders had never been opened. The Council having directed them to advertise for all furniture and fittings of the new building, the committee had to decide whether they should advertise for tenders, open the tenders received, or ask the Council to rescind the resolution as regarded the electroliers. Mr. Ricketts thought it was their business and duty to obey a superior power. Alderman Chaffin said they had these tenders and it seemed to be obeying the Council. Mr. Ricketts: I want everybody to have a chance. Alderman Chaffin: It is delaying the work. The Mayor: I propose that these tenders be opened. Mr. Ricketts: And I propose that we obey our superiors and advertise for tenders. Alderman Taylor seconded. Mr. Brydon explained that the design for these electroliers was his own, and the manufacturers would have to work from his drawings. Colonel Perkins said they were tied by an absurd restriction, which would mean spending a lot more money in advertising and putting up fresh scaffolding when they already had tenders from the best men before them. Mr. Morris thought they could not disregard the resolution of the Council, though he should like to do so. The Mayor asked Mr. Brydon when the buildings would be ready for the opening. Mr. Brydon: In September. Colonel Davis seconded

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the Mayor's proposition that the tenders be opened. Only the Mayor and Colonel Davis voted for this, and Mr. Rickett's motion to advertise was carried. Mr. Brydon pointed out that unless tenderers came and saw him personally he did not think they could give a tender that would be reliable. Each of the firms who had tendered had gone through his drawings with him personally. If they were advertised, he believed they would withdraw. After conversation as to what should be done with the tenders sent in, Mr. Brydon remarked that he could not take any further responsibility in the matter. They were doing this entirely against his judgment. He had done his best for the work, and to be met in this way was very discouraging. Of course, it was nothing to him personally except his interest in the work. Mr. Ricketts asked what objection the firms who had tendered would have to the advertising? Mr. Brydon said if they advertised they would have people tendering who did not understand the work, who would give ridiculous prices at which the work could not be done properly. Mr. Ricketts: You can provide against that? Mr. Brydon: No, you cannot. Mr. Ricketts: I must ask you not to contradict me. You can say that the lowest or any other tender will not necessarily be accepted. It was eventually agreed to advertise in two local papers, the *Birmingham Daily Post*, the *Building News*, and the *Contract Journal*. The Chairman said he should return the tenders received at once to the firms who sent them.

PROVISIONAL PATENTS, 1897.

APRIL 20.

9878. Improvements in incandescing electric lamps. John Archibald Sinclair, 191, Fleet-street, London.

9879. Improvements in and connected with electric railways or tramways. Ernest Wilson, 64, St. John's-park, Blackheath, London.

9913. A manufacture of electrodes for electric accumulators. Eduard Marckwald, 28, Southampton-buildings, Chancery-lane, London. (Complete specification.)

9914. A manufacture of electrodes for electric accumulators. Eduard Marckwald, 28, Southampton-buildings, Chancery-lane, London. (Complete specification.)

APRIL 21.

9967. Improvements in telegraphic transmitters. Edward Porter, 45, Southampton-buildings, Chancery-lane, London.

9968. Improvements in or relating to the electric control of gas. John Henry Kerridge, 111, Hatton-garden, London.

APRIL 22.

10019. Electric arc lamp. James McDonald Burnett, 94, Gellatly-road, Nunhead, London.

10040. An improved coupling for attaching electric wire conduits to junction-boxes. George Croydon Marks, 18, Southampton-buildings, Chancery-lane, London. (John Patrick Coghlin, United States.) (Complete specification.)

10051. Improvements in or connected with holders for incandescent electric lamps. Louis Masson, 33, Chancery-lane, London. (Date applied for under Patents, etc., Act, 1883, Sec 103, September 24, 1896, being date of application in France.)

10056. Improvements in rail-bonds for electric railways and in the method of making the same. William Bingham Cleveland, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

10057. Improvements in electric pendulum indicators. Frederick Jones, 64, Grant-road, Clapham Junction London.

10062. Improvements in electric bells and the like. John George Dixon, 70, Palace-chambers, Westminster, London.

10065. Improvements in electric arc lamps. Franz Paul Liesegang, 37, Essex-street, Strand, London.

APRIL 23.

10120. Improvements in reversing switches for electric motors. Charles Brooke Crawshaw and Claude William Hill, Rufford Lodge, Dewsbury.

10121. Improvements in switches for electric motors. Charles Brooke Crawshaw and Claude William Hill, Rufford Lodge, Dewsbury.

10168. A new or improved mode of long-distance telephoning and in apparatus therefor. Ignazio Giuliani, 18, Buckingham-street, Strand, London.

10187. Automatic apparatus for cutting off a supply of gas, water, or electricity. John Holmes Sheldrake and John Tourtel, 67, Aldersgate-street, London.

10197. Improvements in or relating to dynamo and like electrical contact brushes. Louis Boudreaux, 111, Hatton-garden, London. (Complete specification.)

APRIL 24.

10231. Improvements in electric arc lamps. J. Edmondson, Penny Bank-chambers, Halifax.

10232. Telephone system. Cecylja Balukiewicz, 10, Friedrich-strasse, Berlin.

10250. Improvements in electric arc lamps. William Phillips Thompson, 6, Lord-street, Liverpool. (Frits Hansen, Germany.) (Complete specification.)

10263. Improvements in and relating to electric motors and dynamo-electric machinery. Joseph Daniel Rowbotham Blain, 48, St. Alban's-crescent, Wood Green, London.

10279. Improvements in galvanic batteries. Alfred Ernest Ann, 46, Lincoln's-inn-fields, London. (Carl W. Hertel, Germany.)

10280. Improvements in electric incandescence lamps. Friedrich Egger, 46, Lincoln's-inn fields, London.

SPECIFICATIONS PUBLISHED.

1896.

1237. Electric lamps. Robertson. (Amended specification.)

7054. Electrical signal system for railways. Werner.

9060. Telephones for domestic use. Anders and Wedekind.

9555. Electric burglar and other alarms. Clarke.

9974. Electrical switches. Binswanger and Bell.

9976. Hand telephones and compound switches therefor. Binswanger and Bell.

10718. Manufacture of positive lead electrodes for electric accumulators. Tudor.

11212. Dry cells for galvanic batteries. Clark.

11801. Sockets or holders for electric incandescent lamps. Katzenstein.

12550. Electrical circuit-closing thermometers. Luraschi.

15834. Electrolysis of soluble salts, especially applicable for the production of chlorine. Outhenin-Chalandre.

18839. Electrical apparatus for railroad and fog signalling to be used in conjunction with the present system of railroad signalling. Gilhespie.

22893. Incandescence electric lamps. Satchwell.

30,115. Method of and means for combining phonographs with electrical telephone circuits, and vice versa. Obelt.

1897.

2082. Electric furnaces. Joyce and Deuther.

2953. Conduits for electric railways and tramways. Cope.

5477. Arc lamps. Hays. (Puritan Electric Company.)

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	9½-9¾
Brush Company, Ordinary	3	¾ 1½
—— Non. Cum., 6 per cent. Pref.	2	1⅝-1⅞
—— 4½ per cent. Debenture Stock	100	104-106
—— 4½ per cent. 2nd Debenture Stock	100	95-99
Callender's Cable Company, Debentures	100	108-113
Central London Railway, Ordinary	10	9½-10
——	6	5¼-6
Charing Cross and Strand	5	10½-11½
Chelsea Electricity Company	5	8½-9½
—— 4½ per cent. Debentures	100	112-115
City of London, Ordinary	10	22-23
—— 6 per cent. Cumulative Pref.	10	16½-17½
—— 5 per cent. Debenture Stock	100	128-133
City and South London Railway, Consolidated Ordinary	100	59 61
—— 4 per cent. Debenture Stock	100	137-139
—— 5 per cent. Pref. Shares	10	15½-16
County of London and Brush Provincial Co., Ordinary	10	12-12½
—— 6 per cent. Cum. Pref.	10	14½-14¾
—— 4½ per cent. 2nd Debenture Stock	10	14¼-14¾
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	1¾ 2¼
—— 5 per cent. Debentures	—	90-95
Edison and Swan United Ordinary	3	1¾-2¼
—— 5 per cent. Debentures	5	3-4
—— 4½ per cent. Debentures	100	105-110
Electric Construction, Limited	2	1½-1¾
—— 7 per cent. Cumulative Pref.	2	2¾ 3¼
Elmore's Copper Depositing	1	¾-1
Elmore's Wire Company	2	¾-1
W. T. Henley's Telegraph Works, Ordinary	10	18½-19½
—— 7 per cent. Preference	10	18½-19½
—— 4½ per cent. Debentures	100	106-113
House-to-House Company, Ordinary	5	7½-7¾
—— 7 per cent. Preference	5	9½-9¾
India Rubber and Gutta Percha Works	10	20½-21½
—— 4½ per cent. Debentures	100	104-107
Kensington and Knightsbridge Ordinary	5	11¾-12¼
—— 6 per cent. Pref.	5	8-9¼
London Electric Supply	5	1¼-1½
Metropolitan Electric Supply	10	16½-17½
—— 4½ per cent. First Mortgage Debenture Stock	100	120-124
National Telephone, Ordinary	5	6⅜-6⅝
—— 6 per cent. Cum. First Pref.	10	15-17
—— 6 per cent. Cum. Second Pref.	10	15-17
—— 5 per cent. Non. Cum. Third Pref.	5	6-6½
—— 3½ per cent. Deb. Stock	100	102-105
Notting Hill Company	10	12½-13½
Oriental, Limited, £1 shares	1	1¼-2
—— £5 Shares	5	8½-9
—— £4½ shares	4½	7½-8
Oriental Telephone and Electric Company	1	1¼-2
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	101-103
St. James's and Pall Mall, Ordinary	5	15-16
—— 7 per cent. Pref.	5	9½-10½
Telegraph Construction and Maintenance	12	34-37
—— 5 per cent. Bonds	100	103-106
Waterloo and City Railway, Ordinary	3	10½-11½
Westminster Electric Supply, Ordinary	5	13½-14¼
Yorkshire House-to-House	5	8½-9

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NOTES.

The Synchronograph.—We have to acknowledge the receipt from America of Mr. Crehorne and Mr. Squier's paper on the synchronograph, and hope to summarise it next week.

Italian Electrical Engineers.—A branch of the Associazione Italiana Electrotecnica for Sicily has been started at Palermo, or, at any rate, a sufficient committee has been appointed to do so at once.

The Horse-Power.—Our Milan contemporary—*L'Elettricità*—has given a summary of some length of Mr. Preece's Watt lecture at Glasgow. Needless to say, it agrees with Mr. Preece as to the superiority of the kilowatt to the horse-power as a unit, and the probability of the supersession of the latter by the former.

Motorcarts.—The motorcart becomes less and less instead of more and more in evidence. Sir David Salomons is, however, announced as to deal with the technical aspects of motor traffic at the Society of Arts next Wednesday. But it is believed that Sir David has for the present abandoned electricity for motorcart propulsion.

The American Pacific Cable.—According to telegrams from San Francisco, it would appear that Mr. Spalding, the promoter of the United States Pacific cable scheme, has returned to Honolulu from Washington. His agreement expired on May 1, but he has been making efforts to have the term extended. It is believed, however, that the Dole Cabinet, which represents the ruling party in the Hawaiian Islands, will oppose any exclusive concession.

Electric Tramways in Austria.—Writing in the *Bautechniker*, Mr. P. Liez gives statistics of the progress of electric tramways in the Austro-Hungarian Empire. In 1883 there was about a mile of electric line; last year it was just under 60 miles. There are in all 15 lines, including one in Sarajevo, a city which some of us can remember as being regarded as one of the most out-of-the-way places in the Turkish Empire. Austrian administration has, however, done wonders there.

Society of Engineers.—At the meeting of the Society of Engineers, held at the Royal United Service Institution last Monday, Mr. G. Maxwell Lawford, president, in the chair, a paper was read by Mr. Henry O'Connor (vice-president), entitled "Automatic Gas Station Governors." The author pointed out that the pattern of governor now is use was practically the same as that made 50 years ago, and described the most notable of the suggestions made from time to time to improve the working of the governors.

Another Primary Battery.—An arrangement called the Essick hot fluid battery is described in the American technical papers. It is really very much a modification of the old Daniell cell. That is to say, it is a zinc-copper element of large superficial area, which consumes copper sulphate. Its novelty is that it is heated by paraffin burners, and the inventor believes that he gets some energy from these, although he knows that his E.M.F. is only "about one volt." The thing appears, so far as one can see, to be simply a cell of low internal resistance.

The Blackwall Tunnel.—There is to be great ceremony at the opening of the Blackwall tunnel. The Duke of York, the Duke of Cambridge, and the Duke of Teck have accepted the invitation of the chairman and members of the London County Council to be present on Saturday, May 22, and the opening ceremony will be performed, on behalf of the Queen, by the Prince of Wales, who, it is understood, will be accompanied by the Princess. There will be an escort, and the route from Marlborough House is along the Thames-embankment and Queen Victoria-street. The return will be on the south side of the river through Southwark.

In the Cenis Tunnel and After.—It is reported, says *L'Elettricità*, that the Upper Italy Electricity Company and the Mediterranean Railway Company have concluded an agreement for the application of electric traction to the railway trains in the Mount Cenis Tunnel between Bardonnecchia and Modane, and, further, it is intended subsequently to extend the system of electrical traction down to Turin. *L'Elettricità* thinks if this latter extension proves a success, it will be only a forerunner of the complete conversion of the railways to the electric system; at any rate in all those districts in which it is possible to make use of the numerous waterfalls with which Italy abounds.

Congress on Technical Education.—For the meeting of the Congrès International de l'Enseignement Technique, to begin on June 15, at the Society of Arts, papers have been promised, among others, by Prof. Ayrton, Prof. Silvanus Thompson, Sir John Donnelly, Sir Philip Magnus, and Prof. Armstrong. The proceedings will be reported in English, but papers may be in French, German, or English, and speakers may make use of any of these languages. Sir Henry Trueman Wood, secretary of the Society of Arts, will be general secretary, and from him, at the office of the society in John-street, Adelphi, any desired information about the congress can be obtained.

Decimal Minutes.—It is stated that the official commission appointed in France to report on the decimalisation of measures of time has decided in favour of retaining the hour (24 to the day) and splitting it up into 100 parts and these again into 100. This is really unreasonable. The second may be a silly unit, but it has been adopted as the basis of all the scientific derived units, and for that purpose it will not be easy to do away with it. The commission are welcome to divide the hour into 100 parts of 36 seconds each if they can, but it is highly improbable that they will succeed. Even the movement to number the hours up to 24, instead of breaking off and beginning again in the middle of the day, was a failure.

Rontgen Ray Work.—The *Lancet* has described a case at the Netley hospital, in which, by the help of the Röntgen radiations, a bullet was localised which was embedded in the shin bone in such a manner that it was quite impossible to trace its presence by any ordinary means. (It was supposed to have been removed.) The patient was a private in the 1st Battalion Gordon Highlanders, and had received a bullet wound just below the left knee on April 3, 1895, at the battle of Malakand in the Chitral Expedition. The case is interesting as showing that by using radiations of high penetrative power to which bone is comparatively transparent, a bullet can be found wherever it may get. The bullet, when localised, was duly extracted.

The Paris Fire.—The Paris fire was a very terrible affair. As to its origin, one account ascribes it to "an electric wire of the cinematograph" having in some "unexplained way set fire to the hangings which hid the walls." According to another account, it was still the cinematograph, but in this case a lamp (not electric) which "exploded." A more circumstantial account is that, at the stall of a certain great lady, a nun lighted some spirit under a large toy balloon, which caught fire and lighted the flimsy drapery nailed to the timber of the ramshackle structure. The whole horrible catastrophe is a terrible example of the result of neglecting in the case of a charitable show the elementary precautions which in any other case would be rigidly insisted on. Nature makes no exceptions in favour of a "good object."

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The Mechanical Engineers.—At the jubilee dinner of the Institution of Mechanical Engineers last week, Mr. E. Windsor Richards, the president, occupied the chair, and there were something like 400 there, including the Duke of Cambridge, Lord Medway, Sir F. Abel, Sir Lowthian Bell, Sir F. Bramwell, Sir H. Mance (president of the Institution of Electrical Engineers), Sir E. Leader Williams, Sir A. Seale Haslam, Vice-Admiral Colomb, Mr. D. Watney, the Lord Mayor of Belfast, Prof. Kennedy, Mr. Flannery (president of the Institution of Marine Engineers), Mr. J. Wolfe Barry (president of the Institution of Civil Engineers), and Prof. Unwin. As to the meetings, Mr. Robinson's paper was dealt with last week, and Mr. Walker's paper, read last Friday, will be given elsewhere than in these notes.

Royal Institution.—The annual meeting of the Royal Institution of Great Britain was held last Saturday, Sir James Crichton-Browne, F.R.S., treasurer and vice-president, in the chair. The report of the Committee of Visitors for the year 1896, testifying to the continued prosperity and efficient management of the institution, was read and adopted. Fifty-eight new members were elected during the year, and 64 lectures and 19 evening discourses were delivered. A total of 895 volumes had been added to the library in the year. The following gentlemen were unanimously elected as officers for the ensuing year: president, the Duke of Northumberland; treasurer, Sir James Crichton-Browne; secretary, Sir Frederick Bramwell. The discourse this (Friday) evening is by "Anthony Hope"; and next week it is to be Prof. Harold Dixon on explosions.

Institution of Electrical Engineers.—The next meeting is on Thursday, May 13, when the paper on "The Generation of Electrical Energy for Tramways," by Mr. J. S. Raworth, stands first for discussion. If this is concluded in time, there will be a paper on "Disturbances of Submarine Cable Working by Electric Tramways," by Mr. A. P. Trotter. So it would seem that we have got fairly into step for the plan of discussion first and paper afterwards. It cannot last long, however, although at the last meeting Sir Henry Mance threw out hints of an extra one being necessary, as there is only one more on the programme after next Thursday. There is a students' visit to Liverpool-street to-morrow (Saturday), and the next students' meeting will be held in the library, 28, Victoria-street, on Wednesday, May 12, at 7.30 p.m., when a paper will be read on "Electric Power in Workshops and Factories" by Mr. E. C. Short.

Matters Medical.—The *Lancet* has referred to a hæmostatic application of the electro-cautery reported by Dr. Alexander J. C. Skene in the *New York Medical Journal*. This consists in its employment instead of the ordinary torsion artery forceps and the compression forceps. In the case of the artery forceps the thin platinum plate, which is heated by the current, is "attached to the distal extremity of either blade," but insulated from it by a sheet of mica. Further details would probably not be particularly comprehensible to those of our readers who are not surgeons, nor would another of Dr. Skene's applications of electricity to an appliance used in certain operations. It is interesting, however, as showing that as the electric current becomes more familiar and accessible, it is found to be useful in a variety of uncontemplated ways. Among the various communications made to the Paris Academy of Science is a plan for treating certain nervous diseases by an electrical current interrupted according to a regular musical rhythm. As, however, the effects of suggestion are also brought into play, the indications of muscular activity obtained may not be wholly due to the current. It would be interesting to know if, when the periodicity of the excitement happens to be nearly right, there is any tendency on the part of such involuntary periodic action as that of the heart, for instance, to get into step with it.

Cable Interruptions. — From the monthly list published by the *Journal Télégraphique* of interruptions on "international" lines up to April 25, it appears that the Assab and Massowa cable was interrupted from March 20 to March 25, just failing therefore to be included as repaired in the previous list. The Tenedos and Dardanelles cable was repaired on March 29, after seven days' interruption, and the Malta and Alexandria cable on the same date after six days. The other interruptions are short ones of about a day or so in Mexico, Siam, and the Greek islands. The Hong-Kong and Macao cable failed on April 20, and communication had not been restored when the list was compiled. Neither had it on the Benguela to Mossamedes link in the West Coast of Africa cable, which failed on April 13. The other unrestored communications are the Amazon cable beyond Obidos, and the Santa Catherina and Larissa line, which went wrong in December last. The Amazon cable is a special matter, and at Larissa there are things happening which distract one's attention from telegraph line repairs. Next to these come the Ste Croix and Trinidad cable (November 29), the land lines in Colombia (Cartagena and Barranquilla), and the trans-continental African line beyond Mazoe, which date from June and March of last year respectively.

Engineering as a Profession.—Our contemporary the *Engineer* is troubled with a large number of letters from parents and guardians asking for information concerning the value of engineering as a profession, and in particular the road by which "a young man can attain an income as an engineer." It is impossible to reply to these questions at once satisfactorily and briefly, and the editorial soul is therefore liberated in a leader. The general advice (which will not be accepted) is, "Seek any other profession." Of civil engineers our esteemed contemporary absolutely refuses to speak. As to electrical engineers, it does speak, and with emphasis: "No word that can aid a misguided young man to enter their ranks shall flow from our pen." And as to mechanical engineering, which represents by far the largest branch of the profession, it would appear that if a young man has the abilities that in any other profession would bring him to the top of the tree, and, joined with these, all the merits and none of the faults of the British workman (not to mention, in addition, the constitution of an arctic explorer), he may, if he has good luck, some money, a certain amount of influence, and parents who know exactly how to start him and avoid the numerous pitfalls that beset the entrance to the profession, in course of time manage to get along passibly as a mechanical engineer. Otherwise, he would be better off as a "mechanic." At least, that is what we gather from the *Engineer*.

The Telephones at Glasgow.—In reference to the trouble with the National Telephone Company, the *Glasgow Herald* says that "the Post Office has at last vouchsafed a reply to the demand of the Corporation of Glasgow for a telephone license, and it is, in accordance with many precedents, an evasive answer. There is to be a Government enquiry into the complaints made by the Corporation about the existing telephone service, and also into the reasons for the refusal of the Corporation to grant underground wayleave to the National Company. It will be conducted by either a barrister or an expert, and not by officials of the Post Office," and goes on to remark that the validity of the complaint of the Corporation against the Telephone Company is not denied by anybody, and the Corporation, for reasons of the adequacy of which nobody else

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apparently need take the trouble to judge, absolutely refuses to grant the company wayleave for underground wires. There is, therefore, nothing to enquire about, and the proceedings must be wholly futile. "The grounds upon which the Corporation declines to allow the National Telephone Company the privilege of taking up the roadways for the purpose of laying their wires" have been very plainly put before the Postmaster-General by a deputation, and even if there were anything in this connection for a barrister to unearth, the Government cannot compel the Corporation to grant the company wayleave, although it could demand it for itself. Nothing can alter the essential fact that the Corporation has made up its mind not to allow any company or individual henceforth to interfere with the streets of Glasgow. (But then an enquiry at least gains time, and "statesmanship" is a very hand-to-mouth affair.)

The Laws of Dielectrics.—There is published in the *Philosophical Transactions* a detailed description of the experiments performed by Dr. Hopkinson and Mr. E. Wilson in pursuance of their researches into the effect of temperature on the residual charge as ordinarily known, on capacity as ordinarily known, and to how determinations of capacity are affected by residual charge, and on the way in which the properties of an insulator can pass into those of an electrolyte. The bodies principally examined were soda-lime glass, which has interesting properties at a low temperature, and ice, as to which latter it is known that its capacity for a period of charge of one-tenth of a second or more is about 80, while for high frequencies such as one-millionth of a second the capacity is somewhere about 3. Some experiments were also made with castor oil, glycerine, water, and oil of lavender. The experiments are fully detailed, diagrams of the apparatus given, and the results either tabulated or expressed in curves. A summary is not easy. It may be said, however, that the residual charge in glass increases with temperature up to a certain point, but the result then becomes uncertain owing to the conductivity of the glass increasing. An apparent increase in the residual charge at high temperatures is attributed to a change in composition produced by electrolysis. In ice the residual charge is considerable, and increases as the temperature rises. Its capacity at – 18 C. is twice as great with a frequency of 10 as with a frequency of 76. At lower temperatures the difference is not so great. With a high frequency the figure for the specific inductive capacity is about 3 instead of 50, and this appears to prevail down to a frequency of about 10,000. The authors' conclusion is that the great deviation of ice from Maxwell's law is due to residual charge which comes out between the frequencies of 100 and 10,000. The specific inductive capacity of castor oil at high frequencies (two millions) appears to be 3·5 as against 4·6 for a long-time charge. With glycerine, which has a high capacity, there appears very little difference. With oil of lavender the figures are 3·9 and 4·2. Results for oil of lavender as high as described by Stankewitsch were not obtained. There is a preface on the mathematical theory of the subject, and some remarks on the capacity of metals; but that is more than can be dealt with at the end of a note.

Lord Kelvin on Art.—The Royal Academy banquet is a very grand affair. Last Saturday, Sir E. J. Poynter, president of the Academy, was in the chair. The Prince of Wales responded to the toast of the Royal Family, Mr. Goschen represented the navy and Lord Lansdowne the army, the Marquis of Salisbury spoke for the Government, and Lord Kelvin and the Poet Laureate were coupled together to respond to the toast of "Science and Literature." Being accused by the president of "thinking in algebra," Lord Kelvin simply turned round and claimed the contents of the galleries of the Royal Academy as one of the splendid results of science, and declared that the scientific eye alone could properly appreciate the splendid success of the work of the Royal Academy and of artists throughout the world. Science had contributed in no small measure to artistic development. What would Raphael and Michael Angelo and their great predecessors who for centuries laboured through the geometric art of perspective have thought if they had seen a photograph? Would they not have said, "This is a masterpiece of art"? (This is flat heresy.) He would not venture upon a comparison, and still less would say that the last development of science in relation to art, the automatic photographing of colour, could be for one moment put in competition with artists' work; but he was sure from the liberality of mind always displayed by artists, that they would thoroughly appreciate the scientific marvel of it. The science of Thomas Young and others had taught artists that yellow and blue do not make green, and what the primary colours are. Lord Kelvin went on to contend that, really, artists ought to be interested in the theory of light. Unfortunately, it does not seem so. Perhaps there is a better time coming, when it will be possible to visit an exhibition of good pictures without finding it contain the looking-glass that has forgotten how to reflect, and instead gives the same sort of image as a photographic plate. Fortunately for us, the artist is not called upon to paint electricity; but of late years there has been a decided improvement on the rare occasions when he tries his hand at lightning. Perhaps the instantaneous photograph has had something to do with it. If so, Lord Kelvin may after all be justified in naming in the sacred precincts of Burlington House the thing which is anathema to artists.

Liquid Air.—The first of the three lectures at the Royal Institution by Prof. Dewar on "Liquid Air as an Agent of Research" was given on Thursday, 29th ult. Prof. Dewar said that the general impression was that the work done in this direction in various laboratories was simply in order to reach the lowest temperature possible. This was not correct, as it was impossible to utilise liquid air under these circumstances. A paper read by Prof. Andrews, of Belfast, on the subject, first showed the value of liquid air in research, and induced others to take up the subject. Long ago, of course, Boyle and Charles had formed the theory embodied in the equation $P = R T / V$, but the results arrived at by this were not very accurate. Van der Waals altered this into $P = R T / (V - b) - a / V^2$, a being a constant of pressure, and b a constant of the abstract volume of molecules. Amagat, in 1883, questioned whether Van der Waals's theory was applicable to all gases. He first made experiments on oxygen (liquefied in 1883), and found that it was practically good for all gases. As far back as 1878 Prof. Andrews had predicted that there was one isothermic line for all gases, and if one expressed the relations of volume, temperature, and pressure at the critical (or liquefying) point, it came out that there was one isothermic line for all of them. In reference to the use of liquefied gases as cooling agents, it must be remembered that a body could not be used as a cooling agent at more than one-half the critical range, two-thirds the average critical range being about boiling point and one-half about solidifying point. Experiments were shown as to the way in which, when hydrogen was let into the vessels in which air was being liquefied, all liquefaction stopped, and the horizontal surface of liquid air was projected on the screen. This is very curious, but is a rather difficult thing to show. The surface is seen to be covered all over with minute waves,

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and Prof. Dewar explained that, no matter what the pressure was, these waves were always apparent. The exceedingly small vapour tension of liquefied ethylene at low temperatures was also exhibited. The upper end of a vertical tube containing ethylene was cooled by liquid air, the lower (open) end being immersed in mercury. When the ethylene became liquid the mercury had risen in the tube substantially as high as in the barometer, showing the vapour pressure to be practically as small as in the Torricellian vacuum, and that at these temperatures ethylene behaved in the same manner as mercury does at ordinary temperatures.

Lightning Conductors.—The *Indian and Eastern Engineer* has fallen foul of the Calcutta lightning conductors. Our contemporary begins with one quotation (verse), which is not technically correct, and goes on with another (Latin), which, though there are only three words of it, is worse. And yet the hot season is hardly come. In Calcutta, it would appear, the conductors on private premises are, as a rule, simply lightning conductors in name only, and in most cases might be replaced by a red streak of paint from top to bottom of the house marked "This is a lightning conductor," or a small signboard on the roof lettered "Lightning will be prosecuted," but "what is more surprising is the strange but true fact that many of the lightning conductors on public and Government buildings are very faulty in construction, and not erected at all in accordance with the rules laid down by the various experts that have made the matter a special study." But when one comes to details, however, the *Indian and Eastern Engineer* pays much more attention to the outward appearance of the conductor than to the part which is usually weakest—namely, the earth connections. Much stress is laid on the fact that the conductor is insulated by its supports from the building. Surely this is not very deadly. The end of the article appears to be to suggest that it is a good thing to have a telephone wire carried over your house. Of an altogether different character is an article on the subject by Mr. K. R. Koch in the *Elektrotechnische Zeitschrift*. To make a house absolutely safe he would outline it with cheap galvanised iron wire along all the edges, and shows how, if necessary, it could easily be arranged, by using a little more wire, that oscillatory currents in the conductor wires could produce no dangerous induction effects. The material is cheap, and £1 worth would be more than enough for quite a good-sized house. Mr. Koch, however, insists on the necessity for uncorrodible points to conductors. The real difficulty with lightning conductors is that they are usually erected by people who know nothing about electricity at all, and even if an electrician has any hand in the business he is usually one who knows more about low-tension continuous currents than about oscillatory discharges through non-conductors. One could without much difficulty make a more curious collection of conductor oddities than the Calcutta one, and perhaps as a start it would be well to begin with what sometimes is done on an iron ship with iron standing rigging.

Rapid Cable Laying.—At the United Service Institution last week a paper on "Rapid Cable Laying for War Purposes," by Lieutenant W. C. Crutchley, R.N.R., and Mr. C. Scott Snell, was read. The chair was occupied by Lieutenant-Colonel Sir George S. Clarke. The authors think that submarine telegraphing in any future warfare will play a very important part, and a description was given of an apparatus invented by Mr. Snell, by which it is possible to lay a submarine cable at any rate within the speed of a fast cruiser. The apparatus is capable of being fitted to a warship, or properly-equipped telegraph ship, or, as an alternative, there might be a temporary arrangement which was capable of being adapted to any vessel at very short notice. The risks which might be incurred by the unexpected concentration of an enemy's force might, it was contended, be greatly modified, if not removed, by the adoption of Mr. Snell's invention, and there was the advantage of being able to lay at full speed a cable where none was shown to exist, and which, consequently, would not be searched for and destroyed by an enemy. It would be necessary, the authors contended, in the event of naval war for the Empire to possess its lines of telegraph communications in positions unknown to the enemy; and the proposed plan, though not perfect in detail, yet gave a workable scheme which should render this object a matter of comparatively easy accomplishment. The particular kind of cable which it is proposed to "eject" over the vessel's stern is not intended to be one that would have a long life, but is purely a temporary cable. As for the idea that all known cables would be cut in time of war, it is not quite so easy a matter to cut a cable in deep water as some people imagine, and as long as this country holds the mastery of the sea it would hardly be done extensively unless by some irregular means, such as the use of a neutral flag—and that is a matter which would depend upon whether one of the combatants would have courage enough to treat the action as outside the pale of war and on a level with piracy. The plan seems more suited to short lengths of cable, more especially as one could hardly keep long lengths in stock. But hitherto, if there is anything which experience has shown to be certain in naval warfare, it is that operations governed by directions prepared at home, instead of on the spot, have been always a failure. The experience of cable engineers would appear to be that the question of rapid cable laying is not so much one of the paying-out machinery as the bottom you are going to drop your cable on, and that an ordinary cable may be laid very fast if its permanence is not important.

Shipyard Riveting.—It is one thing, and generally not an easy one, to invent a machine which will do work better and cheaper than the existing ones. It is another and frequently a more difficult thing to get the improvement adopted. The merchant, the master, or the engineer is constantly being lectured for not adopting improvements and keeping England in her proper place ahead of the rest of the industrial world, but the working man—if he happens to be properly organised—is sacrosanct, and may do or not do as he will. For instance, in the discussion of Mr. F. J. Rowan's paper on recent practice in the application of electricity to engineering tools at the Institution of Engineers and Shipbuilders in Scotland, we have the following reasons why electric riveting tools are not and cannot be used in shipbuilding. They form practically the conclusion of Mr. Rowan's reply, and are published in the *Transactions* of the Institution: "Respecting the history of the invention, he spent about eight months during 1881 in making a series of experiments with electromagnets. In going about shipbuilding yards in former years he wondered why so much manual labour was expended in the mere act of riveting, and had puzzled over mechanical methods for doing the work. Without, however, having this in his mind, he started a series of experiments with electromagnets with the object of making an electromagnetic engine. At first there was no connection at all in his mind between electromagnets and ship riveting, but on visiting a Clyde shipyard, some time after his experiments with magnets had ceased, the two ideas came into his mind simultaneously. He at once saw that there was a possible solution of the difficulty of erecting a riveter under the conditions of shipbuilding,

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especially in connection with the side plating, by the use of electromagnets; of course there was a long distance between that step and the construction of a practicable riveting machine, and this he had found. The reason why electric riveters had not been introduced lay in the difficulty with which the masters had to contend—viz., a very strong organisation among the men, which they had allowed to develop to such an extent that, if they attempted to introduce riveting machines, the whole work of the yard would stop, as the platers had joined the riveters in their union. It was not altogether a question of whether the machines, as machines, satisfied the shipbuilders' requirements or not. They had to look to the question of their yards being boycotted, and that had been the difficulty all along to the introduction of machine tools. In the case of drillers there was not the same combination to oppose them, and they had been able to introduce various forms of drilling machines, and to use them successfully."

Cathode Rays.—Prof. J. J. Thomson's discourse on cathode rays at the Royal Institution was awaited with some interest. Prof. Thomson began with an appreciation of the work done by Mr. Crookes in connection with vacuum tubes nearly 20 years ago. Apart from their position as the parents of the Röntgen rays, recent discoveries in connection with the cathode rays were the photoelectric action of the halides of the alkali metals, and especially lithium, under their influence. Another discovery (due to Wiedermann) was that of thermo-luminescence. It was common to most bodies, after being subjected to the action of the rays, that they began to glow when heated at a much lower temperature than that of their usual point of incandescence. Mr. Crookes's discovery of the (fluorescent) fatigue of glass was also important, as this was very permanent. Indeed, the effect might remain after the glass tube had been reblown, showing that there must have been a deep-seated change in molecular arrangement. In Germany, the almost universal theory of the cathode rays was that they were vibrations of the ether. Mr. Crookes's original hypothesis was that they were due to the violent projection of negatively-charged particles from the cathode. He (Prof. Thomson) had found nothing to controvert that, and his investigations made with a view of determining the matter had pointed rather to a confirmation of it. Prof. Thomson exhibited the deflection of the rays in a magnetic field and the so-called "magnetic spectrum" produced where they struck a screen. The bright parts of this did not necessarily correspond to the bright tracks of the rays. The phenomena were quite different to the arc obtained at low exhaustions, which, though deflected by a magnet, was only bent, and was therefore some kind of structure having the property of tension, instead of a projection at right angles to the surface of the cathode, without regard to the anode. A number of experiments were shown, in which the anti-cathode was enclosed in a metal cylinder, which was put to earth, and in this case a negative charge was obtained in the anti-cathode when the rays were directed into the cylinder, which increased until balanced by the leakage across the residual gas, rendered a bad insulator by the rays. Considering the very small amount of matter involved, the quantity of electricity conveyed seemed very large; in fact, in less than a second a capacity of under $1\frac{1}{2}$ microfarads had been raised to a potential of 17 volts. An objection had been raised to the charged particle theory that the particles ought to be deflected by an electrostatic field. In advancing this, it was forgotten that with the discharge passing the gas in the tube became a conductor, and there was no way to get at the rays with an electrostatic force. Attention was called to errors that might occur in the interpretation of experiments, owing to portions of metal in the apparatus becoming charged and setting up as cathode ray sources on their own account, and an experiment was shown illustrating the fact that some of the cathode rays can penetrate a thin sheet of aluminium.

The Stability of the Elements.—Prof. J. J. Thomson, who is an exceedingly eminent physicist, has come to the conclusion that in the phenomena of the cathode discharge the barrier of the chemical elements has at last been broken down, so that we are in the presence of matter in something beyond the ordinary state, and that the carriers of a discharge in a cathode ray are not even atoms, but something very much smaller. Prof. Thomson dealt with the question at the end of his discourse at the Royal Institution, but in a highly-compressed manner, possibly fearing to be for too long more than the usual and proper amount over the heads of most of his audience. Lenard has got the cathode rays outside the vacuum tube, and measured their absorption in air. The rays are found to lose half their intensity in a distance of about one-third of a centimetre. Now, if it was an ordinary molecule which is in question, the distance for absorption should, Prof. Thomson pointed out, be comparable to the mean free path of the molecule (it depends on what a "collision" really means?), which is, of course, more like a 100,000th of a centimetre. The conclusion of Prof. Thomson is that the particles carrying the charge must consist of matter in a much more finely-divided state than the ordinary molecule, and possibly be the primordial element. Prof. Thomson has tackled the matter in a different way, which is dependent on the quantity of electricity carried into the cylinder containing the anti-cathode in a given time. The energy ($\frac{1}{2} N m v^2$) he gets as heat by receiving the discharge upon a thermoelectric junction (thermal capacity known). Ne (N is the number of the particles) is obtainable from the charge produced measured on the electrometer, and the ratio of the momentum of the particle to the charge carried (mv/e) is inferred from the curvature of the rays under the action of a magnetic field. As a result, the ratio (m/e) of the mass of the particle to the charge carried comes out something like a thousand times less than that deduced electrolytically for the hydrogen ion. It is therefore concluded, if the writer understands Prof. Thomson correctly, that the charge must be very great or the particle very small compared with what goes on in the process of electrolysis, and it is the latter which is concluded to be the case—at any rate, in part. Some time ago a qualitative description was given here of Prof. Zeemann's discovery of the effect of the magnetic field upon the light of sodium. If that is gone into quantitatively, it is found that the effect ought to be very much smaller than what was observed. It has been suggested that the meaning of this is that the vibration is not of the atom as a whole, but only a small part of it. It is curious that Prof. Thomson's ratio comes out as of the same order of magnitude as that to be deduced from the Zeemann observation. If Prof. Thomson's conclusions should be substantiated, it need not, however, be supposed that the dream of the alchemist is going to be realised next week or the week after. For even when the *prima materies* has been caught and made to recombine in the manner desired, with an output of about a billionth of a gramme per second to play with, it will take some time to get anything in appreciable quantities. If, however, there are or may be a certain amount of ultra-atoms, so to say, in dilute solution among ordinary molecules it would explain many things.

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THE MECHANICAL CONSTRUCTION OF ELECTRICAL MACHINERY.

BY F. M. WEYMOUTH.

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THE DYNAMO.

(Continued from page 552.)

Foundations (continued).—We have pointed out the general principle of foundations, and enlarged on their providing the mass and inertia necessary to resist vibration. It is to be noted here, however, as in other cases, that it is not always very feasible for practice to be quite even with theory. There is, for instance, more of what we may call "pounding" with some kinds of high-speed engines than with others, and they are consequently a greater source of vibration. To put in, in fact, a mass of concrete sufficiently large to absorb all this vibration is not always very feasible, besides its becoming expensive. We thus hear of such means being adopted as that of putting felt beneath

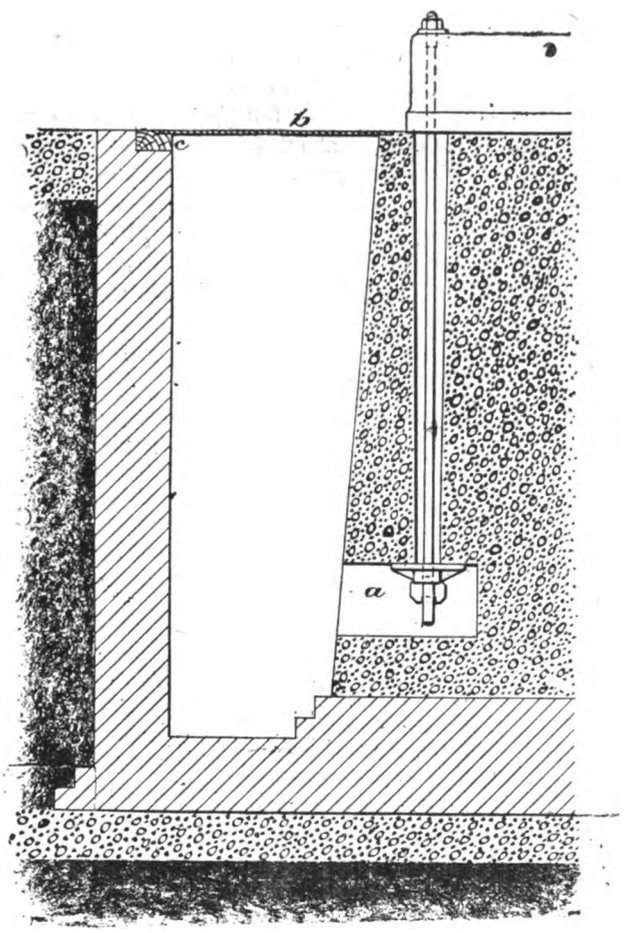

FIG. 179.

the concrete, so as to form what is termed an elastic foundation. Yet this can of course only be regarded as an expedient rendered necessary by the departure from theory, however much such departure may by ulterior considerations be made justifiable.

In preceding remarks we have dealt with the foundations and bolting down of small machinery and belt-driven dynamos. We may now consider the same for larger machinery and direct-driven plant. Fig. 179 indicates one method adopted. This arrangement is designed with a view to meet the difficulty above intimated, and to prevent as much as possible unabsorbed vibrations from being communicated to the ground beyond the immediate locality of the machinery. Thus it will be observed that a deep pit is first excavated. This is walled round with brick; and a more or less thick brickwork bottom is also put down. The possibility of water rising through this bottom brickwork, or of exuding from the surrounding earth and permeating the side walls, are matters requiring of course to be considered; as any dampness in the pit when finished will not be wanted. Above this lower brickwork thus a mass of concrete is raised. This forms a pedestal in the centre of the pit; and the bed-plate of the combined plant is bolted down thereto on top, as illustrated. Of course in cases where there is a row of two or more such plant, then one long pit will be made which will contain all the pedestals. The idea thus is that any unabsorbed vibrations will not pass to the earth generally except a long way below the surface, according to the depth of the pit; and so, by meeting the earth massed above this level as well as below and all round, they will not travel so far, nor be so liable to be felt. Absorbed vibrations will be expended in a disturbance of the apparent immobility of the concrete pedestal, which it would, however, be perhaps too much exaggeration, omitting very bad cases, to describe as shaking.

It would be well of course to construct the lining of such a pit with good bricks put together with Portland cement. Some concrete beneath the bottom, even thicker in proportion than that shown, may be advisable according to the nature of the soil. It is optional to build the pedestal of brickwork instead of concrete: and also to let its top

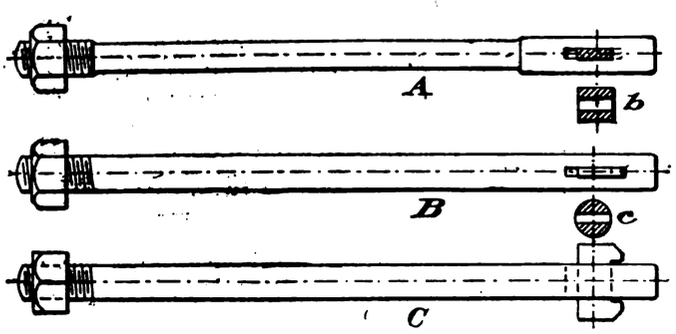

FIG. 180.

project above the floor-level, as shown in Fig. 185. Iron floor-plating, *b*, covers the space between the wall and the pedestal, the outer edge of which rests on a wood strip or plate, as shown at *c*. In practice a wood flooring will sometimes be carried to the top of the pedestal, or even to the bed-plate itself. The space under *b* is useful for receiving steam and exhaust pipes, and the cables when these are not led down from overhead.

A feature presented in Fig. 179, that is introduced in practice, is that of allowing the lower ends of the long holding-down bolts to be accessible. This is of course easily practicable with the pit arrangement. Recesses, as at *a*, are formed in the side of the concrete; and by means of long wooden tapered boxes, as illustrated in Fig. 175, and also in Fig. 182, holes are left for the bolts, which are

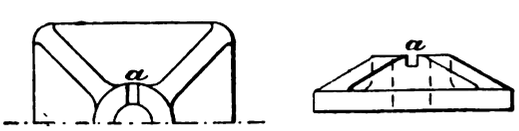

FIG. 181.

passed through from above not till after the main mass of the concrete has set. An ordinary bolt with a head to it being thus not applicable, bolts are used, such as are shown in Fig. 180, having gibbed cotters through the lower ends. Cast-iron plates, such as that illustrated at Fig. 177 D, are used in connection, as depicted (Fig. 179).

To prevent the bolt from turning when the nut is manipulated, the lower end will be made of square section, as shown at A, Fig. 180, to fit loosely the square hole in the plate. Another method however, applicable when the end is round, as in the bolt shown, B and C, in the same figure, is to cast a slot across the boss of the plate, as indicated at *a* in Fig. 181, of a width slightly greater than the thickness of the cotter. The edge of the latter will thus take into the slot; and so the bolt will be prevented from rotating. This method, however, has the inconvenience, if the plate should be held by the cement, or by any means be prevented from descending with the bolt, that a very little lowering of the bolt subsequently will cause the cotter to become disengaged from the slot in the plate, leaving the bolt free to rotate with the nut,

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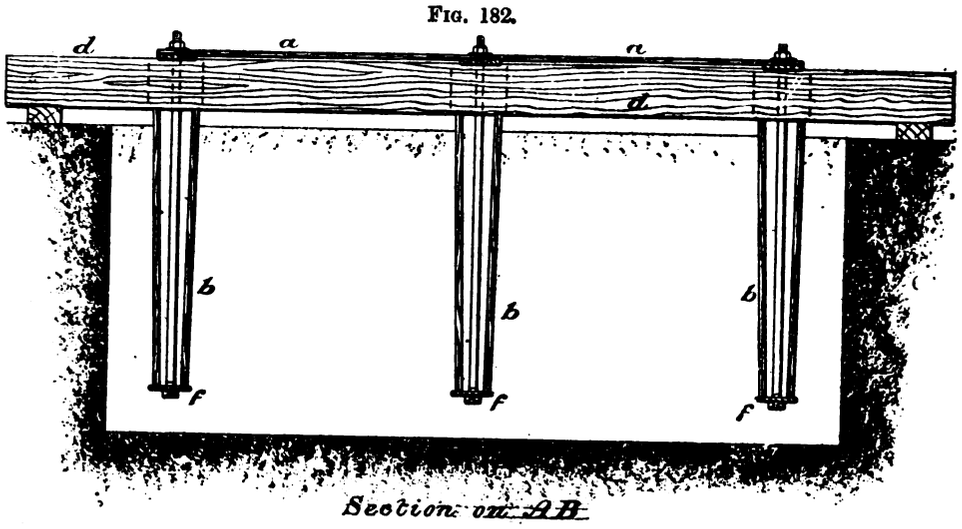
which is not the case with the long square end. Hence the latter is to be preferred.

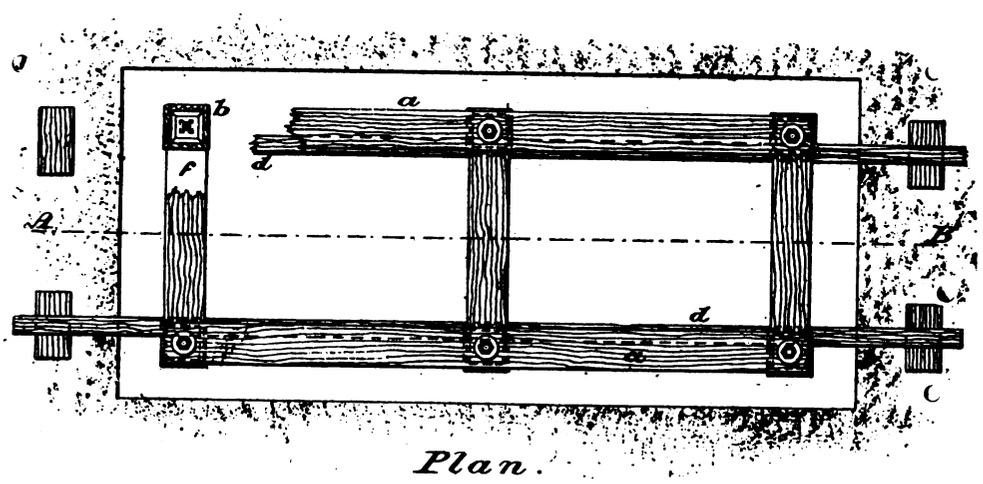
It will be noted in Fig. 180 that the bolt, A, is shown of small diameter in the middle. For in practice the two ends will be made separate, the one screwed, and the other forged square and the hole put through when hot. These are then welded, or "shut," on to the ends of the central portion. There is thus no object in letting this latter be

Six conical wood boxes, *b b*, are also constructed, each about 6in. square inside at the top, and 4in. at the bottom, and made of deal or pine not less than 1in. in thickness. The pit having been excavated, two pieces of timber, 6in. or 9in. by 3in. according to the length of the pit, are then laid over it lengthways, as shown *d d*; and their upper edges are made exactly level by packing under their ends; and they are also placed, as will be observed, so as to come just inside

FIG. 182.



Section on AB



Plan.

FIG. 183.

of greater diameter than that at the bottom of the threads of the screw. Care will be taken that the section, *b*, through the slot is the same as that in the middle portion; and the shearing strength of the cotter must correspond. The type A is for long bolts. But when short, and made out of one piece of round, as in the type shown in two views at B and C, it may still be better to let the lower end be forged square, for reasons given above, rather be circular as at *c*—especially as the bolt must in any case be taken to the smiths' shop to have the slot put through.

It might be suggested that to prevent the bolt from rotating, a pin projecting from its side, and taking into a slot in the cast-iron plate, would answer the purpose. This would be apt to fail however. For should the nut, for instance, be a tight fit on the threads, or be rusted on, the fitters will slip a piece of gaspipe over the end of the spanner, and thus obtaining a longer leverage, and with the assistance perhaps of another pair of man's arms, will put a severe torsional strain on the bolt, and consequent shear on the pin, and the latter will be shorn off.

It has to be noted finally that the plate itself, purposely cast square, must also be prevented from turning by being made a fit in the recess *a*, or by other means.

In Figs. 182 to 184 herewith is represented a method of procedure, taken from practice, for putting in the concrete foundations of a combined plant, which when finished will appear as shown in cross-section, Fig. 185. In the first instance a wood template, *a a*, is made, with holes put through exactly corresponding to the holding-down bolt-holes in the bed-plate, here assumed to be six in number.

the bolts. The template is then laid over these. It will be noted that in the arrangement here illustrated cast-iron plates are not adopted. But rolled wrought-iron or steel plates are used, about 6in. wide and ½in. thick, cut from

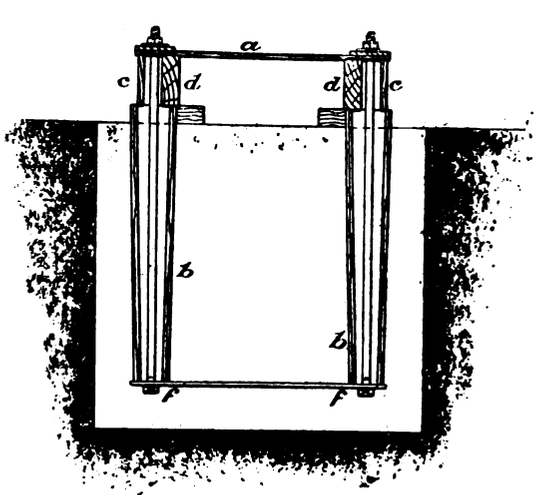


FIG. 184.

flat bar, each plate taking two bolts, as indicated at *f f*. The bolts have square heads and square necks fitting loosely square holes in the plates, so as to prevent them from turning. These plates, bolts, and boxes may be put

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together, and be ready in the pit beforehand. Thus, when the template is in position the bolts are passed up through the holes; and it will be observed then that the upper ends of the boxes will meet the beams, *d d*. Packing pieces, *c c*, are inserted under the overhanging portions of the template. The nut and washer plates are put on; and, with a final adjustment, the whole are bolted tightly together by screwing down the nuts. Consideration will show that by this last operation all the parts, with the plates, *f f*, below, and the template above, are made to form one complete structure. It may be remarked that the height of the timber and template can be so arranged that when complete the concrete shall appear above the surface of the ground as shown, Fig. 185. This is, of course, optional.

Matters are now ready for putting in the concrete. In the first place, however, some brickwork, or else some concrete, is put under and round about the lower ends of each box, so as to permanently fix it, and prevent it swinging out of position. This preliminary work being sufficiently set, the operation of gradually filling up the pit with concrete is proceeded with. As the boxes are intended ultimately to be withdrawn, their outsides may be coated well with boiled soap or other composition, so

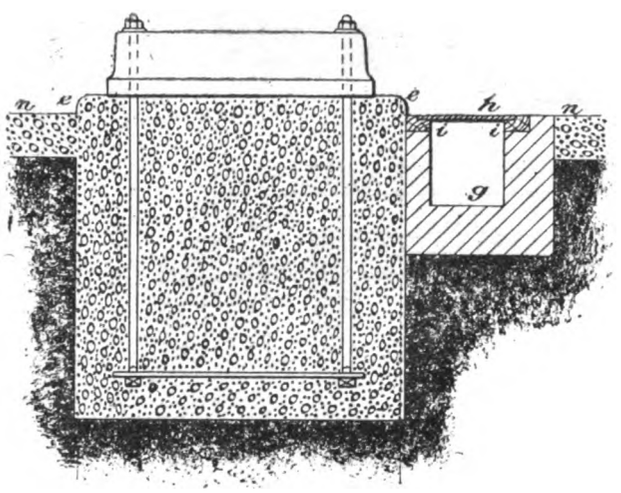

FIG. 185.

as to prevent the concrete from adhering to them. The concrete reaching nearly to the top of the pit, and by this time firmly holding the boxes, the template and other timbers are removed, being no longer required, which will leave more freedom for the men when adding the remainder of the concrete. On this latter being carried to the full height—that is, to the top of the boxes—these boxes, after the concrete is set, require to be pulled up. If they will not start, through being gripped too tight by the concrete, they must be split and broken up, and so be brought out in pieces. After this, the top of the concrete must be finished off with cement, the edges bevelled or rounded, as shown at *e e* (Fig. 185), and the upper surface swept level. This latter operation consists in placing two wood straight-edges along each side with their upper edges level with the surface required. Soft wet cement being spread over the top of the concrete between, another straight-edge is laid across the first two, and being moved sideways and gradually worked along them, leaves the cement in a smooth plain level with the straight-edges each side. When this has set, the bed-plate is hoisted over and gradually lowered so that the bolts rise each in its appropriate hole or boss. Before the nuts are tightened down, however, the upper surface of the foundation is "flooded" with very wet cement, which is poured on from inside the bed-plate. This thus flows under the flanges and edges where the bed-plate is more or less in contact with the hard cement, and so finally brings the foundation up to a complete fit to the footing of the bed-plate, and causes it to afford the latter a thorough and proper support throughout its length and breadth. This last having set, the nuts may then be tightened down; and the holes left by the boxes, *b b*, purposely left too wide to be covered by the bed-plate, are then filled in with grouting, which finally secures the bolts. Subsequently a brickwork channel, as at *g*, may be added to receive the cables at the dynamo end; and a similar channel may be added at the other end for steam-pipes, etc. These are then covered by floor-plates as shown; and the concrete floor may be extended right and left, as at *n n*, according to circumstances.

(To be continued.)

THE LOCAL DISTRIBUTION OF ELECTRIC POWER IN WORKSHOPS, ETC.

BY ERNEST KILBURN SCOTT.

PART I.

(Continued from page 489.)

Table X. gives the leading particulars of *examples of electric driving* of factories and workshops in this country, the United States, and on the Continent. The transmission of power by electricity in factories only dates back to about the year 1890, hence its history is short; and, as one would naturally expect, the earliest examples of electric driving were in the workshops of electrical engineering concerns—the Thomson-Houston Company, Siemens and Halske, and the Electric Construction Corporation being the first examples in their respective countries. Consequently a fair proportion of the examples given in Table X. must to a certain extent be considered as show plants. Sufficient other data is, however, presented to impress the most sceptical with the fact that electric driving has come to stay, and is not merely a passing craze. It should be remembered that these plants have not been put down for the novelty of the thing, but that in all cases electricity has first of all been adopted in a small way and then followed up, cautiously and conservatively, as its advantages and reliability were demonstrated by actual practice. Messrs. Howard and Bullough, machine-makers, of Accrington, is a case in point. This firm, after a good deal of hesitation, some three years ago adopted the suggestion of one of their directors to lay down a small transmission plant of under 100 h.p. It was found to be so successful that since then they have made two separate extensions, and they now have 76 motors at work, averaging 10 h.p. each, or a total of 760 h.p. The fact of this firm going in so extensively for electric driving is of the utmost importance, as it is the result of a real and independent trial; and the step is in reality a bolder one than at first sight appears, as it meant the abandonment of good, working steam-engines, which must be parted with at little better rates than old-iron price.

Messrs. Willans and Robinson are also laying down an extensive power plant for their new works at Rugby, and as the motors (8. h.p. continuous-current) are being supplied by several different firms this installation should be a good test of the lasting qualities of different types of motor.

Reference to the table will also make it clear that the prejudice against high-speed engines driving direct is breaking down, and that the steady running and excellent governing (which result the requirements of the electric lighting industry has brought about) of these engines is being now more widely recognised. The *voltage* employed at the motor terminals has been most generally determined by the incandescent lamps, and is therefore 100 to 120 volts. Now that the high-voltage lamp is a proved success, the pressure can be raised to 200 or 240 volts, thus giving a considerable saving in copper. It will be noticed that the 200-volt lamp is used at Messrs. T. Parker's, Limited, new works at Wolverhampton.

The *typical power installation* in the future for, say, 200 h.p. will most probably be laid down on the three-wire system, with 220-volt lamps. The current will be generated by two large units of 100 h.p. each, driven direct by high-speed enclosed triple-expansion engines, using about 16lb. of steam per indicated horse-power per hour. The motors of, say, above 15 h.p. would be wound for 440 volts, and connected across the outers of the three-wire network; whilst the smaller ones would work with 220 volts—motors of as low a power as $\frac{1}{10}$ h.p. can be wound for this pressure at a very slightly increased cost, so there would be no trouble on this score. The arc lamps would run eight or

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TABLE X.—EXAMPLES OF FACTORY DRIVING BY ELECTRICITY

Name.	Place.	Kind of factory.	System of transmission.	Generating plant.	Total horse-power.	Voltage.	Frequency.	Number of motors.	How employed.	Remarks.
Siemens Bros.	Charlton, Kent.	Electrical engineering and cable manufacturing.	Continuous.	4 300-h.p. dynamos three coupled direct to Willans engine and one to Belliss engine. 350 revolutions.	1,200	120	—	86 motors—$\frac{1}{6}$ h.p. to 100 h.p.	Driving line shafting, rubber machinery, cable-making machines, fire-engines.	Mr. A. Siemens has stated that they are saving 3,000 tons of coal per annum, and the wages of six stokers and engineers.
Bedson Wire Company.	Middlesbrough.	Rolling, etc., of iron wire.	Continuous.	1 600-h.p. dynamo coupled direct to triple-expansion marine-type engine running at 160 revolutions.	600	120	—	50 motors—5 h.p. to 40 h.p.	Rolling mills, cranes, barb-fencing machines.	Every process is carried out by means of electricity, and as there is an entire absence of belting and shafting, the construction of buildings is very light.
Dorman, Long, and Co.	Middlesbrough.	Girder makers, etc.	Continuous.	1 225-h.p. dynamo direct coupled to Willans engine running at 350 revolutions.	225	120	—	40 motors.	Punching, shearing, drilling, circular saws, driving line shafting.	Contemplate doubling their installation. Net saving of 30 tons of coal per week, and labour (stoking and upkeep) in connection therewith.
T. Parker, Limited.	Wolverhampton.	Electrical engineering.	Continuous.	1 110-h.p. dynamo, belt-driven from Belliss or Marshall engine; alternative coupling.	110	210	—	2 8 h.p. 4 10 h.p. 1 5 h.p.	Driving line shafting, two 10-ton cranes, etc.	One motor running at 2,000 revolutions coupled to 40in. Henan's fan. Two hundred volts incandescent lamps are used.
Daniel Adamson and Co.	Hyde.	Boiler-making.	Continuous.	1 100-h.p. dynamo coupled direct to a Belliss engine running at 400 revolutions.	100	120	—	21 motors—2 h.p. to 16 h.p.	Three cranes—30, 10, 5 tons, boiler shell-drilling machines, etc.	The respective efficiencies at full load of the three cranes are 54·3 per cent., 51·3 per cent., and 46·9 per cent. Extensions in hand.
Electric Construction Company, Limited.	Wolverhampton.	Electrical engineering.	Continuous.	1 130-h.p. dynamo, driven by belt by Robey horizontal engine; 1 80-h.p. Willans set running at 350 revolutions.	210	110	—	16 motors—2 h.p. to 15 h.p.	Three cranes, magnetic separator, planing machine, short lengths of line shafting.	This is one of the earliest complete installations in this country. It has given every satisfaction, and is just being extended.
W. Denny and Bros.	Dumbarton.	Shipbuilders	Continuous.	1 30-h.p. dynamo, driven from main shaft of engine.	30	100	—	6 motors.	Driving small detatched workshops, portable drill, and deck planing machines.	An 18-h.p. motor, running at 700 revolutions, drives through gearing a powerful double-ended punching machine.
G. Kynoch and Co., Limited.	Birmingham	Steel-founders, explosives manufacturers, etc.	Continuous.	66-h.p. and 160 h.p. dynamos coupled to Willans engines.	226	120	—	40 motors of various sizes.	Driving line shafting and machinery. One motor to each department.	The installation has given great satisfaction, and will be extended where needed. Electricity has been specially advantageous, on account of the isolation of the explosives factories.
General Electric Company.	Manchester.	Electric supplies and machinery.	Three-phase alternating.	Three-phase alternators manufactured by the Oerlikon Company, Zurich.	200	380/220	50	30 motors, varying from $\frac{1}{4}$ h.p. to 36 h.p.	Some driving direct, and some by belt.	Installation just been put down.
T. King and Co.	Bollington, Macclesfield.	Bleach works.	Continuous.	1 50 h.p. dynamo driven by countershaft from 120 h.p. waterwheel.	50	120	—	11 motors, varying from $\frac{1}{2}$ h.p to 6 h.p.	Driving direct drying machines, mangles, starchers, fans, etc.	Some processes require extreme variation in speed, and this is effected by varying fields of motor. Separate power and lighting circuits.
R. MacLaren and Co.	Glasgow.	Ironfounders	Continuous.	1 90-h.p. Sayers dynamo, running at 600 revolutions and driven by ropes by a 120-h.p. Tangye gas engine.	90	110	—	3 h.p. to 25 h.p.	Driving by belt and direct.	Engine is supplied with producer gas, and 1 b.h.p. is developed per pound of anthracite coal. Below 10 h.p. the motors are enclosed.

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TABLE X.—Examples of Factory Driving by Electricity—*Continued.*

Name.	Place.	Kind of factory.	System of transmission.	Generating plant.	Total horse-power.	Voltage.	Frequency.	Number of motors.	How employed.	Remarks.
Baldwin Works.	Philadelphia, U.S.A.	Locomotive and car building.	Continuous.	2 100 h.p. dynamos 1 250 ,, ,, Direct coupled to engines.	450	120 and 220	—	—	Cranes, large tools driven direct, shafting, etc.	Contemplating laying down three more 250-h.p. generating units. One of the overhead cranes will lift 100 tons.
Westinghouse Company.	Brinton, Pittsburg, U.S.A.	Electrical engineering and engine building.	Two-phase and continuous.	3 500-h.p. two-phase alternators and 2 500-h.p. dynamos, each coupled direct to Westinghouse engine at 215 revs.	2,500	200	25	57 two-phase motors; 24 continuous-current motors.	Cranes, elevators, shafting, etc.	These works employ over 4,000 hands. The motors are mostly bolted to the floor.
State Printing Office.	Washington, U.S.A.	Printing and bookbinding.	Continuous.	1 225-h.p. dynamo, direct coupled to Westinghouse engine.	225	110	—	10 motors of ⅛ h.p. to 30 h.p.	Driving printing presses, lithographic machines, etc.	Motors geared directly to the work. Total generating plant, 425 h.p., the balance being used for lighting.
Ponemah Mills.	Taftville, Connecticut, U.S.A.	Cotton spinning and weaving. (1,700 looms)	Three-phase alternating.	2 335-h.p. three-phase alternators running at 600 revolutions, and driven by belt from horizontal turbines.	670	2,500	50	Two synchronous self-starting motors.	Driving the line shafting.	The generators are run in parallel, the turbines being regulated by Schenck electric governors. The two motors have replaced Corliss engines.
Pelzer Manufacturing Company.	South Carolina, U S.A.	Cotton spinning and weaving. (55,000 spindles; 1,400 looms.)	Three-phase alternating.	3 1,000-h.p. three-phase alternators, driven by Victor horizontal turbines running at 167 revolutions.	3,000	3,300/200	40	15 110 h.p. 4 75 ,, 2 50 ,, 4 5 ,,	Driving line shafting, 2 5-h.p. pumps, 2 5-h.p. fans.	Power is transmitted 2¾ miles on 40ft. poles. The efficiency $\frac{\text{motor shaft}}{\text{turbine shaft}} = 80\%$. A 400-h.p. motor driving another (No. 3) mill has saved 2,500 tons of coal annually.
Nonstuck Silk Company.	Massachusetts U.S.A.	Silk manufactory	Continuous.	1 85-h.p. Thomson-Houston generator, driven by a waterwheel.	85	500	—	1 45 h.p. 2 20 ,, 1 10 ,,	Driving line shafting.	Power transmitted ¼ mile. The 45-h.p. motor is belted to main line shaft (driven by two waterwheels) and only acts as a regulator.
Donnell Manufacturing Company.	Pawtucket, U.S.A.	Calico printing.	Continuous.	6 27-h.p. dynamos 4 34 ,, ,, Driven by belt from Corliss engine.	298	250	—	6 25 h.p. 4 32 ,,	Driving printing machine direct.	Difficult work, especially at starting of motors. Mr. S. B. Paine states there has been an increase of production of 25 per cent.
Simmonds Sawmill.	Fitchburg, Massachusetts U.S.A.	Sawmill.	Two-phase alternating.	1 400-h.p. two-phase Westinghouse alternator, direct coupled to six Pelton wheels running at 135 revolutions.	600	2,250/220	50	11 Tesla self-starting motors.	Driving shafting.	The working has proved so satisfactory that extensions are in hand.
Columbia Cotton Company.	Columbia, S. Carolina, U.S.A.	Cotton spinning.	Three-phase alternating.	2 680-h.p. three-phase General Electric Company's alternators, direct coupled to turbines running at 108 revolutions.	1,360	575	36	2065-h.p ceiling motors, running at 535 revolutions.	Driving shafts on each floor.	Efficiency from shaft of generator to shaft of motor, 82 per cent. Eight hundred lights are also supplied.
National Arms Factory.	Herstal, Liège.	Manufacturing small-arms.	Continuous.	1 350-h.p. multipolar dynamo, direct coupled to Van de Kerchove engine running at 66 revolutions.	350	125	—	2 37 h.p. 9 16 h.p. 5 of 3 to 21 h.p.	Driving 13 lengths of shafting, etc.	Running satisfactorily since 1893. A 300-h.p. Pieper dynamo, direct coupled to Willans engine, running at 300 revolutions, has since been added.
Biberist Paper Mill.	Soleure, Switzerland.	Manufacturing paper.	Continuous.	2 180 h.p. dynamos connected by Raffard couplings to turbines, running at 275 revolutions.	360	3,300	—	2 130 h.p. at 200 revs.	Driving main line shafting, etc.	The two dynamos are in series, each giving 3,300 volts. Distance of transmission, 19 miles.

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TABLE X.—EXAMPLES OF FACTORY DRIVING BY ELECTRICITY—*Continued.*

Name.	Place.	Kind of factory.	System of transmission.	Generating plant.	Total horse-power.	Voltage.	Frequency.	Number of motors.	How employed.	Remarks.
Bally and Sons.	Schoenenwerd, Switzerland.	Boot and shoe factory.	Three-phase alternating.	1 100-h.p. Brown three-phase alternator attached direct to Jonval turbine, running at 30 revolutions.	100	173	20	8 10 h.p. 1 5 h.p. 1 1 h.p. Speed 600 revs.	Driving line shafting, etc.	For some of the operations which require motors with low voltage, the pressure is transformed down to 10 volts.
Leijkam Josefthal Mills.	Austria.	Manufacturing paper.	Three-phase alternating.	2 250-h.p. Ganz three-phase alternators, running at 170 revolutions, and driven by belt from turbine	500	3,000/300	40	6 motors—3 h.p. to 160 h.p.	Driving short lengths of line shafting, etc.	The electricity is transmitted 2 miles, with a loss of 5½ per cent. A constant-current dynamo is used for lighting.
Veille Montagne Company.	Belgium.	Zinc works.	Continuous.	1 600-h.p. Pieper flywheel dynamo, coupled direct to Corliss engine, running at 800 revolutions.	600	500	—	6 1 h.p. 7 2 h.p. 6 3½ h.p. 6 5 h.p. 4 7 h.p. 3 10½ h.p. 5 14 h.p. 2 45 h.p. 1 64 h.p. 1 80 h.p. 41 motors.	Driving short lengths of line shafting, machines, cranes, etc.	Efficiencies at full load: engine 90 per cent., dynamo 90 per cent., cables 98 per cent., motors 86 per cent. Total commercial efficiency, 68·5 per cent.
The Northern of France Railway.	Saint Ouen-les-Docks, Paris.	Electrical department.	Continuous.	Current for about 20 h.p. is supplied by the Société d'éclairage et de force.	20	115	—	18 motors—$\frac{1}{10}$ h.p. to 3 h.p.	Driving direct lathes, drilling machines, milling machines, bandsaw, etc.	This installation has been running since 1891. The attendant who formerly looked after gas-engines and shafting has been dispensed with.
Weyher and Richemond.	Pantin, Paris.	Engine and machine makers.	Two-phase alternating.	3 110-h.p. two-phase alternators driven by belt at 400 revolutions.	330	110	40	19 motors—2 h.p. to 60 h.p.	Driving line shafting, cranes, coal hoist, etc.	The alternators run in parallel. Motors started by self-induction & resistance coils
Oerlikon Machine Company.	Zurich, Switzerland.	Electrical engineering.	Three-phase-alternating.	3 200-h.p. three-phase Brown Umbrella type alternator, coupled direct to vertical shaft of turbine, running at 180 revolutions.	600	86/13,000/190	50	—	Driving shafting. The motors attached to side of building, and in slides to keep belt tight.	This was the first example of three-phase transmission. Current is conveyed from Hochfelden to Zurich (15½ miles) at 13,000 volts.
Vonwiller Company.	Romagnano-Sesia, Italy.	Paper-making.	Two-phase alternating.	3 260-h.p. two-phase Brown alternators, direct coupled to Bell vertical turbines, running at 180 revolutions.	810	3,600/230	83	Small motors from 3 h.p. to 15 h.p. Six large 120-h.p. motors.	Driving shafting.	Current is transmitted 3 miles by four cables, and of the 810 h.p., 648 h.p. is delivered to the motors; 40 h.p. is used for lighting.
P. Schwenger's Löhne.	Uerdingen, Germany.	Sugar refinery.	Three-phase alternating.	2 225-h.p. three-phase alternators.	50	100	50	94 motors—1 h.p. to 5 h.p.	Direct coupled to centrifugals.	Electric motors are specially suitable, on account of the high speed of centrifugal machines.
Dietrich and Co.	Lunéville, France.	Sawmill.	Continuous.	1 70-h.p. dynamo, running at 630 revolutions, and driven by belt from steam-engine.	70	125	—	4 10-h.p. for circular rack and bandsaw 1 5-h.p. pump 1 22-h.p. blower.	Five of the motors drive direct.	The annual cost when pump was driven by steam-engine was £180; it is now £23.

four in series, according as to whether they were the ordinary type or of the enclosed or Jandus lamp. A large accumulator plant will light the offices, etc., and run any machines that are required for breakdown jobs during the night. Concentric cables would be used, with the inner conductor thoroughly well insulated and the outer connected to earth. Single-pole switches, connected to the inner wire, are all that is necessary in such a case to break the circuit; and, as anyone knows who has worked with electrical apparatus, one single-pole switch with plenty of contact surface and length of break is much more reliable than a double-pole switch in which everything is crowded: and there is the trouble of insulating the two opposite potentials in a limited area of slate or porcelain. All branch connections would be made in strongly ribbed cast-iron junction-boxes, fitted with lids having faced joints of large area. Only the smallest connections would be soldered, all the rest being made with bolts and nuts (not less than ½in. diameter); check nuts and Thackeray spring washers being provided to make sure that long-continued vibration shall not make the connection slack.

It is curious to note that there are two firms connected with the electrical business who have laid down new works recently and yet have not adopted electric driving. In the large ironworks of Messrs. Bullers, Limited, Tipton, South Staffordshire, a gas-producing plant has been laid down, and it supplies gas to three 30-h.p. engines, one in each of the separate buildings. The other firm, the Brush Company, are driving their winding and brass shops at Loughborough by means of vertical high-speed engines, such as they supply for

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direct coupling to dynamos. Each engine is placed almost immediately under the line shafting, and it is lowered about 2ft. below the floor level so as to give a longer drive and more head power. One would have thought that the Brush Company would have jumped at this opportunity of seeing what the alternate-current motor could do. As a matter of fact, their action, or rather inaction, in this motor question is rather strange; for with the exception of one or two much-advertised suggestions of Mr. Mordey's, practically nothing appears to have been done.

A point that remains to be mentioned is the buying of electricity for power purposes from central stations. The *lowest price* charged for electric power purposes by a central electric light station is at Sunderland. Here, single-phase alternating current is supplied during the hours of day load at 2d. per Board of Trade unit. It is proposed to go as low as 1½d. at Manchester. Bradford, St. Pancras Vestry, Hull, and other places supply continuous current at less than 3d. per unit; and the proprietor of a small works within these areas could not do better than get his power direct from the electric light station. In this way he would save rent, because the space taken up by an engine (and possibly a boiler) could be utilised, and he would also save on interest and depreciation, insurance charges, and cost of attendance. Moreover, there is greater security against breakdown than could otherwise be obtained without costly duplication of plant. Why more small users of power within the areas of electric supply have not availed themselves of the low rates for electricity to a greater extent than they have hitherto done, is difficult to understand. It is interesting to note that several firms have settled their works in the St. Pancras district (where the charge is now 2½d. per Board of Trade unit), in order that they might have electric power. Of course, the low rates above mentioned are only during the daylight hours, and power for overtime would have to be paid for at a higher rate. An employer so situated would therefore find it policy to so proportion his orders and the number of hands that there would be little or no overtime—an advantage to himself and his employés in more ways than one.

That a day load is coming for those electric light undertakings in industrial centres is a foregone conclusion, but it will take time. It is said that already in the United States some of the supply companies find their day or power load more difficult to cope with than the evening or lighting load. There are, of course, the oil and gas engine to be reckoned with, and the competition of the electric motor will no doubt bring about improvements in them; but even at their best, explosive types of motors are not very desirable, steady running being altogether out of the question. Starting off is also very troublesome, what with lighting up, regulating of cocks, lubricating, and pulling round of heavy flywheels. These points, combined with the periodical cleaning out of valves, ports, and cylinders, will need a vast amount of improvement to enable these engines to compete in the near future with electric motors supplied with energy from a public supply system, and which can be started by the mere turning of a switch.

(To be continued.)

TESTS OF THREE-PHASE MOTORS.*

BY ERNEST B. TRUE, B.SC.

Seven years ago the three-phase motor was simply an interesting scientific curiosity. It is still a novel sight to see an armature which has no visible connection—in fact, no mechanical connection to any motive power—running as if by magic. However, that revolving mass of iron and copper is more wonderful now, as it can do work equal to that of an engine larger than itself. In the last five years the three-phase motor has been developed to such an extent that it takes equal practical rank with its older brother, the direct-current motor, and promises, with the aid of long-distance transmission, to leave it far behind. Such advance has been made in the design and manufacture of this class of motor, that further progress can come only as a result of careful study and painstaking investigation. The object of this test was the separation of the losses of the machines. As this was done for several loads, it made possible the computation of the efficiency and power factor curves, thus giving a no-load efficiency test. The practical benefit to be derived from this is that it affords a no-load test the results of which approach very nearly to those obtained from a brake test. This test does away with the loss of power necessitated by the ordinary commercial test, and is also easier to conduct. At the same time, the separation enables the designer to work to better purpose, as he can see where to make changes to the best advantage. With this end in view, it would be very desirable if a more complete separation of the losses than I have attempted were carried out.

The test is very simple. The iron losses are obtained from readings taken when the machine is running light at normal voltage. Under these circumstances, the total losses consist of the desired iron losses, the field C^2R loss, a negligible armature C^2R loss, and the air and bearing friction loss. The motor is run light, and the power absorbed, the current in each line, the pressure between the lines and the motor and generator speeds are taken. The resistance of the field windings is measured at the running temperature. The field C^2R loss is computed from the measured currents and resistances. The bearing losses are obtained by taking the speed carefully and then cutting off the power and noting the time it takes the motor to run down. From these readings, the weight of the armature and the measured dimensions of the armature, the moment of inertia, kinetic energy, and finally the friction loss are figured. The total loss, as read from the wattmeters, minus the friction and C^2R losses, gives the iron loss. The wattless magnetising current, which is constant for constant voltages, is also found from these readings by the following formula:

$$C_m = C_c \sin \phi.$$

C_m is the wattless magnetising current in one coil, C_c is the current in one coil as measured by the ammeter, and $\sin \phi$ is the true watts divided by the apparent watts.

The C^2R losses are obtained from readings taken when the motor is blocked and the voltage cut down by resistances placed in the lines. The total watts absorbed, the current in each line, and the pressures between the lines are measured for several values of the current. In this case the total loss is made up of the desired field and armature C^2R losses and the iron losses. The iron losses vary with the one and six-tenths power of the voltage. This is on the assumption that the Steinmetz constant for the relation between the iron losses and the magnetisation is correct; and that the magnetisation varies directly with the voltage. Both of these assumptions have been proved to be nearly correct. Remembering this fact, the iron losses at the reduced voltages are obtained from the iron loss at the normal voltage already found. The difference between the total loss and the iron loss at that voltage is the C^2R loss for that current. The actual working current corresponding to any current in a coil is as follows:

$$C_a = (C_c^2 - C_m^2)^{\frac{1}{2}}.$$

C_a is the actual working current in one coil. Consequently, the load for any current in one coil is computed according to the following formula:

$$L = (C_c^2 - C_m^2)^{\frac{1}{2}} l v.$$

In the above formula l is the number of phases, v is the normal voltage in the coil, and L is the load in watts.

It will be found convenient to compute the value of the current in one line at full load before making the blocked test. In order to do this transpose the load formula into the following form:

$$C_c = \left[\frac{L^2}{l^2 v^2} + C_m^2 \right]^{\frac{1}{2}}$$

By determining the C^2R loss for this value of C_c and for three or four smaller values and plotting a curve between the values of C_c and the corresponding losses, the C^2R loss for any value of the current in one line is easily found.

The iron and bearing losses are constant for all loads.

* "The Separation of the Losses of Three-Phase Motors and a Comparison of the Losses on Balanced and Unbalanced Circuits," From the *Wisconsin Engineer*.

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The C^2 R loss for any value of the current in one coil can be read from the C^2 R loss curve just mentioned. The efficiency for any value of the current is the total load for the current minus the losses for the value of the current divided by the total load. The power factor for any load is obtained by dividing that load (true watts) by the corresponding apparent watts ($C_o v l$).

The power for the test was taken from the monocyclic dynamo at the Four Lakes light and power station at Madison, Wisconsin. This system does not give balanced currents. An artificial balance was obtained for this test

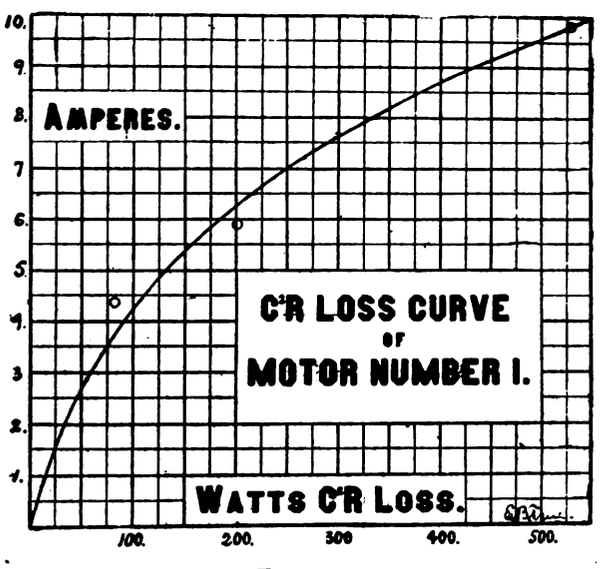

FIG. 1.

by placing water resistances in the lines. I also carried out an unbalanced test in which the distribution of the current for the blocked readings was kept proportional to that during the light-running readings. The resulting C^2 R losses found were not satisfactory in both tests for reasons which will be explained later.

Motor No. 1 was a 5-h.p. three-phase motor built in 1896. The field windings were delta connected, and the motor was designed to run on a 220-volt 60-frequency

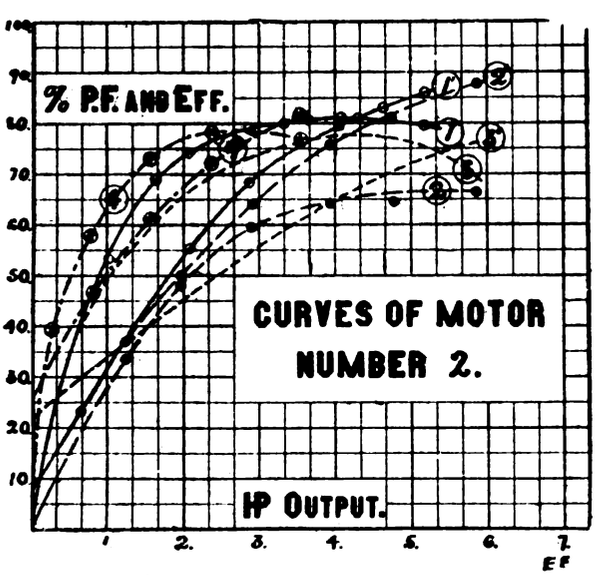

FIG. 2.

current at a speed of 1,200 revolutions per minute. The power was measured by the "two-wattmeter method." In each test three sets of readings were taken at one time, and later a check set of two or three more readings was taken. The results were figured from an average of the five or six readings. The line amperes were measured, and the coil amperes obtained, by multiplying the readings by the square root of 3.

The balanced test C^2 R loss curve is shown by Fig. 1. Table 1 is a summary of the results of the balanced test, and Table 2 gives the same summary for the unbalanced test. In Fig. 2, Curve 1 is the efficiency curve for the balanced test, and Curve 2 is the one obtained from the unbalanced test. Curve 1′ is the balanced power factor curve, and Curve 2′ is the unbalanced power factor curve.

Motor No. 2 was a 5-h.p. induction motor built in 1893. The fields were star connected, and the motor was designed to run on a 100-volt 50-frequency current at a speed of 1,500 revolutions per minute. In the test a 60-frequency current was used, so it ran at 1,800 revolutions. The power was measured by the "one-wattmeter method." Tables 3 and 4 are respectively the summaries of the balanced and unbalanced tests. In Fig. 3, Curves 1 and 2 are respectively the balanced and unbalanced efficiency curves; and Curves 1′ and 2′ are the power factor curves. The unbalanced curves do not check with the brake test curves obtained by Messrs. Perkins and Williams on the same circuit* (see Curves 3 and 3′.) The greater part of this difference is easily accounted for by examining the data of Perkins and Williams's test. This shows that, under ordinary working circumstances, the distribution of the current in the lines becomes nearer balanced as the load increases. The natural consequence is a material decrease in the C^2 R loss from what it would have been if the ratio of the currents in the lines had remained as it was, at no load. In the no-load test this ratio was kept nearly constant.

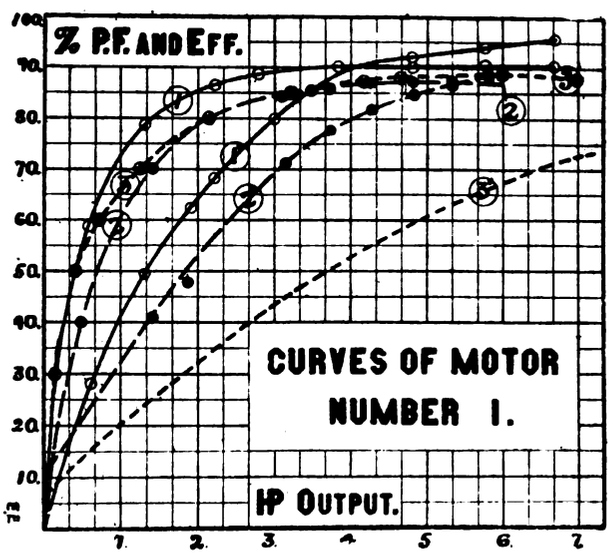

FIG. 3.

An examination of Table 1 shows that the bearing loss of motor No. 1 is about 15 per cent. of the full-load loss. The iron loss is 29 per cent. and the C^2 R loss is 56 per cent. of the full-load loss. Table 2 shows that the varying conditions, caused by the lack of balance, have increased the iron loss about 50 watts, or 50 per cent. The C^2 R loss is increased 80 watts, or nearly 30 per cent.

A similar examination of Table 3 shows the balanced motor No. 2 bearing loss to be 10 per cent., the iron loss 20 per cent., and the C^2 R loss 70 per cent. of the full-load loss. By comparing Tables 3 and 4 it is seen that the unbalanced circuits increased the iron loss 50 per cent. and the C^2 R loss about 300 watts, or over 50 per cent. of the total full-load loss.

Fig. 2 contains all the available curves of the motor No. 1. Curves 1 and 1′ are the balanced computed curves, 2 and 2′ are the unbalanced computed curves, 3 and 3′ are the curves from the unbalanced brake test of Perkins and Williams. Fig. 3 is made up of curves of motor No. 2. Curves 1 and 1′ are from the balanced no-load test, 2 and 2′ are from the unbalanced no-load test, 3 and 3′ are from Perkins and Williams's unbalanced brake test, and 4 and 4′ are from a balanced brake test made by Messrs. Bertrand and Schumann in 1895.

The test shows that, on unbalanced circuits, the iron loss is 50 per cent. higher than under normal circumstances. No dependence can be placed on the C^2 R loss increases as

* *Wis. Engineer*, Vol. I., No. 2.

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given earlier in the paper. The increase in the C^2R loss depends only on the amount that the balance is disturbed. A comparison of the corresponding balanced and unbalanced curves in Figs. 2 and 3 shows that the motor efficiencies are from 4 per cent. to 5 per cent. lower when they are run on unbalanced circuits.

TABLE 1.—Summary of the Results of the Balanced Test of Motor No. 1.

Coil amperes.	Losses.				Load.		Eff.	Power factor.
	C^2R.	Iron	Bearing.	Total.	Watts	H.P.		
2·5	46	98·5	50·5	195	462	0·62	58·3	·281
3·0	60	98·5	50·5	209	988	1·32	78·8	·499
3·5	75	98·5	50·5	224	1,679	2·25	86·9	·682
4	92	98·5	50·5	241	2,112	2·84	88·5	·831
5·0	135	98·5	50·5	284	2,895	3·88	90·5	·877
6	187	98·5	50·5	336	3,626	4·86	90·0	·916
7	250	98·5	50·5	399	4,348	5·80	91·0	·939
8	335	98·5	50·5	484	5,041	6·75	90·5	·955

TABLE 2.—Summary of the Results of the Unbalanced Test of Motor No. 1.

Amperes in heavy coil.	Losses.				Load.		Eff.	Power factor.
	C^2R	Iron.	Bearing.	Total.	Watts	H.P.		
8	123	148	50·5	231·5	1,080	1·45	70·2	·410
9	145	148	50·5	343·5	1,820	1·90	81·2	·478
10	170	148	50·5	368·5	2,347	3·15	84·2	·712
11	200	148	50·5	398·5	2,807	3·77	85·8	·775
12	237	148	50·5	433·5	3,220	4·31	86·6	·814
13	270	148	50·5	468·5	3,621	4·85	87·0	845
14	312	148	50·5	510·5	4,001	5·37	87·0	·866

TABLE 3.—Summary of the Results of the Balanced Test of Motor No. 2.

Amperes.	Losses.				Load.		Eff.	Power factor
	C^2R.	Iron.	Bearing.	Total.	Watts	H.P.		
14	124	154	74·6	354·6	761	1·02	53·5	·313
14·5	136	154	74·6	366·6	1,003	1·35	63·4	·398
15	143	154	74·6	373·6	1,205	1·62	69·0	·462
16	165	154	74·6	395·6	1,548	2·08	74·5	·556
17	192	154	74·6	422·6	1,842	2·47	77·0	·623
18	220	154	74·6	450·6	2,124	2·88	78·8	·684
20	285	154	74·6	515·6	2,600	3·48	80·4	·784
22	340	154	74·6	570·6	3,049	4·09	81·3	·797
24	477	154	74·6	707·6	3,475	4·65	79·7	·833
26	560	154	74·6	790·6	3,885	5·21	79·6	·859

TABLE 4.—Summary of Results of the Unbalanced Test of Motor No. 2.

Amperes.	Losses.				Load.		Eff.	Power factor.
	C^2R.	Iron.	Bearing.	Total.	Watts	H.P.		
11·82	112·6	316	74·6	503·2	477	·64	—	·233
14·47	213·0	316	74·6	603·6	920	1·23	34·4	·366
19·38	495·1	316	74·6	885·7	2,192	2·94	59·7	·642
22·20	671·1	316	74·6	1,061·7	2,941	3·95	64·0	·762
25·55	892·2	316	74·6	1,282·8	3,589	4·80	64·5	·811
29·02	1,080·5	316	74·6	1,471·1	4,406	5·90	66·7	·887

The comparative value of this test and the brake test is found by examining Figs. 2 and 3. In Fig. 2 take Curves 2 and 3. From 1½ h.p. to 4½ h.p. the calculated curve and the brake curve practically coincide. From there on the brake curve is about 1 per cent. higher than the calculated one. The power factor curves show no similarity. In Fig. 3, Curves 1 and 4 are balanced curves. The computed one rises more slowly, but stays up longer than the brake curve. The unbalanced curves (2 and 3) are decidedly unlike for reasons explained before. Although the computed and brake curves of motor No. 1 are nearly alike, the no-load test cannot be depended on when unbalanced circuits are used. On balanced circuits it is probably correct within 1 per cent. The computed power factor curves do not seem to be much related to the brake power factor curves.

In drawing final conclusions as to the value of this method as a practical test, it should be borne in mind that in this case the circuits were not balanced. Even in the so-called balanced portion, the pressures were only approximately equal. The water resistances heated so rapidly and unevenly at the higher pressures that it was impossible to obtain exactly balanced readings. To give the test a fair trial, a lamp bank, or some other constant resistance, should be used. After the pressures have been balanced, by a constant resistance, or with a generator giving balanced circuits, the pressure could be varied for the blocked readings by changing the excitation.

Motor No. 2 was a good example of the machine of its date, and motor No. 1 is a commercial machine of the present design. This enables us to see the advance that has been made in three-phase motor design and manufacture in the last three years. The difference in the highest efficiencies is nearly 10 per cent. The iron loss of motor No. 2 is more than 57 per cent. larger than that of motor No. 1. The improvement in the electrical properties of the iron now used is responsible for much of this gain.

THE INFLUENCE OF HEAT ON MAGNETISED STEEL.*

The influence of heat on the magnetic properties of iron and steel has been the subject of several classic treatises which have thrown much light on the subject and led to valuable practical results in the treatment of iron and steel, especially in relation to dynamo-electric machinery and transformers. That this field of study is not exhausted, however, is evident from the excellent paper read before the American Institute of Electrical Engineers at its last meeting, by Dr. K. E. Guthe. About 12 years ago, Barus and Strouhal, in an exhaustive article embodied in the United States Geological Survey Reports, showed the influence of tempering on the retentivity of steel magnets, and originated the well-known method of seasoning magnets by subjecting them for several hours to a temperature of 100deg. It was this and some additional results that Dr. Guthe took as a stepping stone to further work in the investigation of the effects of annealing. Without going into the details of the elaborate tests made by Dr. Guthe, we deem it of importance to draw attention to some of the principal results obtained. Thus he found that: (1) The point at which steel becomes magnetically hardened by quenching lies at different temperatures, according to the amount of carbon contained. It is considerably lower in high-carbon steel than in low-carbon steel, and corresponds closely to the different temperatures at which occur recalescence of steel. (2) The higher above the point of recalescence steel is heated before being quenched, the harder it is magnetically. (3) The magnetic hardening produced by quenching is the larger the higher the percentage of carbon. (4) Reheating has in general a softening effect upon the magnetic properties of hardened steel—*i.e.*, the permeability increases, and is accompanied by an increase of maximum induction and a decrease of the coercive force. But a hardening is noticeable in the low-carbon steel after it has been reheated for a short time to 100deg. The greatest change in the maximum induction takes place for high-carbon steel between 200deg. and 300deg., for low-carbon steel between 300deg. and 450deg., beyond which temperature there is hardly any change in the practical limit of saturation. All change taking place in reheating beyond 450deg. consists in an increase of permeability for small magnetising forces—*i.e.*, a decrease in the coercive force or hysteresis loss. (5) To produce strong magnets, the hardened steel should first be heated to 450deg. (6) Heating to a high temperature below the point of recalescence and sudden quenching produces a steel with a very weak retentivity; in consequence of which the hysteresis loss in a cycle is greatly decreased. This result may also be obtained, though in a lesser degree, by annealing at a very high temperature.

The results above indicated are directly applicable to a variety of important electrical apparatus, not the least important being its bearing on the manipulation of magnets for electrical measuring instruments. For, in spite of the

* From the *Electrical Engineer* (New York).

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old objection to the employment of permanent steel magnets, the fact remains that instruments embodying them in their construction are to-day the most accurate and reliable for commercial measurements, while even in the laboratory they are coming into more general use on account of their great convenience. Their permanency of indication must always rest on the efficacy of the hardening and ageing processes employed for the magnets, and anything that can add to our present knowledge on the subject, such as the work of Dr. Guthe, is of direct benefit to the whole profession.

ELECTRICALLY-CONTROLLED INDICATORS.

The utility of an invention is always enhanced if the invention is simple in detail, and this is essentially the case in the instrument now before us. Anyone having to take indicator diagrams of a modern engine will be conversant with the need of some means of controlling the indicators so that all the diagrams are taken at precisely the same time. The number of indicators required frequently reaches

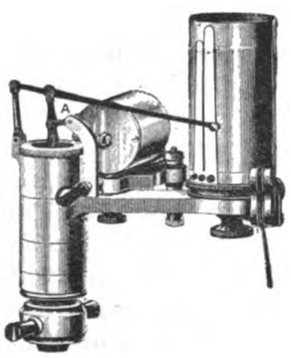

FIG. 1.

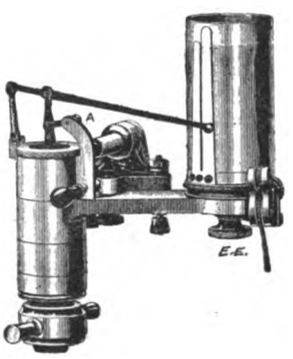

FIG. 2.

double figures, and when marine engines are being tested this is invariably the case. Without some such controlling device as many assistants as indicators are wanted, and the personal time lag then largely affects the period of the record. Mr. F. Sargent invented the apparatus described below, and the Crosby Steam Gauge Company, of 15, Queen Victoria-street, E.C., are manufacturing it and putting it on the market. Thus Fig. 1 shows a Crosby indicator fitted with a Sargent's electrical attachment for bringing the pencil into contact with the cylinder at a stated instant, while Fig. 2 shows another indicator fitted with a patent circuit closer, so as to act as a general controller. The new attachments are shown more in detail

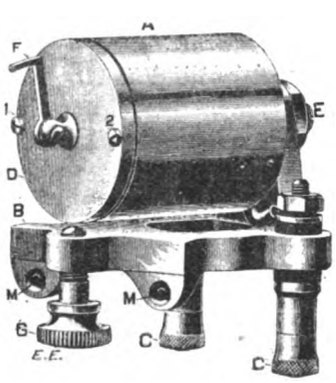

FIG. 3.

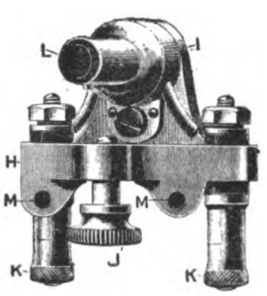

FIG. 4.

in Figs. 3 and 4. The electrical attachment consists of an electromagnet, A, which is supported by a bracket, B, which also secures it to the indicator plate. The terminals, C C, are fixed to the same bracket. The armature, D, is normally kept away from the magnet face by a spiral spring inside the core. The compression of this spring is adjusted by the screw, F. The movement of the armature outwardly is limited by two screws, 1 and 2. To this armature is secured a small latch or hook, F, which is free to work vertically and engage with a screw-eye inserted in the arm, A (Fig. 1). The thumb-screw, G, is for fastening the attachment to the plate of an indicator. Thus, when the circuit of the electromagnet is completed, the armature is drawn in and holds the stylus against the recording cylinder.

Fig. 4 represent the circuit closer, and is designed to operate the electrically-connected indicators, by closing the circuit through them, when the stylus or marking point is put against the paper on the drum of the indicator, to which it is attached. This enables the engineer making the test to control one of the indicators directly by hand—a feature often desirable. It consists of a bracket, H, with a tubular projection, I, fastened to it, which contains the circuit-closing mechanism. It is attached to the indicator plate by the thumb-screw, J, in precisely the same way that the magnets are to the other indicators, and is electrically connected in the same manner through the binding posts, K, K.

The various indicators are usually connected in parallel and worked by a couple of batteries. We understand that the Admiralty are taking up these electrical attachments, and are using them as means of making standardising tests of different makes of indicators. In this case all the indicators are connected to the one cylinder, so that the records of all the instruments of a given stroke can be directly compared.

HOTEL LIGHTING AT LLANDRINDOD WELLS.

Amongst the spas of mid-Wales well known as health resorts and for the beauty of their scenery, Llandrindod Wells, in Radnorshire, holds a justly popular place. It is frequented not only on account of the mineral springs—saline, sulphur, and chalybeate—which are its *raison d'être*, but also for its beauties of mountain and moorland, through which winds the Ithon, tributary to the Wye, and yearly-increasing numbers of visitors come to drink the "waters" and to draw fresh stores of health from the invigorating air. The Rock House Hotel, Llandrindod, has inaugurated the present season by the installation of electric light, thus maintaining its claim to be not only one of the most comfortable and prettily situated, but also one of the most up-to-date hotels in the neighbourhood. The hotel was for the first time lighted by electricity on the evening of April 15, the contract having been placed only seven weeks before with Messrs. J. C. Howell, of London and Llanelly. During that period approximately 250 lights were installed, the system employed being 110 volts with accumulators. The hotel is wired on the fuse-board system with main distribution board, so that any part of the building is under the control of the private part of the house. Almost every light is controlled by a switch, and this, in a public building, is a great advantage, as, in the dining-room and other rooms containing a number of lights, it is convenient to have the means of lighting only the exact number required at any time.

The generating house is situated in the stable yard, some 75 yards to the rear of the hotel. The current is produced by a Parker dynamo running at 1,300 revolutions, giving an output of 50 amperes at 135 volts. The engine is of the Marshall vertical type running at 216 revolutions, and on the same foundation is fixed a vertical boiler working at 80lb. steam pressure. The accumulators consist of a set of 53 Tudor cells, having a capacity of 350 ampere-hours at a discharge rate of 35 amperes. The switchboard has been made to a special design, having a large number of regulating contacts, so that the regulation of volts is a very simple matter. The whole plant is contained in a building 33ft. long by 14ft. wide, a partition having been carried along one side to separate the accumulator from the engine-room. It is worthy of note that the engine and boiler, though only delivered on Tuesday, April 13, were supplying light to the hotel on the evening of Thursday, April 15, and since that date the supply has been continuous.

Books Received.—We have received from Whittaker and Co. Mr. W. Perren Maycock's "The Alternating-Current Circuit," and Mr. Lucien Serraillier's "Vocabulaire Technique des Chemins de Fer," both of which works shall be noticed in due course. From Effingham Wilson comes "The Premier Telegraph Code," by Mr. W. H. Hawke, which shall also receive attention directly.

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All communications intended for the Editor should be addressed C. H. W. Biggs, *139-140, Salisbury Court, Fleet Street, London, E.C Anonymous communications will not be noticed.*

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Vol. XVIII. of new series of "The Electrical Engineer" can be had bound in blue cloth, gilt lettered, price 8s. 6d. Subscribers can have their own copies bound for 2s. 6d., or covers for binding can be obtained, price 2s.

THE PARIS CATASTROPHE.

The awful calamity that occurred on Tuesday at Paris has been attributed to three causes. According to one account, the overturning of a lamp at one of the stalls originated the fire; according to another, the electric wires connected to what we may call the kinematographic show formed the seat of the outbreak; while a third attributes it to the oxy-hydrogen apparatus. If a deliberate attempt had been made to bring about a disastrous fire, it could not have succeeded better than at Paris. The erection of about as inflammable a structure as it is possible to conceive, the grouping of picturesque but highly-inflammable hangings all about, tortuous, narrow passages, a gay throng, exits few and altogether inadequate to the requirements of an excited, horrified, crushing, panic-stricken crowd — these brought about a death-scene unequalled in rapidity or intensity since the burning of the Vienna theatre. It is not the fault of caterers for public amusement, it is not the fault of the organisers of bazaars that similar accidents have not previously occurred. Quite recently we visited a series of representative old buildings—it matters not when nor where—and were astonished at the lack of preparation in case of a panic. There the features existed, inflammable buildings, narrow turnings, and inadequate exits. Probably the authorities will take warning from Paris. Our purpose, however, on the morrow of this catastrophe is to call attention to the criminal carelessness that goes on everywhere in regard to temporary electrical fittings. We contend now, as we have contended for years past, that, properly done, an electrical installation is the safest possible method of artificial lighting so far as regards "setting a place on fire." We do not know the law in France, but we do know that here in England temporary wires are continually carried to points for temporary use. No supervision at all is exercised over such work, and often it is carried out with materials and in such a manner as would make a fire-insurance inspector shudder. "It is only for a night, or a day. You need not be very particular. It will be all right." Such are the instructions, and if the experimentalist, lecturer, or showman gets the current between the terminals when he wants it, he never gives a thought to aught else. No doubt for a time there will be a rigid examination of all temporary installations, but the warning will pass away like a nine days' wonder, and things will go on as usual. In many things legislators are exceedingly lax. They permit the use of dangerous lamps, they exercise supervision over paraffins up to a certain point, then say "do as you like." It is the same with electrical and with gas apparatus. These things do not affect votes, hence no one troubles about them till the upheaving of the social fabric comes about by means of a holocaust as at Vienna, as at Paris. Even now it would be dreadful to contemplate the result of a panic at some of our theatres, and these constructed within the past few years. The permanent electric installations usually, but not necessarily, come under the

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ken of the insurance companies, but if the owner of the building does not insure, and happens to employ a somewhat careless contractor, there is no certainty of any real supervision. The Board of Trade may suggest they do not compel, hence the danger, at some unforeseen moment, of an accident.

THE SUMMER LOAD.

In the present state of the development of the electric lighting industry the electricity supply stations make all their profit during the winter months. In fact, most of the plants are run at a loss during the summer, as the small output then obtaining is not sufficient to pay the standing charges. To this general rule, the summer of 1897 should be an exception as far as London is concerned. The great influx of visitors in the early part of next month will cause much extra demand through the ordinary channels. This increase in population coming during the season will result in many extra festivities being organised. As most of the best public and private rooms are now customers of one or other of the various electric lighting stations, an increased output will result. Perhaps, however, the greatest increase will be due to another cause. We refer to the electric signs and decorative effects, of which so many notices have appeared in our columns of late. The orders received for these have exceeded all precedent, and the question arises as to whether the central-station engineers will be able to cope with the extra demand. To ensure that such shall be the case, we would advise all electric light contractors to give the earliest possible notice to the station engineers of the magnitude of the work they have in hand for the special occasion. We have had a few figures given us by three of the leading contractors, and hear, for example, of certain buildings which will require 2,000, 1,200, and 800 lamps respectively; also these lamps are of 16 c.p., so that these three installations alone will add the equivalent of 8,000 8-c.p. lamps to the mains. From such figures and others we gather that 200,000 lamps would not be an outside estimate of the extra load to be expected on this occasion. This is only about 15 per cent. of the equivalent number of 8-c.p. lamps now fixed in London, but it must be remembered that the whole of these extra lamps will be burning at the same time. This will make the additional load much more heavily felt. It is interesting to look back to 1887, the last Jubilee celebration, to see what was done in electric illuminations. The Stock Exchange had rows of incandescent lamps arranged round the building, surmounted by the letters "V R" in coloured lamps. Two arc lamps of intense brilliancy surmounted the whole. The Institution of Civil Engineers had some 500 incandescent lamps of 10 c.p. on the front of the building, arranged to express the loyalty of the members. Several other places had electric signs, but arc lamps were used more than incandescents. Perhaps the greatest difference this year will be that the lamps will not be run by temporary plants, as they were in 1887. The portable engine placed on planks in a by-street or backyard is now a thing of the past, so far as London is concerned. We trust that the central-station engineers will rise to the occasion, and even exceed the statutory pressure on June 22 in honour of her Majesty's record reign.

BRUSSELS TRAMWAYS.

History moveth apace in tramway work, and that part which is modern to-day becomes ancient to-morrow. Through stress of circumstances, we have this week to deal with a variety of tramway matter. Thus we continue the Sheffield report, dealing with Brussels, of which more hereafter. Then the Dover lines is dealt with, and some details are given as read in Mr. Stilgoe's paper before the Municipal Engineers, while last week we had the Birmingham report. Our readers will have seen that the Sheffield report is fairly exhaustive, but although issued only a short time ago, it must be corrected largely for Brussels. We have long ago fully described and illustrated the overhead system, which has worked so well, running from the Midi Station up the broad boulevard by the Port du Hal, and thus on to the Waterloo Boulevard, and so down past the botanical gardens to the Northern Station.

The conversion of the other tramways at Brussels from horse to electrically equipped lines is rapidly proceeding, and the result will be watched with considerable interest. From Saerbeck to the Bois de la Cambre, by the Rue Royale, the Place Royale, in front of the Palais de Justice and through the Avenue Louise, with branches from the Impasse at the Rue Royale end to the circus in front of the exhibition, and passing in front of the palace to the Waterloo Boulevard, most of the lines are finished; and thankful the inhabitants will be when they see the last of the army of workmen. We hope to give at the earliest moment a fully-illustrated account of this new work, but till actual running has commenced it would be premature to say too much about the work, especially as many people are doubting the possibility of success. It is somewhat remarkable that Belgium, as well as England, should hand herself in this matter of electric traction to outsiders. In England, Anglo-American combinations seem to have found the pluck, the go, and the money to carry on traction enterprise; in Belgium, it is to German enterprise the work is due. The cost in Brussels is very great, but it seems generally accepted "that if it will work, it will pay." There is, we think, no doubt about the working, but at the present time we are inclined to think some modifications must be made in the track, and especially at points and cross-overs. There is a growing feeling, which we confess we do not understand, as to the municipalisation of tramways. Mr. Pritchard, at Dover, inclined to this view, and was supported by other responsible engineers, and some of their *confrères* upon the Continent also incline to a like opinion. It is well to keep these things in mind, because a general adoption of such conclusions will revolutionise the working of many industries.

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REVIEWS.

Metrical Tables for Engineers, Surveyors, Chemists, Merchants, etc. By FREDERIC ELIE GAY, assistant city surveyor, Bath. London: The St. Bride's Press, Limited. 16mo. Price 2s.

In consulting foreign works or papers nothing is more annoying than the feeling of vagueness due to the unfamiliarity with the measures used. Metres into yards or kilos into pounds, of course, come easy enough, but the compound quantities, such as kilogrammes per square centimetre in comparison with pounds per square inch, simply convey no idea at all, and most people cannot do the double multiplication off-hand, and naturally shirk the trouble of making a special calculation of it. One is therefore always pleased to see the appearance of such a little book as "Metrical Tables for Engineers and Surveyors, etc.," which has been compiled by Mr. F. E. Gay, the assistant city surveyor of Bath. The book contains in all 192 conversion tables. That means that, in order to convert mentally at once by a single multiplication, it would (omitting the less important ones) be necessary to remember something like 150 factors—an addition to one's mental cargo which may reasonably be shirked. The book, though not published in pocket-book form, will go into a coat pocket.

FORTHCOMING EVENTS.

The following are some of the announcements for the forthcoming week:

TO-DAY (FRIDAY).—Royal Institution (Mr. "Anthony Hope" on "Romance"), 9 p.m.—Institution of Junior Engineers (Mr. Ferriera on Electrical Railway Signalling), Westminster Palace Hotel, 8 p.m.—And at Paris, meeting of the Ingénieurs Civils de France.

TO-MORROW (SATURDAY).—Royal Institution (Dr. Mahaffy on the Greek Theatre), 3 p.m.—Institution of Electrical Engineers Students' visit to Liverpool-street Station (G. E. R.)—Also at Nottingham, Chesterfield and Midland Engineers' meeting, 3 p.m.

MONDAY, MAY 10.—Society of Arts (Mr. L. F. Day on Lettering, Cantor lecture), 8 p.m.—Iron and Steel Institution (reception), 9.30 p.m.

TUESDAY, MAY 11.—Iron and Steel Institute (at the Civil Engineers'), 10.30 a.m.; (at the Hotel Cecil, annual dinner), 7 p.m.—Submarine Cables Trust (meeting of certificate-holders at the offices, Winchester House), 12 noon.—Royal Institution (Dr. Anderson on Volcanoes), 3 p.m.—Society of Arts (Mr. Clulow on Line Engraving), 8 p.m.

WEDNESDAY, MAY 12.—Iron and Steel Institute, 10 30 a.m.—Institution of Electrical Engineers Students' meeting (Mr. E. C. Short on Electric Power in Workshops), 28, Victoria-street, 7.30 p.m.—Crystal Palace Wednesday lecture ("Parliaments"), 8 p.m.—Society of Arts ("Motor Traffic: Technical Considerations," by Sir David Salomons, Bart.; Mr. J. F. Moulton, Q.C., will preside), 8 p.m.—And at Newcastle-on-Tyne, meeting of the North-East Coast Engineers.

THURSDAY, MAY 13.—Institution of Electrical Engineers (at the Civil Engineers', at 8 p.m), discussion of Mr. Raworth's paper and reading of Mr. A. Trotter's paper on "Disturbances of Submarine Cable Working by Electric Tramways."—Royal Institution (Prof. Dewar on Research with Liquid Air), 3 p.m.

FRIDAY, MAY 14.—Royal Institution (Prof. Harold Dixon on "Explosion Flames"), 9 p.m.—Physical Society ("Effect of Temperature on the Magnetic and Electric Properties of Iron," by Mr. Morris; "The Formation of Mercury Films by Electric Osmosis," by Mr. Appleyard; and other papers), Burlington House, 5 p.m.

SATURDAY, MAY 15.—Royal Institution (The Greek Theatre), 3 p.m.

CRYSTAL PALACE VICTORIAN EXHIBITION.

It was a happy thought of the Crystal Palace authorities to hold a commemorative Victorian exhibition in this year of the Diamond Jubilee. The Crystal Palace itself is an ever-standing reminder of the most remarkable of all international exhibitions; hence the peculiar appropriateness of an exhibition therein at the present time. Yesterday, in Queen's weather, the Queen's daughter (Princess Christian) duly opened the exhibition. It was a gala day at the Palace, and from early morn till late at night attractions other than exhibits were shown to the visitors, but with us the exhibition must take first place. At one o'clock a large number of guests assembled in the Garden Hall to lunch, at the invitation of the Palace authorities, and we congratulate them upon a scene rendered far more attractive than usual, inasmuch as many ladies were to be seen among the guests. The toasts (after an excellent lunch, catered for by Messrs. Bertram and Roberts) were few; the speeches were admirable and not lengthy. The usual loyal toasts had precedence, followed by "The Navy and Army," and "Art, Science, and Industry." As the time was approaching for the opening ceremony, the guests at once proceeded to the centre of the Palace, where on the one side massed bands conducted by Mr. August Manns discoursed excellent music during the short interval of waiting. Princess Christian having arrived, she proceeded to unveil a statue of the Queen amid the strains of the National Anthem, which was followed by "God Bless the Prince of Wales." The Princess then proceeded through the aisles to see the exhibits, and pronounced the exhibition open.

Although it was found necessary to open the exhibition rather earlier than at first intended, we must congratulate the management upon having so many exhibits actually ready. It will be our duty to examine the various exhibits, and in future issues to describe them. But we may at once say that there is one which always appeals to us—in the Post Office exhibit of old telegraphic apparatus. Whenever we see this, we are led to consider the vast strides that have been made during the Queen's reign in the transmission of intelligence; and when the electric light exhibits are completely ready, what a study these two classes of exhibits ought to make. The one made history at the commencement of the reign, the other is making history after 60 years. The advance made in the time hardly seems credible. But the exhibition is open, and the Crystal Palace has added that attraction to the many others it possesses. We trust it will be successful.

SHEFFIELD.

REPORT ON TRAMWAY TRACTION.

BRUSSELS.—Population, 482,000.

(Continued from page 563.)

The cars are of the small pattern usually preferred in Continental towns, without outside seats. Trailer cars are, however, attached, and although the nominal capacity is 32 to 34 passengers, frequently 60 to 70 persons are carried on the car and trailer, which, however, reduces the speed. The cars are very well lighted, and on the better class lines are divided into first and second class—the first-class portion being provided with cushioned seats, while in the second-class bent wood is used. The motors are usually 15 h.p. and 25 h.p., the maximum being stated at 30 h.p., and there are two motors on each car. An instance of the rapidity with which electric tramway traction is developing was pointed out to the deputation. Two car frames—one two years old, the other quite modern—were in the depôt. The frames were about the same weight, but the new one (a little the lighter of the two) had been fitted with a new armature, by means of which the horse-power was increased from 15 to 25, with a slight saving in the weight in addition. The weight of the cars is 6¼ tons empty. The cost is £670 per car. Each car runs about 80 miles per day. At present there are 28 motorcars, but the number is to be increased this year to 100. The "fishing-rod" trolley with pulley is generally used in Brussels. The "bow" form is said to take the curves better, but unless well oiled it is noisy, and the oil makes the top of the car dirty. The charge for second-class passengers is about halfpenny per section, no account being taken of distance, and for first-class a halfpenny extra for any distance. The minimum fare is about 1d. second class and 1½d. first class, and the maximum 2½d. and 3d. respectively for a distance of little more than four miles. The ticket system is used. The cars take up passengers at any point, but have certain stopping places (200 to 300 yards apart), and only stop there to set down. It is stated that accidents are very rare, and what there are are chiefly due to the negligence of passengers and the public. Regulations are

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made compelling the companies to provide doors on the platforms, and to keep two of the latter closed. The companies are also called upon to provide safety guards or fenders. It is stated that when accumulators were used traffic was frequently interrupted, but very few interruptions have taken place on the overhead electric lines. All that has occurred in the way of unusual interruptions has been caused by hot motors or broken axles (which are very rare) or through the trolley arm jumping from the wires. This, however, only occurred where there were old light rails and unsuitable roadways, and all that was necessary to enable the journey to be resumed was for the driver to replace the pulley on the wire, which could be done in a few seconds. The speed is nominally limited to about 7½ miles per hour, but this is often exceeded. The employés are provided with uniform. Electric traction is said to be very much cheaper than horses or steam, and the company's receipts are 70 per cent. more on the electric lines than on those worked by horses. The overhead is much preferred to the underground, the latter being said to possess many technical difficulties from which the former is free, and the company regard the overhead as the best system both from the financial and engineering points of view, and also on account of the convenience it affords to the public. The service is frequent (every 3½ minutes on some days and every seven minutes on others), and next year there are to be 18 cars per hour.

Although the present lines were very expensive to construct, great satisfaction is expressed both by the municipal authorities, the public, and the company, with the electric traction, and great extensions are contemplated. It is, however, said that the inhabitants do not care to have the electric tramways in the particular street in which they live. Before overhead electric traction was permitted the Ministry appointed a commission to enquire into the advisability of granting the necessary permission, and the following points were specially considered: (1) danger to the person; (2) danger and inconvenience to traffic; (3) danger from falling of wires; (4) danger arising from lightning; (5) inconvenience to telegraphic and telephonic services. The recommendation of the commission was that overhead electric traction should be permitted subject to certain conditions as to (1) the current being continuous and not at a greater voltage than 600; (2) the height of the wires; (3) protection at crossings of the overhead wires; (4) the provision of lightning conductors.

ROUEN.—Population, 112,000.

In Rouen the deputation were received by the managing director of the tramway company, and conducted over the tramways by Mr. G. S. Albanese, the representative of the Cie. Française Thomson-Houston of Paris. The city of Rouen is a very ancient one, and many of the streets forming tramway routes are narrow, the narrowest being only 14ft. between the kerbs. Steep gradients are frequent, the steepest being about 1 in 13, while the sharpest curve has a radius of 49ft. The paving is of stone, granite, or basalt. Usually it extends right across the track, and 18in. on each side. In many cases the track is on one side of the road, and not in the centre. The rails are of the girder pattern, 88lb. to the yard, specially bonded for the return of the electric current. The old rails, which were very light and of an American pattern, were nearly all worn out, and have been taken up and sold for old iron. Originally, and up to February, 1896, there were about 15½ miles of single tramways worked by horses. The tramways have now been extended to a length of about 23 miles, and are worked by overhead electricity. Most of the routes are single line, but along the quay, where the road is wide, the track is double with centre posts, which are also used for electric lighting. The gauge is 4ft. 8½in. The tramways are in the hands of a company (Cie. des Tramways de Rouen), and the share capital is about £280,000.

The system in use is the overhead electric (Thomson-Houston). Rosettes are not used in Rouen, partly because there would be difficulty in obtaining permission on account of the age and unstable character of the buildings, and also because the standards for the overhead wires can with advantage be used for electric lighting, which is done in some parts of the town. Overhead wires, however, are also used for the lighting, which makes the trolley wires more noticeable. The lighting is in the hands of a separate company. It was offered to the tramway company, but declined by them. The posts do not appear at all objectionable. There are about 50 posts to the mile allowed for in the estimate for both sides of track, and the usual distance between is about 40 yards. The cost was from £10 to £18 per pole, including fixing. Armoured feeders are laid under the ground to carry the current to different sections of the route. The cost of overhead construction in Rouen is said to have averaged from £1,300 to £2,000 per mile, about one-third of the line being double track and two-thirds single. The power-house is extensive and well built. The present horse-power is 1,200, but it is being increased to 2,000 h.p. There are one 500 and three 300 kilowatt dynamos. The current is direct and the voltage is 500 to 570. The boilers are of the Babcock and Wilcox pattern. No accumulators are used at the station or on the cars. The cars are 75 in number, and there are also 30 trailers. Some are provided with outside seats, and carry from 40 to 50 passengers. It is, however, stated that on Sundays a car with outside seats and trailer sometimes carries as many as 150 persons up a gradient. There are two motors on each car, of 20 h.p. or 25 h.p. When horse traction was used there were only 30 cars. The cars are lighted with electricity and divided into first and second class, the difference between the two classes being that the first have cushioned and the second uncushioned seats. The weight is from 6½ to 6¾ tons per car, and the distance travelled per car per day about 81 miles. The fares are 1d. and 1½d. according to the class from the centre to the city boundary, and from centre to termini 2d. and 3d. In the morning workmen's cars are run at 1d. for five miles, and a return ticket can be obtained for 1½d. only. The ticket system is used. Stopping places are provided and indicated by the poles being painted white. It is stated there have been no accidents or interruptions since the plant was completed. Although the gradients are steep, the cars are under perfect control. The deputation were taken on a special car down a gradient of 1 in 13 at a speed of about 15 miles per hour, and the car was stopped in half its length, reversed, and driven back. Part of the journey was at the rate of 20 miles per hour, and then the car was stopped in 25 yards. The maximum speed allowed in the city is 10 miles per hour, but this is said to be often exceeded. The service is generally every five minutes, but on some lines every 10 minutes. The drivers and conductors are provided with uniform.

The company's representative informed the deputation that the electric tramways had become so popular that on one Sunday as many as 83,000 fares were taken. As the city has only a population of 112,000, it will be seen that this is a very large proportion. The remarkable success of the electric tramways in Rouen can to some extent be judged from the above, and the deputation were assured that the result of the change from horses to electricity was most satisfactory in every respect. As the system has not been in use for a year, the financial results cannot be given accurately, but it is stated on behalf of the company that the number of car miles run per annum is estimated at two millions, and the receipts at £75,000, which would be equal to 9d. per car mile. As, however, the deputation have no information as to the working cost, it is impossible to arrive at the profits per car mile. A notable fact is that the whole of the electric tramways are said to have been completed in 10 months. It may be added that waiting-rooms are provided at many important points for the use of passengers

(To be continued.)

Barking.—We are glad to hear that Mr. W. C. Hawtayne has been instructed by the Electric Lighting Committee of the Barking Town Urban District Council to prepare specifications for tenders and to carry out his electric lighting scheme for the district. This scheme was submitted to the Council in November last, and embodies the low-tension direct-current system with supply on three-wire mains at 220 and 440 volts.

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THE DOVER CORPORATION ELECTRIC TRAMWAYS.*

BY HENRY E. STILGOE, A.M.I.C.E.

The rapid development of building operations on the new estates being laid out in the borough, and the advance of commercial enterprise in connection with the coalfields and the proposed new national harbour at Dover, have made the construction of tramways in the town almost a necessity, particularly from the point of view of conveying the working population to and from their work and for the convenience of the general public. The population of the borough is about 37,100, but the hamlets of River and Kearshey will also be served by the tramways. The Town Council recognised the importance of these considerations, and determined to avail themselves of a project which cannot fail to be a valuable property, and a consequent relief to the rates.

Viewing the town from the high ground, it will at once be seen that the two main arteries of traffic are the road leading from the town station of the South-Eastern Railway towards London, and the road branching from the same and leading to Folkestone. These roads are situate in the valleys, and receive practically the whole of the traffic of the other roads. The

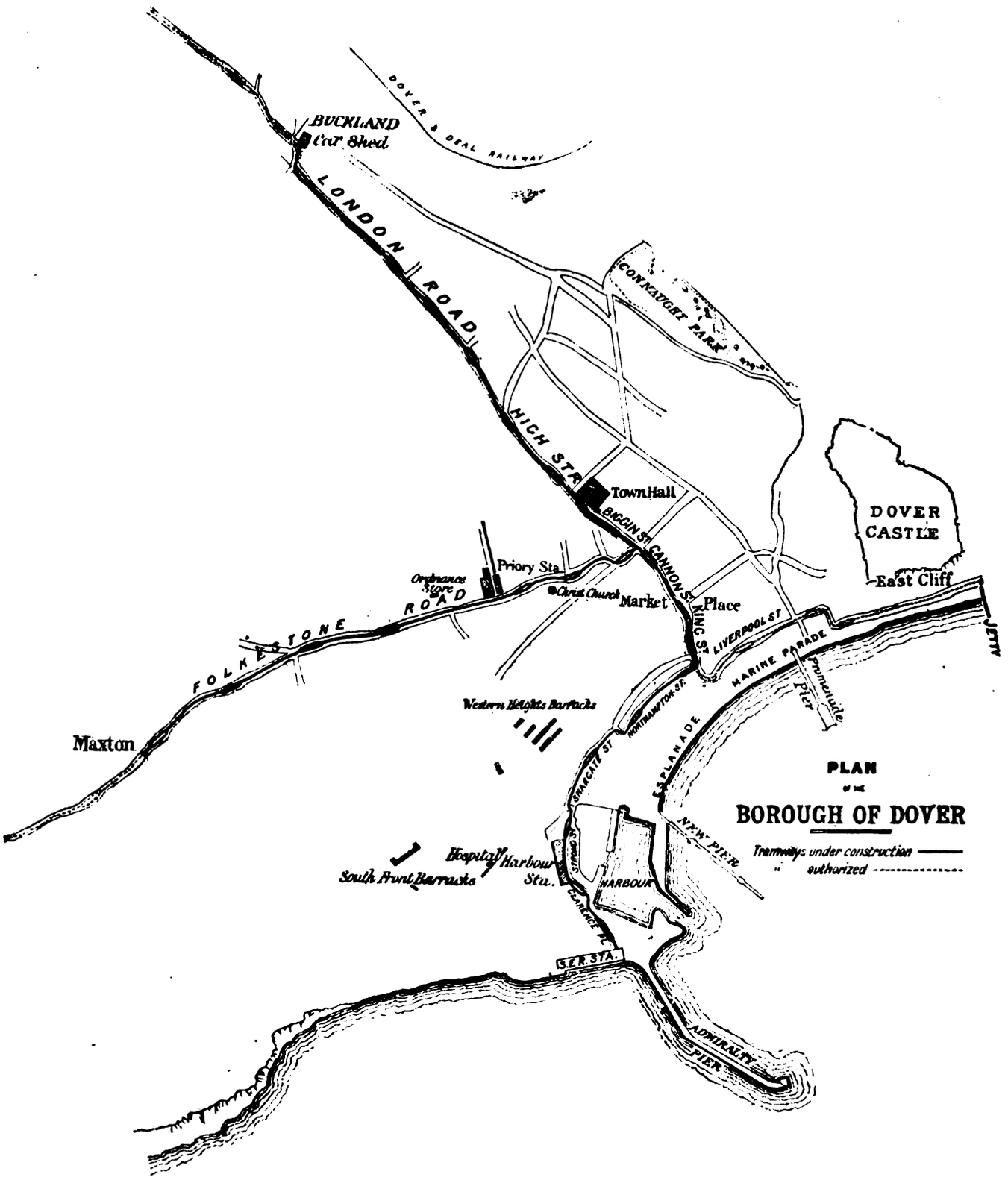

FIG. 1.—Map of Dover showing Tramways Contemplated and in Course of Construction.

author was instructed to prepare plans and sections of the tramways for the Session 1896; and the provisional order of the Board of Trade was obtained, and subsequently confirmed by the Tramways Orders Confirmation (No. 1) Act, 1896. This Act gave the Corporation, as promoters, the power to work the tramways by horse or mechanical traction (except steam locomotives), and the power which had never been granted to a local authority before—viz., that of working the tramways.

The tramways are single lines, with passing-places; the total

* Paper read before the meeting of the Incorporated Association of Municipal and County Engineers at Dover, April 24.

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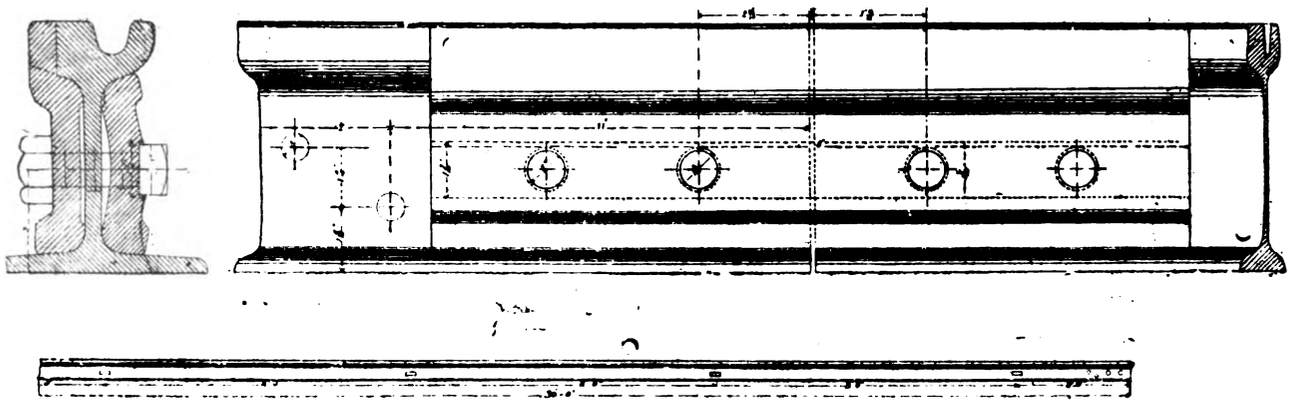
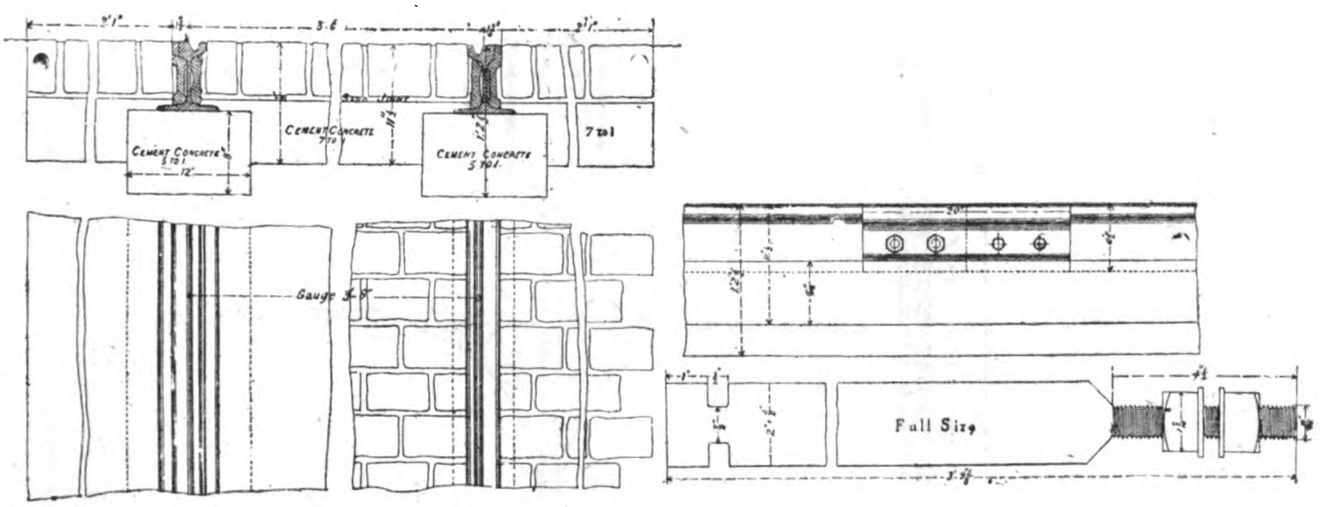
length being 4 miles 3 furlongs 6·05 chains, of which 3 miles 1 furlong 8·15 chains is single line, 1 mile 1 furlong 2·25 chains double line, and 5·65 chains interlacing lines. The centre line of the tramway corresponds with the centre line of the road, except for a short length, where it was necessary to go to one side to pass round a sharp corner. The gauge is 3ft. 6in., and was decided by the narrowness of one or two of the streets through which the line passes; but in the interests of economy of the initial cost of permanent way, the author would have recommended it in preference to a broader gauge. At the passing-places, which are three chains in length, the distance between the centre of each pair of metals is 7ft. 6in. Tramway No. 1. commences at the town station of the South-Eastern Railway, runs through Clarence-place, crosses the level crossing



FIGS. 2, 3, AND 4.—Details of Rails and Fishplates.



FIGS. 5, 6, AND 7.—Details of Track Construction and Tie-Bars.

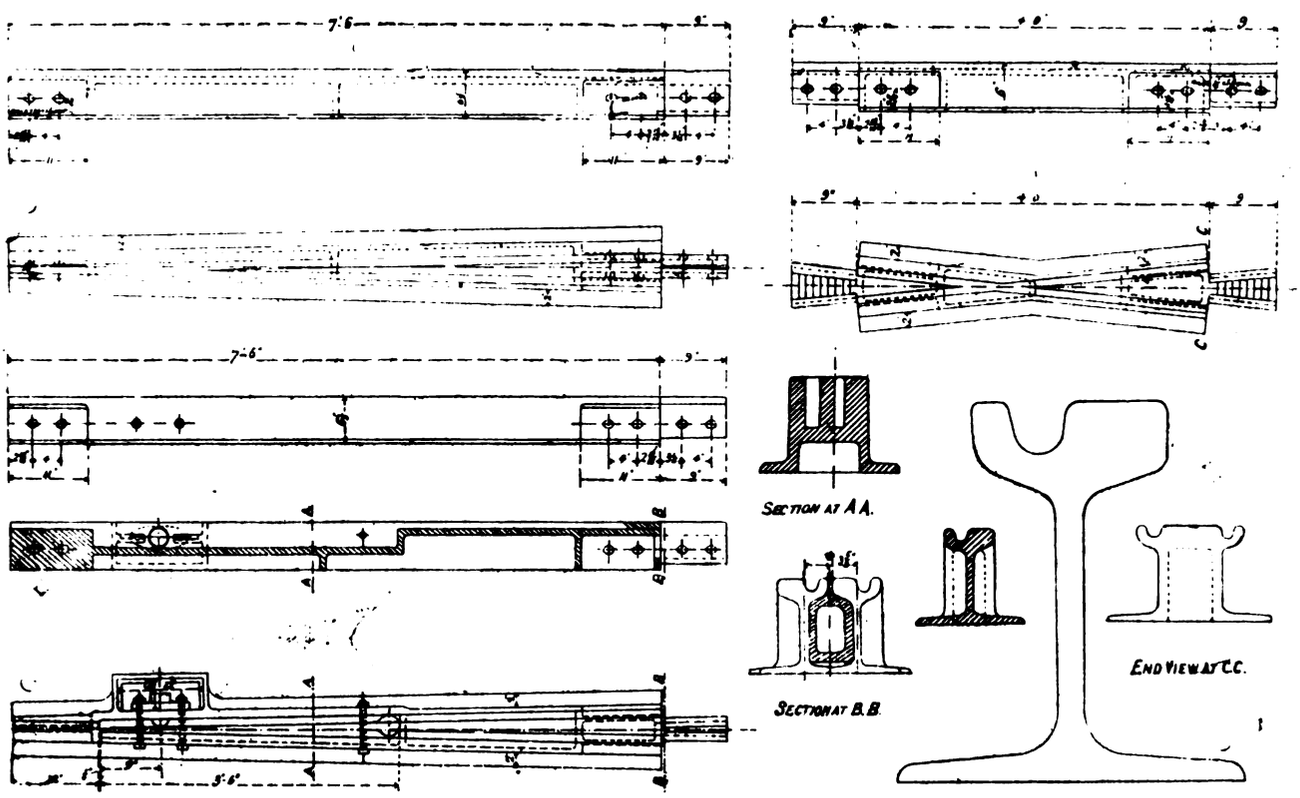


FIG. 8.—Details of the various Points and Crossings Used on the Dover Tramways.

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of the London, Chatham, and Dover Railway at Crosswall, and terminates there (see Fig. 1).

Tramway No. 2 is a continuation of No. 1. It runs through Strond-street, past the London, Chatham, and Dover Railway Company's harbour station there, George-corner, Snargate-street, Court's-corner, Northampton-street, New Bridge, Bench-street, King-street, Market-place, Cannon-street, Biggin-street, High-street, London-road, and Canterbury-road, terminating in the last-mentioned road at the borough boundary. It would appear, from the general plan, to have been more advantageous to take the straight route through Commercial Quay, instead of passing through George-corner, Snargate-street, and Court's-corner; but the number of vehicles employed in unloading the vessels there settled this point. Trade and the punctual running of the tramcars would have been interfered with.

Tramway No. 10 commences at the junction with Tramway No. 2, in Biggin-street, runs through Worthington-street, Priory-place, and Folkestone-road, terminating at the junction of that road with Elms-road.

Tramway No. 11 is a continuation of No. 10, running through Folkestone-road and Maxton, terminating at the borough boundary. The roads in which Tramways Nos. 1 and 2 and Nos. 10 and 11 are laid are respectively situated in the two valleys previously mentioned.

Tramway No. 5 commences at the junction of Tramway No. 2 in Northampton-street, runs along New Bridge and Camden-crescent, and terminates there.

Tramway No. 7 is a continuation of No. 5. It runs through Liverpool-street, Douro-place, Marine-parade, and East Cliff-road, and terminates there.

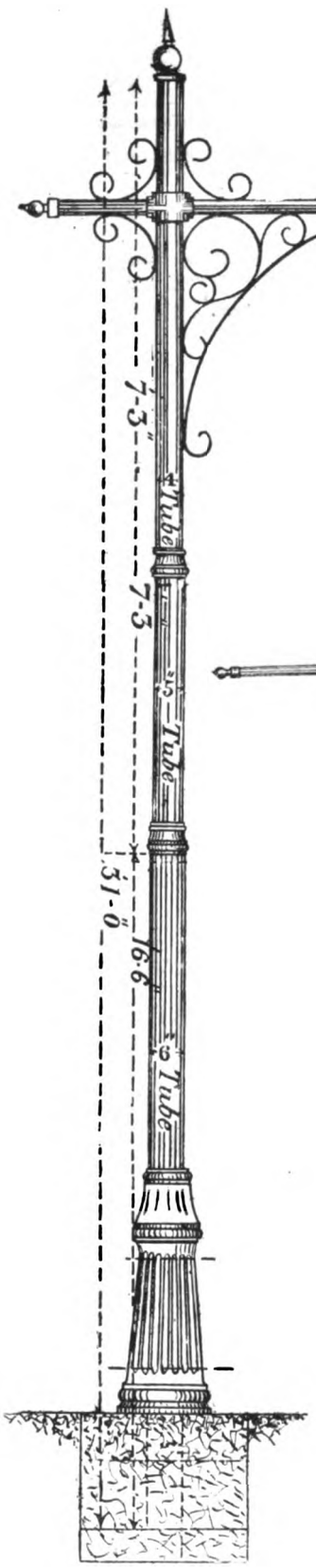

FIG. 9.—Post with Side Bracket, as used at Dover.

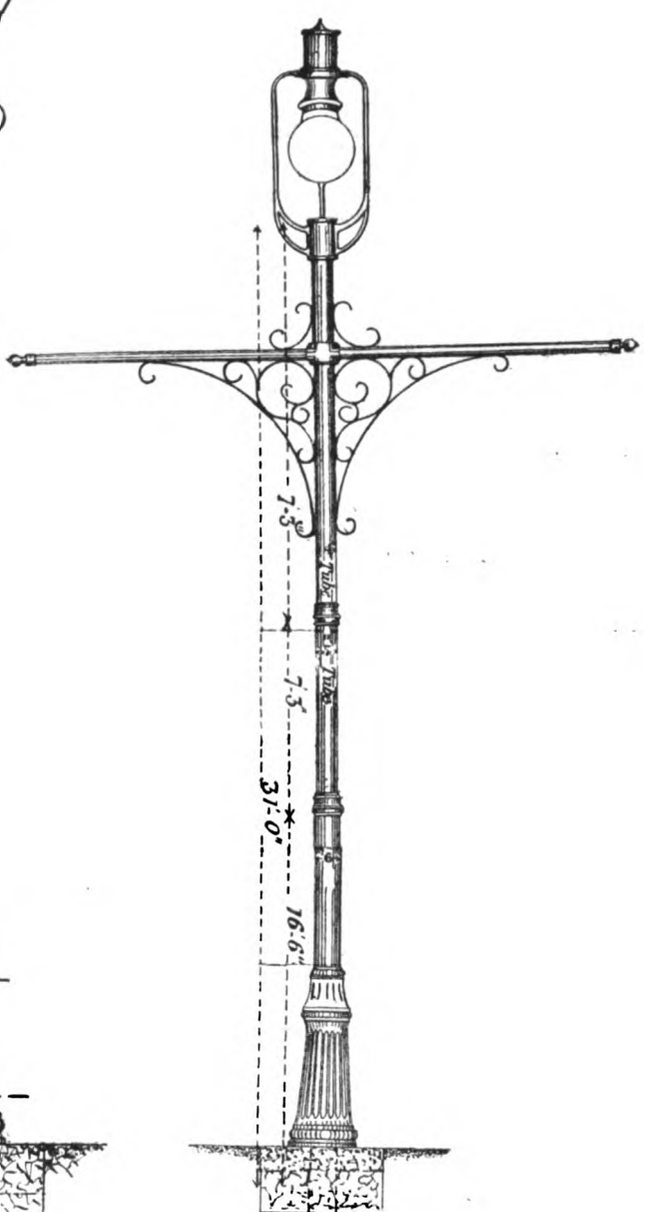

FIG. 10.—Central Post with Arc Lamp at the Top, as used for the Dover Electric Tramways.

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Tramway No. 8 is a continuation of No. 7, passing along East Cliff-road, and terminating at the Castle Jetty.

Tramways Nos. 3, 4, 5, 6, and 9 are short lengths of alternative routes, which were abandoned.

Contracts are let for the construction of the permanent way, and the electrical equipment of 3 miles 0 furlongs 6·45 chains, being Tramways No. 1, No. 2 (part of), No 10, and No. 11 (part of). The steepest gradient on the lines is 1 in 13·32 ; but on the portions now under construction it does not exceed 1 in 25·69. The sharpest curve is 45ft. radius. The permanent way, which has been designed by, and is being carried out under the direction of, the author, is of substantial character. The rails are of the girder type, of steel, weighing 87lb. per yard. They are 30ft. long, 6½in. deep, and are slotted for the tie-bars, and drilled for the fishbolts and electrical bonding, as shown by Fig. 2. A portion of the head of the rail is cut away at the joint for fitting the outer fishplate. The fishplates (Figs. 3 and 4) are of steel, 20in. long, and are of special design, the patent of Messrs. Dick, Kerr, and Co. The outer plate is of the full height of the rail above the flange, and fits into the portion of the head of the rail cut away to receive it. The object of this high fishplate is to add strength to the rail at the joint, which is its weakest part, as may be seen by examining rails which have been laid for a considerable time. The fishbolts (Fig. 2) are of wrought iron, ⅞in. in diameter. There are four bolts to each joint. The tie-bars (Fig. 7) are also of wrought iron, 2in. by ⅝in., with a double-grooved head to fit the slot in the rails. They are placed 8ft. centre to centre, and 3ft. from the ends of the rails. The points and crossings (Fig. 8) are of crucible cast steel, except two or three special crossings, which are built from the girder rails. Marshall's patent spring points are used ; they are 7ft. 6in. long. The crossings are 4ft. long, and the angle is 1 in 5. Dawson's patent drain rails are used at various points ; they are a contrivance made to drain the water from the groove in the head of the rail, and can be connected to the drains in the street.

The passing-places, which, as before mentioned, are three chains in length, are laid in the centre of the roads. The distance between the centre line of each pair of metals is 7ft. 6in., where they run parallel. These are designed so that two or even three cars may stand on one pair of metals while the same number of cars pass on the other. The reverse curves from the single to the double lines are 300ft. radius, and allow the car to travel with great ease, and the consequent comfort of the passengers and saving of wear and tear to the rolling-stock. Each rail is laid on a continuous block of Portland cement concrete (5 to 1), 12in. wide and 8in. deep. The concrete is mixed and laid with great care, and finished to a true surface. The roadway between the rails, and for a distance of 25in. outside of each rail, is paved with Guernsey granite setts, 5in. deep and 4in. wide, 5-16in. above the level of the rails, grouted in with Portland cement mortar (3 to 1), well swept into the

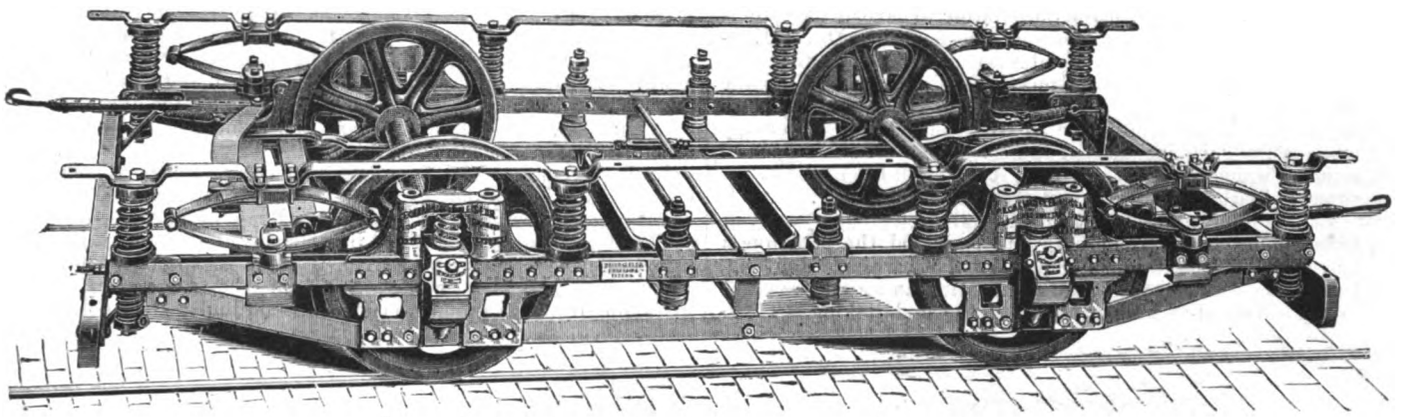

FIG. 11.—Special Design of Peckham Spring Cantilever Truck: Dover Tramways.

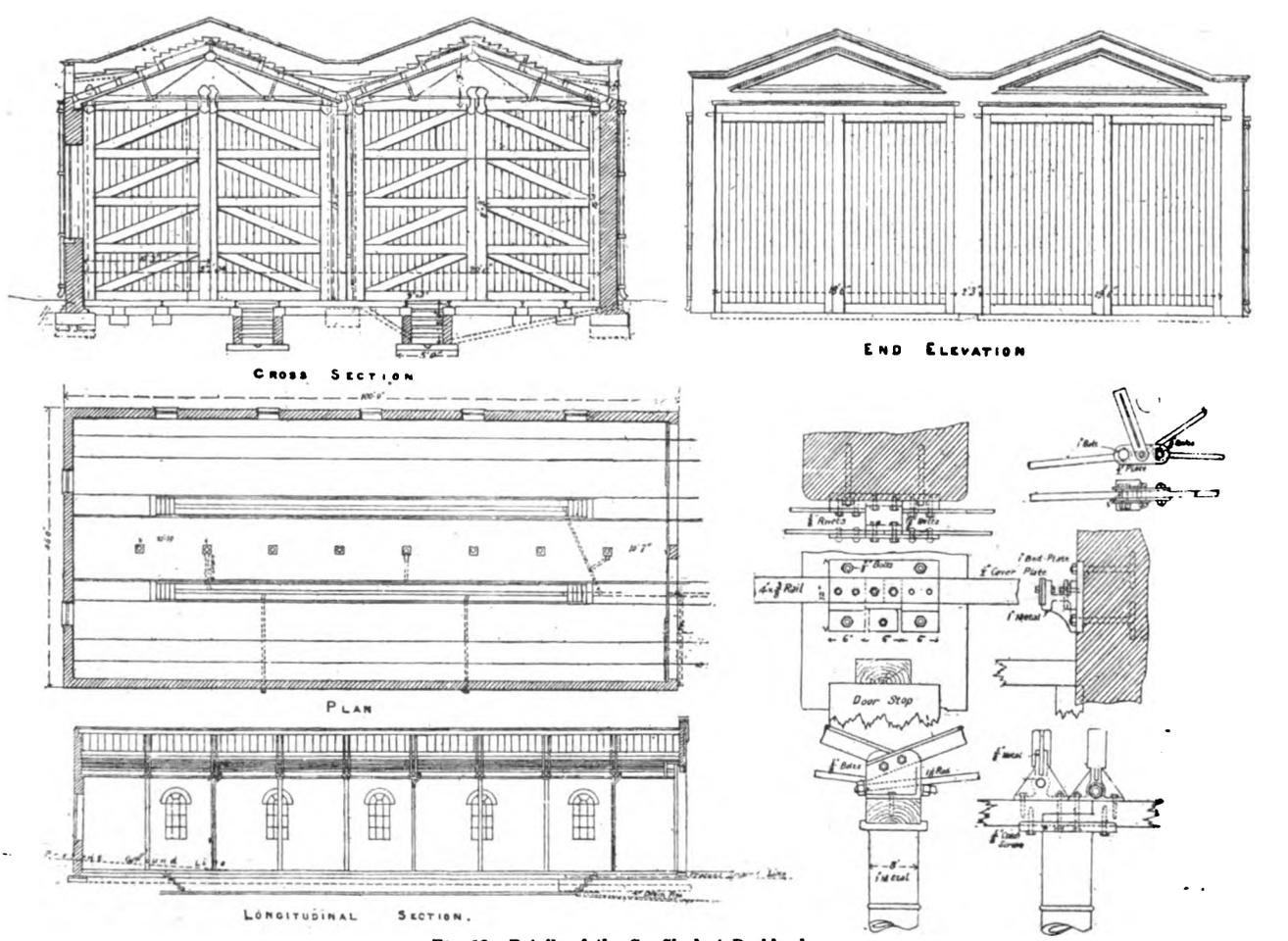

FIG. 12.—Details of the Car Shed at Buckland.

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joints and laid on a ½in. bed of sand on a 6in. foundation of Portland cement concrete (7 to 1), as shown by Figs. 5 and 6.

With regard to the motive power of the tramways, it may here be briefly stated that, acting on the report prepared by the town clerk of Dover and the author as to the duties and cost of the various modes of tramway traction, the Town Council decided to adopt the electric trolley system. Acting on the advice of their electrical adviser, Mr. Stephen Sellon, A.M.I.C.E., who had carefully considered the question of whether it would be more advantageous for the Corporation to have its own power station, or to take the necessary current from the Dover Electricity Supply Company, entered into an agreement with that company to provide all the power required for working the tramways at a price of 3d. per Board of Trade unit, subject to reductions on a sliding scale as the consumption of energy increases. This installation possesses features of unusual interest, which deserve the careful study of all interested in the success of either tramways or electric lighting stations.

The well-known disadvantages that all electric supply stations labour under is the want of a day load, and the consequent length of time that the plant is not only not earning a dividend, but that its stand-by losses are constituting an actual drawback to the dividend-earning capacity of the undertaking. Tramways, on the other hand, find the inevitable fixed charges in connection with a generating station (and particularly with those of smaller size) are a serious consideration, and make it possible for a tramway to purchase its supply of electric energy from an electric lighting station at a price which, while yielding them a fair profit, will be below the cost at which the tramway can generate its own electricity.

The Dover Corporation is the first body which has practically grasped the economic possibilities of the problem before them, and the Dover tramways will be the first tramways to be worked from an existing electric lighting station. This pioneer movement and its results will be watched with much interest by all municipalities interested in the success of their electric lighting stations, and, doubtless, it will not be long before a number of other municipalities will follow in the wake of the experience gained at Dover.

The power station is situated about the centre of the system. The generating plant which the Dover Electricity Supply Company will install will consist of two 200-h.p. Babcock and Wilcox water-tube boilers, two horizontal tandem compound engines, running at a speed of 235 revolutions per minute, and coupled direct to four-pole compound-wound railway generators giving an output of 100 kilowatts at 500 volts. The steam consumption of each engine will not exceed 18½lb. of steam at 150lb. pressure per indicated horse-power per hour, and the over-all efficiency of each engine and generator combined—that is to say, the ratio of the energy available at the terminals of the machines to the indicated horse-power of the engine driving it—will not be less than 84 per cent. A motor-generator of a capacity of 30 kilowatts will be provided, the alternator side to take or generate current at 2,500 volts at a frequency of 100, and the dynamo side to take or generate current at 500 volts and 60 amperes. This arrangement will provide simple and economical means of handling the cars in and about the car-sheds, etc., when the main engines are shut down. Separate switchboards of enamelled slate will be provided for each dynamo and the motor-generator, together with ammeters and voltmeters, both continuous recording and otherwise, automatic circuit breakers with magnetic blow-outs, lightning arresters, and recording wattmeters for measuring the consumption of energy, and the apparatus required for complying with the requirements of the Board of Trade.

The electric equipment of the line is being carried out on the side trolley system, with two No. 0 B. & S. special copper wires, extending the whole length of the route, carried 21ft. 6in. from the ground on ornamental tubular steel poles.

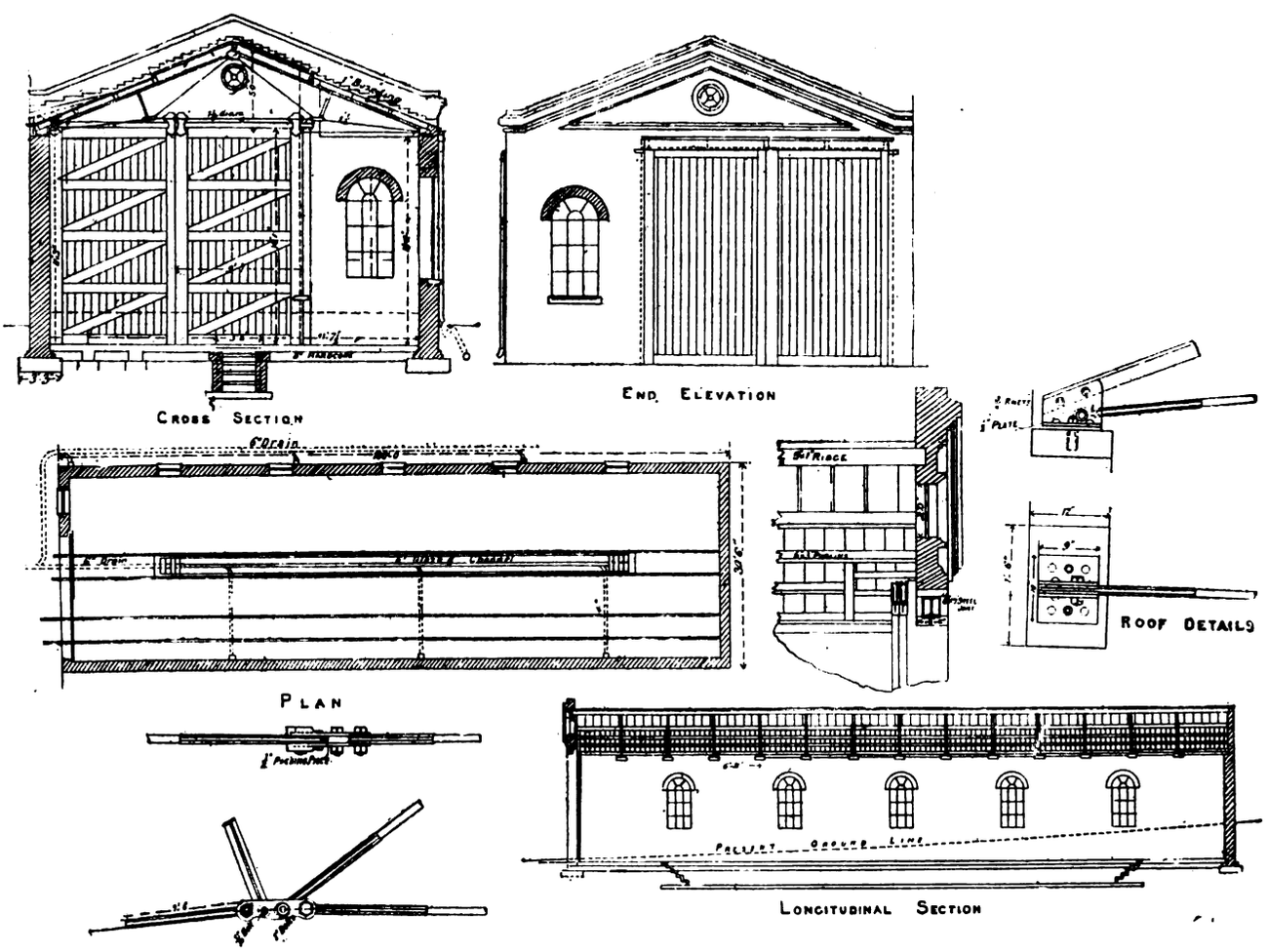

Fig. 13.—Details of the Car Shed at Maxton.

The steel poles (Figs. 9 and 10) are 31ft. long. The first section is of 6in. pipe, 16ft. 6in. long; the second section of 5in. pipe, 7ft. 3in. long; and the third section of 4in. pipe, 7ft. 3in. long. The base has an ornamental cast-iron sleeve, and the top is fitted with a cast-iron terminal or lamp as required. They are sunk 6ft. in the ground, and set in concrete, and are placed 40 yards apart where the line is straight. Side brackets (Fig. 9) are fitted to the poles when placed on the kerb, the lengths of the arms being adapted to the varying widths of the roads, and double brackets (Fig. 10) when the poles can be placed between the double lines—for instance, along the Market-square. Steel guard wires, with insulated supports, are fixed where necessary for the protection of telegraph and telephone wires.

The tramways will be divided into three sections, radiating from a central feeder pillar, and will be further divided into half-mile sections, at suitable switch pillars. The use of a double trolley wire, in addition to its other advantages, obviates the use of frogs, unsightly overhead gear, and minimises sparking. Every attempt has been made to introduce an ornamental as well as a thoroughly efficient system of tramway traction. It is the intention of the Corporation to fix arc lamps, of ornamental design, on the upper portion of a number

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of the standards—notably in the Market-place, where centre-pole construction is adopted.

The cars will be capable of holding 20 passengers inside and 24 out, and will be carried on Peckham spring cantilever trucks of special design (Fig. 11), and provided with two 25-h.p. motors, series-parallel controllers, electric and mechanical brakes, etc. A special feature will be the fitting of a wattmeter on each car, so that the consumption of energy on each car can be recorded. There will be eight motor and two trailer cars. The Chicago bond is being used for the electrical bonding of the rails.

The entire tramway and car-sheds will be at intervals put into telephonic communication with the Dover Electricity Supply Company's works and the offices of the borough engineer, who will be provided in his own office with a switchboard and separate set of recording instruments, from which, at a glance, he will be able to check the efficient electrical working of the entire system. A car-shed will be built at Buckland, and another at Maxton, from designs prepared by the author. The former (Fig. 12) will be 97ft. by 42ft. internal measurements, to hold 12 cars, and the latter (Fig. 13) 97ft. by 27ft. 6in., to hold nine cars. Both sheds will be built of 18in. brickwork, and roofed with slate and glass on light wrought-iron principals. Pits for inspection and repairing are provided in each shed. It is intended to run a 10 minutes' service on Tramways Nos. 1 and 2, and a 15 minutes' service on Tramways Nos. 10 and 11.

The cost of the works now in hand is estimated to be as follows:

	£	s.	d.
Laying 3 miles 0 furlongs 6·45 chains of single line, with passing places	15,600	0	0
Electrical equipment ditto, including eight motor and two trailer cars	8,200	0	0
Two car-sheds and land	3,000	0	0
Electrical bonding	900	0	0
	£27,700	0	0

The author is indebted to Mr. Stephen Sellon for the particulars of the electrical equipment.

ST. PANCRAS VESTRY.

The following is the annual report of the Electricity and Public Lighting Committee of the above Vestry, under date of April 22, 1897:

Your committee beg to present the accounts in respect of the Regent's Park and King's-road stations for the year ending December 31, 1896, prepared in the form required by the Board of Trade. Inasmuch as the foregoing accounts are the first published in connection with the King's-road station, and which embrace a period of about 15 months' running, your committee also present, for the information of the Vestry, supplementary revenue accounts, showing the result of each station's working. It will be seen that the past year's working of the Regent's Park station has produced a revenue of £23,133. 16s. 2d., this amount being an increase over 1895 of £4,211. 18s. 9d., a gross profit of £8,785. 3s. 2d., which is an increase over 1895 of £2,209. 7s. 10d. The net profit for the year on the Regent's Park station, after meeting all interest charges and capital repayments, and also interest on the bank overdraft, amounts to £2,816. 4s. 5d. To this amount the balance of £1,149. 6s. 7d. brought forward from 1895 is added, making a total profit to the credit of Regent's Park station at December 31, 1896, of £3,965. 11s. The King's-road station accounts, as previously mentioned, cover a period of about 15 months, and the result shows a loss of £4,766. 3s. 7d. This, however, is accounted for by the fact that up to the period when the station commenced to supply a sum of nearly £1,650 had been spent in repayment of instalments and interest on loans, salaries, wages, and other working and standing charges; also, in consequence of the demand upon the station being small at the time it commenced to supply, and the working expenses and standing charges being almost as high as when the station is delivering a larger output, it is therefore somewhat to be expected that the first year's running would result in a loss. As an illustration, it may be stated that of the total sale of current during the 15 months in question—viz, £3,824—the sum of £1,670—*i.e*, 43 per cent.—is in respect of the last three months' working. The net result of the two stations' working shows a loss of £807. 12s. 7d., but your committee would remind the Vestry that exceptional charges had to be met during the year for compensation and law charges, in connection with explosions in the culverts, which occurred in February, 1895; and the large expenditure involved for repairs to the arc lighting mains in consequence of the breakdown of the public arc lighting in August, 1896. Had these unexpected charges not have occurred, the year's working, notwithstanding the loss on the King's-road station, would have resulted in a profit on the Vestry's undertaking as a whole, and not a loss as shown.

The following is Mr. Albert E. Pycraft's report on the financial results.

I beg to submit a statement of the electric lighting accounts in respect of the Regent's Park and King's-road stations for the year ending December 31, 1896: The total amount of loans received at December 31, 1896, is £153 300. Since that date a further £6,540—part of the £10,000 applied for in November, 1895—has been received, and there are balances still outstanding to be received from the London County Council amounting to £11,582. 18s. 4d. The total capital expenditure on account of the two stations amounts to £187,135 10s. 5d., and to adjust the capital account and pay off the temporary bank loans a further loan of £16 012. 12s. 1d. is required. The gross revenue for the year amounts to £27,089. 16s. 5d., which is an increase over the year 1895 of £8,167. 19s.; but the net revenue account shows a loss of £800. 12s. 7d., which is accounted for by the fact that this is the first year in which the King's-road station has been in operation, and, as a consequence, the working expenses and standing charges are necessarily higher owing to the small demand upon the station at the time it commenced supplying current. It may, however, be confidently expected that the great increase in the number of consumers at the close of the year to what there were connected to the mains in the earlier part will result in a profit on the working during the current year. The following table shows the yearly progress since the commencement of the electricity undertaking:

Regent's Park Station.

Year ending Dec.	No. of consumers.	Current sold to private consumers. 3d. per unit. £ s. d.	5d. and 6d. per unit. £ s. d.	Lamps, etc., applied for. Incandescent. 16 c.p.	Arc.	Motors.
1892	172	—	8,167 7 8	9,990	82	11
1893	238	384 11 6	9,161 6 0	12,851	110	19
1894	349	1,236 13 9	10,819 15 9	15,532	129	22
1895	447	2,142 9 6	12,682 6 0	19,195	139	37
1896	530	2,490 12 9	16,064 4 5	21,511	151	44
		King's-road Station.				
1896	142	458 2 0	3,366 4 3	4,912	36	3

REVENUE ACCOUNT, DEC. 31, 1896.

Dr. To Generation of Electricity.			£	s.	d.
Coal or other fuel, including dues, carriage, unloading, storing, and all expenses of placing the same on works	£4,956	14 2			
Oil, waste, water, and engine-room stores	705	0 6			
Wages at generating stations	2,982	12 9			
Sundry petty expenses	136	1 11			
Repairs and maintenance, as follows: buildings, £270. 19s.; engines, boilers, etc., £1,186. 1s. 5d.; dynamos, exciters, accumulators, etc., £270. 11s. 11d.; other machinery, instruments and tools, £248. 17s. 10d.—£1,976. 10s. 2d.; less received for old material, £4...	1,972	10 2			
			10,752	19	6
To Distribution of Electricity.					
Wages and other remuneration to linesmen, fitters, labourers	633	8 7			
Repairs, maintenance, and renewals of mains of all classes, including materials and labour	2,600	14 10			
Repairs, maintenance, and renewals of meters, switches, fuses, and other apparatus on consumers' premises	269	4 10			
Water, etc., at sub-stations	6	18 8			
			3,510	6	11
To Public Lamps.					
Carbons	178	14 1			
Attending	279	6 7			
Repairs	70	10 3			
			528	10	11
To Royalties, etc.					
Licenses for mains laid on Crown property, etc.			16	15	0
To Rents, Rates, and Taxes.					
Rents payable			142	19	0
Rates and taxes			518	16	5
To Management Expenses.					
Salaries—engineer's department and clerical staff	2,004	14 1			
Stationery and printing	293	7 3			
General establishment charges	364	14 11			
			2,662	16	3
To Law and Parliamentary and Special Charges.					
Law expenses	193	2 2			
Insurances, etc	207	9 5			
Expenses, fixing meters, etc., on consumers' premises	242	6 7			
Expenses obtaining loans	106	12 4			
Compensation claims paid for injuries *re* explosions	269	0 9			
			1,018	11	3
Total expenditure			19,151	15	3
To balance carried to net revenue account			7,938	1	2
			£27,089	16	5

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Cr.	£	s.	d.
Sale of current per B.T.U. per meter at 6d.	18,877	1	2
Sale of current per B.T.U. per meter at 5d.	553	7	6
Sale of current per B.T.U. per meter at 3d.	2,948	14	9
	22,379	3	5
Public lighting	3,826	15	10
Rental of meters and other apparatus on consumers' premises	289	6	8
Work done on consumers' premises	149	3	11
Special works executed for contractors	56	19	7
Sale of reports	0	2	0
Fees for testing installations	5	10	0
Rents receivable	177	1	2
Proportion of office expenses chargeable to the Lighting (Gas) Department	205	13	10
	£27,089	16	5

GENERAL BALANCE-SHEET, DEC. 31, 1896.

Liabilities.	£	s.	d.
Capital account—amount received	191,867	4	11
Sundry creditors	9,263	13	11
Interest accrued on loans	1,588	7	3
	£202,719	6	1
Assets.			
Capital account—amount expended for works	187,135	10	5
Stores on hand at Dec. 31, 1896—coal, £186. 3s.; oils, waste, etc., £130. 3s. 7d.; carbons, £2. 9s.; general, £4,530. 13s.	4,849	8	7
Sundry debtors for current supplied to Dec. 31, 1896, £9,779. 17s. 7d.; less consumers' deposits, £119	9,660	17	7
Other debtors	263	6	2
Cash in hand	9	10	9
Net revenue account	800	12	7
	£202,719	6	1

STATEMENT OF ELECTRICITY GENERATED, SOLD, ETC., DURING 1896.

King's-road Station.		
Quantity generated in B.T. units		245,943
Quantity sold to private consumers by meter		162,777
Quantity used on works		105,168
Total quantity accounted for		*267,945
Quantity not accounted for		7,169
Total maximum supply demanded (amperes)		5,702
Regent's Park Station.		
Quantity generated in B.T. units		1,196,872
Quantity sold { Public lamps	183,686	1,025,852
Quantity sold { Private consumers	842,166	
Quantity used on works		51,805
Total quantity accounted for		*1,077,657
Quantity not accounted for		90,044
Number of public lamps		97
Total maximum supply demanded (amperes)		14,672

* During the year King's-road station received from Regent's Park station 39,584 units and returned 10,413 units.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Dusseldorf.—Proposals will be received by the municipal authorities of Dusseldorf up to May 20 for the conversion of the horse tramways of Dusseldorf to electric traction.

Sofia (Bulgaria).—Tenders will be received on May 13 by the Bulgarian Ministry of Posts and Telegraphs for the supply of galvanised-iron wire, bronze wire, insulators, supports, etc.

Jassy (Roumania).—There will shortly be open for tender the concession for a network of electric tramways, electric lighting, and waterworks for the city of Jassy. Application is to the Mairie.

Bucharest.—The Roumanian Government will want tenders on August 20 for the supply of 55,000 porcelain insulators (double bell), and other porcelain telegraphic fittings. Application should be made to the Direction of Posts and Telegraphs at Bucharest.

Morecambe.—The Urban District Council want tenders for a chimney shaft (129ft.), engine and boiler houses for the electric light generating station. Plans and specifications can be obtained from the Surveyor, at the offices of the Urban District Council, and tenders must be in by June 7.

Paris.—Tenders will be received by the French Telegraphic Authorities (Paris, Rue de Grenelle 103) on May 25 for nine lots of telegraph instruments and fittings and materials for telephone batteries. Application must be made by May 15. Also on May 22 for installing the electric light at the Prefecture Archives, 30 quai Henri IV.

Santiago de Chile.—The Chilian Government Telegraphic Department will receive tenders on June 19, at Santiago, for the supply of galvanised iron wire, insulators, Morse instruments, paper for same, etc. Particulars (a summary only, and in Spanish) can be consulted at the Musée Commerciale, Brussels; otherwise application is to Santiago.

Rio de Janeiro.—The Secretary of State for Foreign Affairs has received a despatch from H.M. Consul-General at Rio de Janeiro enclosing a translation of an official notice setting forth the conditions under which tenders are invited for the telephonic service of that city and its suburbs. The tenders are to be presented by June 30, and the conditions may be inspected at the Commercial Department of the Foreign Office any day between 11 and 6.

London, E.C.—The Great Eastern Railway Company invite tenders for the supply of stores and materials—including telegraph materials. Forms of tender may be had on application to the Secretary's Office, Liverpool-street Terminus, E.C. The patterns may be seen at the Company's Stores, Stratford, between 10 a.m. and 4 p.m. until May 12. Tenders, endorsed "Tender for Stores," to be forwarded by post in the envelope provided by the company to Mr. W. H. Peppercorne, secretary, Liverpool-street Terminus, London, E.C., by 10 a.m. on May 13.

Dundee.—The Gas Commissioners are prepared to receive tenders for the supply of (*a*) arc lamps and accessories, (*b*) arc lamp pillars, (*c*) Lancashire boiler and fittings, (*d*) high-speed steam-engine and dynamo, (*e*) accumulator battery and switching gear. Specifications and forms of tender may be obtained on application to Mr. Walter H. Tittensor, city electrical engineer. Applications for sections (*c*), (*d*), (*e*) must be accompanied by a deposit of 10s. for each section, which will be refunded on receipt of a bona fide tender. Sealed tenders (marked on the outside) must be deposited with Sir Thomas Thornton, LL.D., clerk to the Commissioners, City Chambers, Dundee, on or before May 12.

Manchester.—The Electricity Committee invite tenders for the purchase and removal from their electric light station, Dickinson-street, of certain plant, which is being disposed of in consequence of the committee having decided to put down larger plant—viz., six 100-i.h.p. Hornsby vertical compound condensing engines, six 60-unit Elwell-Parker shunt-wound dynamos. The plant, which was erected in 1893, can be inspected, and further particulars obtained on application to the engineer, Mr. C. H. Wordingham. Sealed tenders, addressed to the Chairman of the Electricity Committee, and endorsed "Tender for Purchase of Plant," must be delivered at the Gas Offices, Town Hall, not later than 10 a.m. on May 12.

Sunderland.—The Corporation require tenders for the supply of high-speed three-crank steam dynamo. Specification and schedule of quantities can be obtained from Mr. J. F. C. Snell, borough electrical engineer, Dunning-street, on payment of a deposit of £2. 2s., which will be returned on receipt of a bona fide tender. The persons or firms whose tenders are accepted will be expected to pay the rate of wages to the workmen engaged in carrying out the work which is payable by the particular trade affected by the contract in the district where the work is executed. Sealed tenders, addressed to the Chairman of the Highways Committee, Town Hall, Sunderland, must be sent to Mr. Fras. M. Bowey, town clerk, Town Hall, Sunderland, by 26th inst. not later than 12 noon. Tenders to be endorsed "Tender for Steam Dynamo."

Wakefield.—The Guardians invite tenders for the following work at the new infirmary: (1) electric lighting plant, combined steam-engine and dynamo, belt-driven dynamo, motor-dynamo, motor, switchboard, storage cells, etc.; (2) complete system of wiring for the electric light, also bells and telephones; (3) vertical steam-engine, feed-water heater, tank, pumps, and pipe work, etc. Contractors wishing to tender for any of above sections must forward to Messrs. Shepherd and Watney, engineers, 71, Albion-street, Leeds, a deposit of £1. 1s. for such section, which will be returned on receipt of a bona fide tender. Specifications will then be forwarded to such applicants on or about May 13. Tenders must be delivered to Mr. H. Beaumont, clerk, Union Offices, Tetley House, Wakefield, in sealed envelopes, endorsed "Section No. 1, etc.," by noon on June 2.

Blackburn.—The Corporation are prepared to receive tenders for the supply and erection of electric tramway equipment as follows: two steam dynamos, switchboard, instruments and connections, steam and exhaust pipes, valves, etc., posts and bracket arms, etc., overhead line equipment, underground cables, pilot wires, etc., section boxes, etc., railbonding, etc. Tenders, in conjunction with the above, are also invited for street-lighting—both arc and incandescent. The specifications and plans, with conditions and forms of tender, may be obtained at the offices of Mr. E. M. Lacey, the consulting engineer to the Corporation, 10, Delahay-street, Westminster, S.W., on payment of £7. 7s. for each copy, which sum will be refunded on the return of the specification filled up, with bona fide tenders. Tenders, sealed, and endorsed "Traction," to be delivered to Mr. Robert E. Fox, town clerk, Town Hall, Blackburn, on or before Saturday, May 8 next.

West Ham.—The Council invite tenders for pipe work, feed pumps, feed-water tank, etc. Plans of the suggested arrangements, specification, form of tender, and further particulars may be obtained at the office of Mr. John J. Steinitz, borough electrical engineer, Quadrant-street, Canning Town, E., on the deposit of £5 Bank of England note, which will be returned on receipt of a bona fide tender. Tenders, endorsed "Tender for Pipe Work, etc., to be sent to the Town Clerk's Office not later than 4 o'clock on May 11. The contractor will be required to enter into a bond, with two sureties, for the due performance of the contract, and no work will be ordered under the contract until such bond has been duly executed. The contractor whose tender is accepted, and with whom a contract is entered into, will be required to pay the whole of his workmen such rate of wages and observe such hours of labour as are recognised by the workmen's trades unions and in force at the time of signing the contract. In the event of any breach of such agreement the Council will enforce the penalty clause in its entirety.

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RESULTS OF TENDERS.

Hull.—The Committee have recommended the acceptance of Messrs. Venner and Sillar's tender for Pritchett cells for the new station battery.

Derby.—The Town Council have accepted the tender of the British Insulated Wire Company, at £120. 12s. 6d., for 550 yards of high-tension cable.

Hammersmith.—The Vestry have accepted the tender of Messrs. Rickett, Smith, and Co. for the supply of Powell Duffryn coal at 14s. 11½d. per ton for the electric light works.

Ashton-under-Lyne.—The Committee have recommended the acceptance of Messrs. Venner and Sillar's tender for the batteries to the specification of Messrs. Fawcus and Clirehugh.

Colchester.—Tenders for the erection of the Town Council electric light station have been received as follows:

W. Chambers, Colchester	£3.775
A. Diss, Colchester	3,740
F. Dupont, Colchester	3,690
Dobson and Son, Colchester	3,689
H. Everett and Son, Colchester	3,594
G. Grimwood and Sons, Sudbury (accepted)	2,996

Hull.—The following tenders have been received by the Corporation for the supply of plant for the extension of the electric light in the borough. The tenders marked with an asterisk have been recommended by the Electric Lighting Committee for acceptance:

Section A.—Lancashire boilers.			
A. and W. Smith	£1,620	0	0
D. Stewart and Co.	1,522	0	0
Leeds and Bradford Boiler Company	1,304	0	0
Spurr, Inman, and Co.	1,275	0	0
J. and B. Umpleby	1 260	0	0
Holdsworth and Sons	1,252	0	0
Clayton and Sons	1,140	0	0
Tetlow Bros.	1,120	0	0
Tinker Bros.*	1,100	0	0
A. Anderton and Sons	980	0	0
Section B.—Babcock-Wilcox boiler.			
Babcock and Wilcox*	410	0	0
R. Hornsby and Son	344	0	0
Section C.—Green's economiser.			
Tinker Bros.	320	0	0
E. Green and Sons*	300	4	0
Roberts Bros.	250	0	0
Section D.—Overhead travelling crane.			
Ransome and Rapier	440	0	0
A. and W. Smith	315	0	0
Carrick and Ritchie	260	0	0
J. Spencer and Co.*	237	0	0
Bedford Engineering Company	235	0	0
J. Hargreaves and Co.	180	0	0
Section E.—High-speed engines.			
T. Parker, Limited	3,889	0	0
Electric Construction Company	3,796	12	0
Siemens Bros. and Co.	3,704	0	0
Willans and Robinson*	3,704	0	0
Brush Electrical Engineering Company	3,062	0	0
W. Sissons and Co.	2,765	0	0
Clench and Co. (partial)	1,150	0	0
Section F.—Steam-pipes, condensers, &c.			
J. Hargreaves and Co.	2,900	0	0
C. S. Mallett and Co.	2,844	10	0
Brush Electrical Engineering Company	2,576	0	0
Blake and Knowles	2 200	0	0
Rose, Downs, and Thompson*	2,200	0	0
Section G.—Dynamos, switchboard, &c.			
W. Hartnell	16,773	0	0
Laing, Wharton, and Down	14,790	0	0
Brush Electrical Engineering Company	11,910	0	0
Mavor and Coulson	11,412	0	0
P. R. Jackson and Co.	10,800	0	0
Electric Construction Company	10.386	0	0
Siemens Bros., and Co.	10,240	0	0
Easton, Anderson, and Goolden	9 996	0	0
T. Parker, Limited*	9,450	0	0
Section H.—Storage batteries.			
Laing, Wharton, and Down	1,442	10	0
Epstein Electric Accumulator Company	1,418	4	2
Electric Construction Company	1,050	0	0
A. B. Pescatore	1,030	0	0
Electrical Power Storage Company	1,021	0	0
Chloride Electrical Syndicate	975	0	0
Pritchetts and Gold*	885	0	0
Section I.—Mains.			
British Insulated Wire Company	19,445	0	0
W. T. Glover and Co.	18,616	0	0
Henley's Telegraph Works	18,510	0	0
Callender's Cable and Construction Company	17,855	0	0
Reid Bros.	17,800	0	0
Siemens Bros. and Co.*	16,920	0	0
Fowler-Waring Cable Company	16,482	0	0

Aberdeen.—The Corporation have accepted the following tenders for the manufacture, delivery, and erection of an electrical storage battery, to consist of 125 cells of 400 ampere-hours capacity, also for battery-regulating switches: Electrical Power Storage Company, Limited, battery £700, maintenance (£80 per annum) for five years £400; Williamson and Joseph, London, battery-regulating switches £50; Zürich Incandescent Lamp Company and Edison and Swan, Limited, incandescent lamps—8 c.p. 1s. 3d. each, 16 c.p. 1s. 3d., 25 c.p. 1s. 3d., 32 c.p., 1s. 6d.. 50 c.p. 2s. 6d., 100 c.p. 4s. 8d.; Edison and Swan Company, Limited, arc lamps £6. 0s 2d each; General Electric Company, Limited, house main switches and fuses, and single switches and fuses (for probable requirements), £136. 0s. 9d. The Council have also accepted contracts for indicators to be placed on the electric lighting meters at a total cost of £522. 18s. 2d. Estimates were also accepted for rewinding the dynamos at the electrical station amounting to £1,437. The successful contractors are the Electrical Construction Company, Wolverhampton; Messrs. Holmes and Co, Liverpool; and Messrs. Crompton and Co., London.

BUSINESS NOTES.

St. Helens.—The Town Council have decided to duplicate the electric plant.

Western and Brazilian Telegraph Company.—For the past week the receipts were £2,192.

Derby.—The Town Council have ordered a superheater for the electric light works at a cost of £350.

Colchester.—The Eastern Counties' Asylum for Idiots propose to use electric current for lighting purposes or for driving electric fans.

Cuba Submarine Telegraph Comany.—For the month of January the receipts were £3,594, as against £4,843 for the corresponding period of 1896.

Bath.—It was stated at the meeting of the Urban Sanitary Authority that the amount to be spent on low-tension mains was £2,825, and on high-tension mains £1,745.

West India and Panama Telegraph Company.—For the half-month ended April 30 the receipts were £2,229, as against £2,777 for the corresponding period of 1896.

London Lighting Extensions.—The Notting Hill and the House-to House Companies have received sanction from the Kensington Vestry to extensions of their mains.

Stourport.—Special services have been held in connection with the dedication and opening of the Hope-Jones electric organ, which has been built for the parish church at a cost of £700.

Acton.—The District Council have decided to take into consideration the best means of putting in force the provisional order granted to the late Local Board and still held by the Council.

Torquay.—The charge for electricity has been fixed at 7d. per unit for the first hour, and 3d. per unit afterwards, with meter rents at 2s. 6d. per quarter for every 50 8-c.p. lamps or fraction thereof.

Hornsey.—A proposal from an electric company that the District Council should apply for a provisional order to light the district by electricity has been referred to the Highways Committee.

The Meter Case.—We are informed that Messrs. Johnson and Phillips have decided not to appeal against the judgment of Mr. Justice Wills in the recent action brought by Messrs. Chamberlain and Hookham.

Electric Launch.—The *Revue Industrielle* says that the Messageries Maritimes have had an electric launch built in England for use at Laos (presumably on the river), and that she is a great success.

Lincoln.—The Bill to confirm the provisional order made by the Board of Trade under the Electric Lighting Acts of 1882 and 1888, and granted to the Corporation of Lincoln, has been ordered to be reported for second reading.

Brighton.—The Lighting Committee are advised by the Board of Trade that they have power to purchase for sale or to let on hire apparatus for the utilisation by consumers of electricity supplied by the Corporation.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended May 2 amounted to £1,276, as compared with £1,145 in the corresponding week of the previous year, being an increase of £131.

Berlin.—A company, with a capital of 25,000,000 marks, has been formed at Berlin for the construction there of an electrical subterranean and overhead railway. The Deutsche Bank is financially connected with the enterprise.

Bristol Tramways and Carriage Company, Limited.—The traffic returns for the week ended April 30 were £2,292. 0s. 3d., compared with £2,059. 6s. 7d. for the corresponding period of last year, being an increase of £232. 13s 8d.

Kirkby-in-Ashfield.—At the Urban District Council meeting, Mr. W. J. Furse, Nottingham, gave an estimate for lighting the parish with electricity on the high-tension alternating system. The cost of site, plant, mains, etc., would be £9,500. The matter was referred to the Gas and Water Committee.

Exeter.—The arrangements for lighting by electricity the whole of the main streets from Exe Bridge to St. Anne's Chapel and the heads of the cross-streets and Queen-street to the Obelisk, have been transferred to the Electric Lighting Committee.

The New London-Paris Telephone Cable.—The Post Office telegraph steamer "Monarch" sailed on Saturday to lay the new London-Paris telephone cable, which has been manufactured under

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the direction of the Post Office authorities at W. T. Henley's Telegraph Works, North Woolwich.

City and South London Railway.—The returns for the week ended May 2 were £934 compared with £878 for the corresponding period of last year, being an increase of £56. The total receipts for the half-year1897 were £18,546, compared with £17,027 last year, being an increase of £1,519.

Motorcar and Motor Cycle Show.—An international motorcar and motor cycle show was to have been opened at the St. Stephen's Great Hall, Royal Aquarium, on Saturday last, but owing to the non arrival of some of the most important foreign exhibits it was decided to postpone the opening until the following Wednesday.

New Aluminium Patents, Limited.—This Company has been registered, with a capital of £30,000 in £1 shares, to enter into a certain agreement, to acquire, develop, turn to account, and deal with certain inventions in relation to the manufacture of aluminium (provisional protection Nos. 6,991, 6,992, and 6,993 of 1897).

Liverpool.—The City Council have decided to reduce the charges for electric light as follows: for each unit up to 3,000 units per quarter, 6d. per unit; for each unit over 3,000 units per quarter, 4d. per unit; for power purposes—for each unit up to 3,000 units per quarter, 3d. per unit; for each unit over 3,000 units per quarter, 2d. per unit.

Brazilian Submarine Telegraph Company.—Including £11 060 brought forward, the accounts of the Brazilian Submarine Telegraph Company for the second half of 1896 show an available balance of £74,274, from which interim dividends amounting to £39,000 have been distributed and £20,000 added to the reserve fund, leaving £15,274 to be carried forward.

Change of Address.—Mr. George Palgrave Simpson (formerly with Messrs. Siemens Bros. and Co., Limited, 12 Queen Anne's-gate, S.W.) has taken up the important post of managing director of the Doherty Iron Castings, Limited, 32, Victoria-street, Westminster. Mr. Simpson has many friends who will be glad to hear of this change to wish him all good things.

Dudley.—At the Town Council meeting the Chairman said a communication had been received from the British Electric Traction Company, stating that application was to be made to the Light Railways Commission for authorisation to construct light railways in Dudley and elsewhere. The matter was referred to the General Purposes Committee, with power to act.

Poplar.—The Board of Works have decided to further postpone the acceptance of the electric light proposals submitted to them by a private company. Some of the members are divided as to the merits of the various proposals submitted to them, while others are anxious that the Board should control the electric lighting, no matter what the cost may be or whether it was remunerative or not.

Edinburgh.—The Electric Light Committee recommend an increase of £100 per annum to the salary of the resident engineer, making his salary £500, and an increase of £40 to the salary of superintendent of mains, making his salary £240. On the report of Prof. Kennedy, the committee also recommend authority to proceed with works and furnishings in connection with the change over to the new voltage system at a cost of £1,600.

Appointments—The St. Pancras Vestry have appointed Mr. W. Anderson Brown distributing engineer to the Electricity and Public Lighting Department. There were three selected candidates.—The Wakefield City Council, on Tuesday next, will be recommended by the Electric Lighting Committee to appoint Mr. John Kempe Brydges, of the Leeds House-to-House Electric Supply Company, as electrical engineer for the city at a salary of £200 per year.

Lancaster.—The Electricity Committee reported at the Town Council meeting that they had received a letter from the Electric Lighting Extension Syndicate Company enclosing a draft of an agreement proposed to be entered into between the company and the Corporation whereby the company propose to inaugurate a system of free wiring and prepayment electricity meters in the borough. It was resolved that the application of the company should not be entertained.

The Blackwall Tunnel.—The opening ceremony has been fixed for May 22. The most important work going on on the northern side of the river is the erection of buildings for the installation of the electric light, including a chimney 120ft. high and about 12ft. square at the base. This part of the work has been in a somewhat backward state, but is proceeding rapidly, and the engines and dynamos are all ready for getting into position as soon as the building is sufficiently advanced.

Hull.—A special meeting of the Works Committee of the Corporation, being also the Tramway Committee, has been held, and the report of the sub-committee recommending the adoption of the overhead electric cable as the best and most suitable tramway system for Hull was submitted and considered. The proceedings were conducted with closed doors, but it is understood that after a full discussion the report was, on the motion of the Mayor, seconded by Mr. Scott, adopted, with only one dissentient.

Llandrindod Wells.—A Bill to confirm certain provisional orders made by the Board of Trade, under the Electric Lighting Acts, 1882 and 1888, has been before the Examiners of the House of Commons for proof of compliance with the Standing Orders. There was no opposition at this stage, and the necessary formal proofs having been given the Bill was ordered to be reported for second reading. Among other orders there was one enabling the Llandrindod Wells Electric Light and Power Company, Limited, to supply electricity in the district.

Ediswan Continuous-Current Dynamo.—The Edison and Swan Company have just placed on the market a dynamo which they claim embodies all the latest improvements both electrically and mechanically, and it is specially manufactured to run at a very high speed without undue wear or vibration. A very special feature is a continuous automatic lubrication system for all bearings, and it is so arranged that after use there is no leakage or waste. If properly run, the machine will not spark at any load.

Shoreditch.—The chairman of the Vestry laid the foundation stone of the new public baths and wash-houses in Pitfield-street a few days ago. Adjoining the baths are the Vestry dust destructor and electric lighting station. The result of combining these services will, it is anticipated, effect a considerable saving. By burning its own rubbish the Vestry will not have to pay for it to be barged away, and the heat from the furnaces will be used for the electric lighting station and for the baths and wash-houses. In the same block of buildings there will also be the free library.

Submarine Cables Trust.—The report of the Submarine Cables Trust for the financial year to April 15 states that the revenue amounted to £23,199. During the past year the following coupons have been met: due April 15, 1896, paid £1, balance July 15, 1896; due October 15, 1896, paid £2. 7s. 6d. on account October 15, 1896, 12s. 6d. balance January 15, 1897; due April 15, 1897, paid £2. 10s. on account, payable April 15, 1897. The expenses of the Trust amounted to £1,063, and the payments on account of the coupons to £21,976, together £23,039, leaving a balance of £159 to be carried forward.

Elmore's German and Austro-Hungarian Metal Company.—The directors in their report for 1896 state that the accounts of the Company require but slight explanation, as there is little alteration from those of 1895. Generally, the directors are pleased to report that the Company's position is gradually being strengthened, and they have every reason to believe that the progress will be continued and increased in the present year. They have been successful in placing sufficient debenture stock to enable them to obtain the necessary copper and to provide such further machinery as is deemed essential.

Vulcanised Fibre.—We have received some samples of the "Genuine" patent vulcanised fibre, a material adapted for the use of electrical engineers. It is claimed that it is superior to rubber and cheaper, that it is an excellent insulator in all dry positions, and that it can be tapped, drilled, and screw-threaded with ease. That it improves with age is a distinctly good feature, though this we have not tested; but we find that it is exceedingly tough and elastic under compression, and is not brittle. It seems to possess most of the qualities that are claimed for it by the makers, Messrs. Mosses and Mitchell, Chiswell-street, E.C.

Guildford.—The Surveyor reported at the Town Council meeting that he had received a letter from the secretary to the electric supply company offering to lay a main through Tun's-gate and Castle-street to the public baths free of cost, on condition that the amount to be paid for the supply of current be not less than £25 a year, and that the offices of the borough surveyor and rate collectors be also lighted with electricity. If the Baths Committee did not find it possible to accept those terms, the company would be willing to consider any proposal they might make The letter was referred to the General Purposes Committee.

Dublin.—The Corporation and the tramway company have come to the following agreement: That the company should pay to the Corporation for their existing lines in the city, and all extensions proposed by them, £500 per street mile per annum, with a minimum rental of £10,000 per annum, and that the company should in addition maintain the wood paving where it has been already laid down by them, and pave with wood pavement all streets in front of hospitals in the city and within jurisdiction of the Corporation and near which the company's lines are placed, as well as the premises of the Royal Academy of Music in Westland-row. It was further agreed that the Corporation should not exercise any purchasing powers before the lapse of a period of 40 years.

An Australian Telegraphic Feat.—A feat in telegraphic operating was performed by the Sydney staff of telegraph operators on the night of the federal elections. No fewer than 1,065,570 words were received and transmitted in the office between 6.20 p.m. and 2.30 a.m., or at the rate of 133,196 words per hour. The staff of operators employed consisted of 120 men, engaged at 56 instruments. This forms the record for Australia. It has been pointed out that this feat was accomplished by the use of the Australian telegraphic code, which the recent Postal Conference wished to be abolished in favour of the English code The assertion was authoritatively made that if the latter code had been employed, 45 per cent. more time would have been required to transmit messages.

Communication in Trains.—The President of the Board of Trade has appointed a committee, consisting of the following gentlemen—viz, Sir Thomas W. P. Blomefield (chairman), Sir William Birt, Sir Douglas Fox. Major-General C. S. Hutchinson, R.E., C.B., and Mr. Gerald W. E. Loder, M.P.—to enquire whether the means of communication between the passengers in railway trains and the servants of the company in charge of the train at present adopted are efficient; whether any particular system of communication in use, or available, is so efficient as to make its general adoption by the railway companies desirable; and also whether any extension or amendment of the law on the subject is desirable. Mr. W. F. Marwood, of the Board of Trade, has been appointed to act as secretary to the committee.

Dublin.—The question of electric traction in Dublin, and the conditions under which it should be permitted, have formed the subject of a conference between the Corporation assembled in com-

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mittee of the whole house and a deputation from the Dublin United Tramways Company, including its chairman and secretary. As the result a provisional agreement was arrived at which is to be brought formally before the Municipal Council for adoption, under which the company propose to pay the Corporation for their existing lines and all extensions of them £500 per street mile per annum, the minimum rental to be £10,000 a year; the company to maintain wood paving where already laid down in streets in front of hospitals and in other places specified; the Corporation not to exercise their purchasing powers for a period of 40 years.

West Hartlepool.—The committee of the Corporation, headed by the Mayor (Councillor J. F. Wilson), appointed some time ago to consider the question of introducing electric lighting, have reported favourably of the scheme after visiting several large northern towns, including Leeds, Bradford, Halifax, Huddersfield, and Edinburgh. The cost of laying down plant is estimated at £30,000; interest and repayment of loan is estimated at £1,530. 12s. 6d., and the yearly maintenance at £2,000; the income from 10,000 8-c.p. lamps, each consuming 18 units per year, equal to 180,000 at 6d., or £4,500, leaving a balance on the right side of £969. 7s. 6d. It is estimated, however, that it would require two years' working before a profit could be guaranteed. The Corporation has all necessary power to carry out the scheme, and the committee unanimously recommend its adoption.

Wells.—Reports were read at the Town Council meeting from the Lighting and the General Purposes Committee, giving full details of the estimate of the cost of an installation of the electric light in the city, which amounted to £7,957, and recommending that the gas company be asked to give prices for lighting the city under different schemes. This information was contained in a letter from the company received that morning and read. The company offered to light the city with the incandescent light for longer hours than at present for the inclusive sum of £350 a year for three years, the present charge being £450. A good deal of discussion ensued, throughout which a tone of satisfaction with the offer of the company pervaded the Council, and ultimately the offer of the company was accepted, there being only two dissentients. The Council will, however, retain the provisional order—which runs for three years—so that they may have it in their power to adopt the electric light at the end of three years if they deem it desirable to do so.

Liverpool.—At a meeting of the Lighting Committee of the Corporation the electrical engineer reported that on March 31 the equivalent number of 16-c.p. lamps connected with the supply mains was, for private lighting 50,804, and for Corporation lighting 4,061, making a total of 54,865, this being an increase of 776 lamps for the month. The value of the electrical energy supplied during the month of March to private consumers was £3,669, and to the Corporation £369, making a total of £4 038, as against £3,077 in the same month last year. The committee appointed a deputation to visit some of the Continental towns for the purpose of inspecting electrical undertakings and systems of lighting. The deputation will consist of the chairman (Mr. Petrie), Alderman Fred. Smith, the electrical engineer, the gas inspector, and superintendent of lighting. The committee decided to extend the mains in Bedford-street at a cost of £187. Mr. W. Decley was appointed clerk of works at the Paradise-street station extension.

Belfast.—At the Corporation meeting Councillor Andrews moved, and Councillor Jaffe seconded, the report of the Electric Committee, which contained the following: "Your committee have appointed the Engine Boiler and Employers' Liability Insurance Company to prepare the specifications for the boilers required for the proposed installation, also to superintend the construction of the boilers. They have accepted the tender of Thos. Parker, Limited, for engines and dynamos, and have advertised for the other plant required for the new station. They have instructed Messrs Graeme-Watt and Tulloch to prepare the plans and specifications for the station buildings according to the engineer's suggestions which have been approved of, and have arranged with Mr. W. H. Stephens, quantity surveyor, to take out the quantities for tenders. Your committee have to report that the output from the present station for the quarter ended March 31, 1897, showed an increase of 7,178 units, being an increase of £208. 1s. 3d., and £8. 2s. 4d. for meter rent. The total output was 53,743 units, of which 53 309 were at 7d. and 434 at 4d." The motion was agreed to.

The Waterloo and City Railway.—The following dialogue, which took place in the House of Commons, is interesting and significant: Sir H. Vincent (Sheffield, Central) asked the President of the Board of Trade whether he was aware that the whole or greater part of the rolling-stock required by the new Waterloo and City Railway had been ordered from America; and whether he would consider the framing of a new standing order directing that companies applying to Parliament to construct new railways should be bound to purchase a fair proportion of the goods required in the United Kingdom. Mr. Ritchie (Croydon) replied that he was not prepared to suggest such a new standing order. With regard to the particular case referred to, he was informed by the company that the order had been placed with an American firm for the reason that, although no less than seven selected English firms were invited to tender, not one of them was able to complete and deliver the rolling-stock in question, consisting of only 22 coaches, the wheels and axles for which are to be supplied by English and Scotch firms, within the time required by the company for the opening of the railway. Sir H. Vincent understood that the contract was not actually signed. Would the right hon. gentleman, therefore, use his influence with the company so that they might be brought to a proper sense of their duty to English trade? Mr. Ritchie said he did not see that any duty was imposed upon railway companies to employ people who could not deliver goods within a specified time.

Sheffield.—The town clerk, acting on the resolution of the City Council, wrote a short time ago to the directors of the Sheffield Electric Light and Power Company, announcing the decision of the Council to purchase forthwith the undertaking of the company, under the powers of the provisional order granted by the Board of Trade in 1892. The directors of the company have replied, stating that they are advised that the notice is invalid and of no effect, inasmuch as the Corporation have no power to issue stock which will produce an annuity in perpetuity. The Parliamentary Committee are now ascertaining the exact position of the Corporation under the provisional order. The section bearing upon the point reads: "The local authority may, at any time before the expiration of 42 years after the commencement of the order, give notice in writing to the undertakers requiring them to sell their undertaking to the local authority, and thereupon the undertakers shall sell the same to the local authority, upon the terms of issuing or transferring to the undertakers such an amount of Sheffield Corporation stock as will produce by the interest or dividends thereon an annuity of 5 per cent. per annum upon the sum properly expended by the undertakers upon the undertaking, and chargeable to capital account."

Bradford.—The subjoined memorial, which has been signed by a numerous body of ratepayers, chiefly in the centre of the town, has been presented to the Parks Committee of the Corporation: "We, the undersigned ratepayers and burgesses of the borough of Bradford, desire to strongly recommend to your consideration the desirability, both in the interests of the enjoyment of the public and for the further popularising of Lister Park, of providing a system of electric lighting around the bandstand, promenade, and the conservatories. We are convinced that such a step, which could be carried out without great initial cost, and which would only entail a small charge per night for the cost of lighting the lamps, would be much appreciated by the general public, and, whilst it would lead to a large increase in the numbers who attend the band performances, would also tend to promote both the good order and the enjoyment of those who congregate on those occasions. We respectfully suggest that steps should be taken so that the first use of electric lighting in the park may be on the night when the Queen's Diamond Jubilee and the jubilee of the incorporation of the borough are celebrated, so that the illumination of the promenade may be a permanent memento of the doubly auspicious jubilee. We as ratepayers and residents of the borough, conscientiously believe that our proposal is not only reasonable and opportune in connection with the jubilee celebrations, but that, apart from all other considerations, it will, if carried into effect, be extremely popular in itself, and would largely contribute to the pleasure of the many thousands who attend the promenade concerts in this the most largely-frequented and most easy of access of all the parks, by foot or tram, in the borough."

Eccles.—At the meeting of the Town Council the report of the members of the Council who visited Brighton recently for the purpose of inspecting the system of electric lighting adopted in that town was received. The visitors were conducted over the generating station, and the methods of production and distribution of current were explained to them. The visitors also had explained to them the Brighton system of charging by a sliding scale, by means of which private consumers are given the advantage due to them in price if they used the light for several hours. On the system of charging adopted, the Brighton consumers have found that electricity is much cheaper than gas where it is wanted for more than two hours on the average each day, and the result has been a large accession of consumers. If the Corporation of Eccles, the report stated, were not to adopt that sliding scale, but were to charge 6d. per unit all round, the Brighton engineer considered that the price of electricity in Eccles would be equal to gas at 3s. 6d. per 1,000ft., light for light. It was not found at Brighton when at first an all-round price equal to gas at 4s. 1d. per 1,000ft. was charged that people were deterred from becoming customers for electricity, as the works were a success from the beginning. The visiting members were of opinion that there was no doubt that by adopting either of the forms of lamps in use at Brighton the streets would be better lighted than at present, and they saw no reason for hesitating to adopt that method of lighting as a commencement, in the main thoroughfare through the borough, as proposed in the modified scheme now before the Council. After a long discussion that scheme, as presented to the Council on April 5, was adopted, and it was resolved to make application to the Local Government Board for permission to borrow £11,408, and also to lay the scheme before the Board of Trade.

Glasgow.—At the Corporation meeting Mr. Alexander, replying to Bailie W. F. Anderson with reference to the question of Mr. Faithfull Begg, M.P., in the House of Commons regarding the Post Office and the Glasgow telephones, said that Mr. Faithfull Begg had no instructions from him or from any member of the Corporation Committee to put any such question. Mr. Faithfull Begg was very largely interested in the National Telephone Company, and they did not want gentlemen who had such a large interest in that company to be the medium of any enquiry. The Corporation never asked anything but a license. They had not asked for any enquiry, and they were satisfied that no enquiry would be beneficial. They were perfectly convinced that the present system was so imperfect that it was unnecessary to have an enquiry. So far as the streets were concerned Mr. M'Farlane would be able to state that no enquiry would cause them to hand over the streets to a private firm.

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Bailie Anderson said he noticed that permission had been given to the postal authorities to lay down tubes for telephone wires, and he asked if these telephone wires were strictly for postal purposes, or if the Post Office had the power to grant the National Telephone Company the use of these wires—whether the application of the Post Office was for postal purposes pure and simple, or with the view of providing facilities for the National Telephone Company, whose direct application the Corporation had refused. Mr. M'Farlane explained that the application from the Post Office was in the usual form, and it was clearly understood by the Statute Labour Committee when they granted the privilege that it was exclusively for Post Office purposes. If it was used for any other purpose, he had no hesitation in saying that the privilege had been surreptitiously obtained from the Corporation. The Corporation would on no account grant liberty to a private company to use the streets in this way.

Newmarket.—A letter was read at the Urban District Council meeting from Messrs. Crompton and Co., Limited, stating that they understood the Council had made an application for a provisional order for the supply of electrical energy in Newmarket, and if the Council would dispose of the order, they were prepared to place before them a company formed for the purpose of taking it over, and would recommend that the company pay all out-of-pocket expenses, or such other sums as might be agreed upon for the transfer of the order. In the event of the Council taking the proposal into consideration, they would be prepared to meet the Council and discuss details. Messrs. Edmundsons, Limited, wrote making a somewhat similar offer, the cost of obtaining and transferring the order to be paid by the company; current for public lighting to be supplied on reduced terms; the Council to have the power of repurchasing the undertaking after a certain period, etc. Mr. Ellis thought that although the Council were actuated by the best intentions, they had perhaps acted a little too hastily at the last meeting. The receipt of these letters made a considerable difference in the aspect of the matter, and to meet that alteration in the position of things he had a motion to propose which he thought would not clash with the resolution passed last week, and would be unanimously adopted by the Council. He moved that in view of the resolution passed at the last meeting the Council should not proceed further as regards an electric lighting order, the clerk be instructed to ask any enquiring companies what they were prepared to offer for the provisional order as it at present stands, and if they were willing to take the same and indemnify the Council against all expenses and liabilities already incurred or likely to be incurred. Mr. Carr seconded the proposition, Messrs. Rodrigo, Sheppard, Segrott, Westrope, and other members spoke in support of it, and it was unanimously adopted. It was also unanimously decided that the Board of Trade be requested to adjourn their consideration of the Council's application for a week, from Wednesday; and as the resolution the previous Monday will prevent the Council laying down an electric light installation, the gentlemen who had opposed the scheme informally stated that, so far as they were concerned, the opposition to the granting of the order would be withdrawn.

Cardiff.—Mr. W. Harpur, the borough engineer, and Mr. N. Applebee, the electrical engineer, have presented a report to the Lighting and Electrical Committee upon the extensions of the electricity works, the mains, and the 200-volt conversion. These extensions are about to be carried out in consequence of the increasing demand. When the works are completed there will be five steam alternators, having a combined capacity of about 17,000 8 c.p. lamps connected to the mains, or about 13,860 alight at once. The sizes of the five machines will have a capacity ranging from 1,250 to 9,370 lamps, and will fill the existing building. It will be necessary, therefore, to proceed with the second block, which will be practically a duplicate of the first. In the engine-room of the new block could be fixed three machines, each having a capacity of about 9,370 lamps, which would bring the total capacity of the works up to about 50,000 lamps connected, provided that high-speed or moderate quick-speed plant was used. More mains would be required, and provision had been made for laying two additional high-pressure feeders along Wellington-street, Cowbridge-road, and Castle-street, to Duke-street, where they would be connected to the existing high-pressure network. Under the new Board of Trade regulations they could now distribute current to consumers up to a pressure of 250 volts, instead of 100 volts, as at present, so that for the same distributing mains they could easily supply double the number of lamps. This was a course which was being adopted all over the country, and one that was recommended. It would necessitate an overhauling of all the existing wiring, and supplying the consumers with a new set of lamps to suit the 200-volt pressure. The alternate-current transformers would need but very little alteration. To carry out the scheme would mean an expenditure of £29,100, which would raise the capacity of the works to about 40,000 lamps. At the end of 1895, at the end of the first year's working, they had connected to the mains the equivalent of 9,330 8-c.p. lamps, which produced a revenue of £3,017. 13s. 6d. At the end of 1896 there were connected 14,130 8-c.p. lamps, which produced a revenue of £5,852. 9s. 11d. For the year ending 1895 there was a deficit after paying off the interest and sinking fund of £2,023, but for the year ending 1896 the deficit was only £380. 12s. 5d. No provision had as yet been made for extending the mains into new districts, but there was no doubt that if the supply were provided in such thoroughfares as Castle-road, Albany-road, the docks, and Tudor-road, the revenue would soon convert them into profitable extensions. The report was gone through *seriatim*, and Mr. Applebee explained that by doubling the pressure they would supply twice the number of lamps at a very great reduction in the cost—something like £9,000. The cost of changing the lamps would be about £700. The light would be more regular. The report was adopted, and the committee decided to recommend the Council to apply to the Local Government Board for power to borrow the money.

Provisional Orders.—The memorandums stating the nature of the proposals contained in the provisional orders included in the Electric Lighting Provisional Order Bills, Nos. 4, 5, and 6, have been published. These cover the Leith Corporation Electric Lighting Order, 1897. The undertakers under this order are the Corporation of Leith. The area of supply is the burgh of Leith, and the order contains provisions that the Corporation shall lay down mains in certain streets within a period of two years, and it provides for the supply of electrical energy in the remainder of the area on certain conditions. In the case of the Ambleside Order the undertakers are the Urban District Council, and in the Ballymena Order the Town Commissioners. These contain similar provisions. In the Llandrindod Wells Electric Lighting Order, 1897, the undertakers are the Llandrindod Wells Electric Light and Power Company, Limited, and the area of supply is the urban district of Llandrindod Wells; and there are provisions for the appointment, remuneration, and duties of electric inspectors, and the testing of electric lines and other works, and for holding enquiries by the Board of Trade as to the causing of accidents affecting the public safety, and for the supply, use, certifying, inspection, etc., of meters. Under the Redditch Electric Lighting Order, 1897, the undertakers are the Urban District Council of Redditch, and the area of supply is the urban district of Redditch; and under the Reigate Corporation Electric Lighting Order, 1897, the undertakers are the Corporation of Reigate, and the area of supply is the borough of Reigate. Both the orders contain provisions similar to those referred to in the case of the Ambleside Electric Lighting Order, 1897. The Barking Town Order, besides similar provisions, provides for the transfer to any company or persons of the powers, duties, and liabilities of the District Council, who are the undertakers, under the order by means of a deed to be approved by the Board of Trade. Under the Morecambe Electric Lighting Order, 1897, the undertakers are the Urban District Council of Morecambe. The area of supply is the urban district of Morecambe. The order contains provisions similar to those referred to in the case of the previous order, and further authorises the District Council to purchase all or any of the lands, buildings, works, etc., used by the Morecambe Electric Light and Power Company, Limited, for the purposes of the Morecambe Electric Light and Power Order, 1890, and provides for the revocation of the Morecambe Electric Light and Power Order, 1890, on the completion of such purchase. In the Ramsbottom Electric Lighting Order, 1897, the undertakers are the Urban District Council of Ramsbottom, and the area of supply is the urban district of Ramsbottom; in the Swadlincote Electric Lighting Order, 1897, the undertakers are the Urban District Council of Swadlincote, and the area of supply is the urban district of Swadlincote; and the Wallasey Electric Lighting Order, 1897, the undertakers are the Urban District Council of Wallasey, and the area of supply is the urban district of Wallasey. All these orders contain similar provisions to the Barking one.

York.—At the meeting of the City Council, the Streets and Buildings Committee reported that they had considered a letter submitted from Messrs. Crompton offering terms upon which the Electric Supply Corporation were prepared to take over the electric lighting provisional order, and a letter from Messrs. Sax and Co. offering terms upon which they would carry out the order. They recommended the Corporation to carry out the electric lighting provisional order. The committee also recommended the increase of the salary of Mr. T. Sawyer, clerk in the city engineer's department, from £85 to £95 per annum. Alderman Wragge, chairman of the committee, moved the adoption of the report, though he took exception to the paragraph relating to the electric light. He said the committee had had several offers sent to them, including one from a firm who proposed to put down the whole plant and machinery for the lighting of the city, with a clause empowering the Corporation, either in one year or fifteen years, to take it over plus 15 per cent. upon the net cost. That was clearly a very reasonable offer indeed, but the Council would be surprised to hear that they never communicated further with the firm referred to, although they knew from their letter that they had been entrusted by the Board of Trade with the transfer of several provisional orders. The alderman went on to refer to the voting on the recommendation in committee, remarking that it was only passed by the casting vote of the chairman. With the rates at 7s. in the pound he maintained that it would be unwise to embark on a speculative undertaking. Mr. H. V. Scott, in seconding the motion said none of the offers made to the committee were such as they could recommend the Corporation to accept. He had not a moment's hesitation in pronouncing in favour of the city carrying out the provisional order, because he was certain the scheme would pay and be a relief to the rates. Mr. Lambert moved and Mr. Hibbert seconded an amendment that the paragraph with respect to the electric light be eliminated from the report. Alderman Dodsworth said it was not worthy of the dignity of the Council to go on shelving the question. He expressed his opinion that the matter would never be carried out by the Streets and Buildings Committee, because they had enough to do, and that it should be referred to a special committee. Mr. Mansfield said there had been a great deal of wire-pulling, and that heaven and earth had

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been moved to prevent the Corporation keeping the electric light in their own hands. Mr. Lund maintained that if the city was polled it would be found that a large majority of the ratepayers were against the Corporation undertaking the electric lighting of the city. Alderman Wragge advocated the initiation of the electric light by some company, with whom the Corporation should make some terms which would enable them, within a reasonable time, if they saw it was a success, to take it over. After further discussion, a vote was taken on the amendment, which was carried by 17 votes to 15. Alderman Dodsworth then moved a further amendment, that the whole question of electric lighting be adjourned for a month, with the object of referring it to a special committee, and this was carried by 18 votes to 13. Subject to these amendments, the report was then adopted.

Newington.—After a long discussion the Newington Vestry have passed the following recommendations with regard to the electric lighting question: "(*a*) That the Vestry disagree with the views expressed by the Board of Trade—viz., 'that in view of the serious objections which have been lodged on behalf of a large number of the ratepayers of the district, it might, in their opinion, be expedient that they should postpone their decision in the matter until the ratepayers have had a further opportunity of expressing their views at the forthcoming election of their new representatives.' (*b*) That inasmuch as the signatures to the petition lodged with the Board against the order by the Newington and Walworth Ratepayers' Association, and the committee of ratepayers, were obtained by canvassers and members of the Moderate party in opposition to the elected Progressive representatives returned by the parishioners at the general election in December, 1894, and also in opposition to a majority of nearly two to one Progressists returned at the May elections of 1896, no grounds exist to justify the assertion that the parishioners are opposed to the Vestry obtaining an order for the distribution of electrical energy from a generating station to be established by the Vestry. (*c*) That from the success attending the distribution of electricity by many municipal corporations, especially Portsmouth and Brighton, and also by metropolitan authorities, under orders sanctioned by Parliament with the support of the Board of Trade, there is no reason to believe that the granting of similar powers to Newington would entail any charge upon the general rates of the parish. (*d*) That whilst admitting as the result of the last local enquiry that the Board of Trade may have had reasonable grounds for declining to proceed with the Vestry's order during the session of 1896, the Vestry is of opinion that no such grounds exist at the present time for delaying the confirmation of the order by Parliament during the present session. (*e*) That in the event of the Board of Trade declining to lay the Vestry's order before Parliament this session, such a course of action on the part of the Board will be tantamount to an encouragement of a party to become mere delegates of the property owners of the parish, and the action of Parliament in removing the qualification of vestrymen under the provisions of the Local Government Act of 1894, in order to place the governmens of the parish in the hands of the popularly elected representatives of the people, will be frustrated. (*f*) That inasmuch as the delay in granting the Vestry the order has already given an impetus to the undertaking of the London Electric Supply Corporation, as shown by the large increase in the number of consumers of electric energy in the district, during even the last few months, to the detriment of the Vestry's proposed undertaking, and that the same corporation will have the opportunity of supplying energy to the new buildings on the Elephant and Castle estate, unless the Vestry are in the meantime authorised to supply such energy, the Vestry protest against any further delay in the order being submitted to Parliament for confirmation, and that in the event of the order not being confirmed this session, the clerk be instructed to give the requisite statutory notices of the intention of the Vestry to proceed during the session of 1898, by means of a private Bill, for securing to the parish the powers sought by the provisional order in consequence of the Board of Trade failing to carry out the spirit of the Electric Lighting Acts, 1882 and 1888."

Birmingham.—At the City Council meeting, Mr. T. Fletcher, in accordance with notice, proposed the following resolution: "That it be an instruction to the General Purposes Committee to consider and report as to the desirability or otherwise of the Council purchasing the undertaking of the Birmingham Electric Supply Company, Limited; also to ascertain and report whether and upon what terms the company are willing to transfer their undertaking to the Council." He said he did not think it was worth while debating now whether the Council seven years ago ought or ought not to have reserved to themselves the monopoly which they granted to the Birmingham Electric Supply Company for 42 years, but it was a very important question to consider whether or not they should attempt to regain those rights at the present time. He believed there was a growing opinion in the city that some day or other it would be desirable, in the public interest, for the Council to purchase those rights, and he suggested that the present was an opportune time to consider the question, because the longer it was delayed the more difficult and expensive it might become. Electric lighting, and the uses of electricity generally, had now passed beyond the stage of theory and experiment to become a proved commercial success, with great possibilities of future development. It seemed to him that Birmingham lagged behind some towns of less importance as regarded its municipal enterprise in this respect, and in the extent to which the electric light was used. He did not consider that the business of the Birmingham Electric Supply Company had been a great success; judging from the financial results they seemed to occupy a very modest position among public electric light companies generally, and he did not think the electric light ever would be so great a success in Birmingham under the control of a company as it would be under the control of the Council. If the undertaking became Corporation property, he believed the general adoption of the electric light would be very speedily brought about. It was the public spirit and loyalty of many citizens that made them averse to doing anything which would injure the gas undertaking. He certainly thought it desirable for the two systems of public lighting to be under the control of the Council, because instead of the electric light being a rival to the gas undertaking it would then become a valuable ally. The demand for the Corporation gas was steadily increasing. But if the Council decided to purchase the interests of the Electric Supply Company, the prospective expenditure on coal-gas plant for ensuring an adequate reserve would not be required, or at any rate the consideration of the question could be safely deferred till the extension was proved to be an absolute necessity. The Council had already made provision for electric light installations in the new market and the technical school, and he took it that if they acquired the monopoly, the street lamps and public buildings would be electrically lighted, and many business men who did not use the electric light at present would be tempted to do so. It had to be borne in mind that if they acquired the electric lighting the city would be involved in a considerable increase of capital expenditure, and increased responsibility and work would be imposed on the members of the Council. He admitted that the financial consideration was a serious matter. They all knew the public debt of the city was sufficiently heavy already to pause and not sanction any further increase till they were quite convinced in their own minds. But he thought the electric lighting undertaking, assuming it could be secured on reasonable terms, embodied a commercial concern which would prove, not only of great public utility, but also a profit to the ratepayers in various ways. A question of primary importance was whether the company would be willing to dispose of their interest to the Corporation. There were some people who imagined that compulsory powers of purchase were already possessed by the Council, but, on the contrary, it would have to be a purely voluntary act. They might remember that in future, and when they granted monopolies to public companies, to always make provision for compulsory purchase on equitable terms in the event of their so desiring. In the present case, he thought it would be to the interest of the company to sell just as much as it would be to the interest of the ratepayers for the Corporation to purchase. Of course, a good deal would depend on the price asked. They knew the capital of the company was £200,000, which, he believed, was all called up, and the shares were at a premium. Providing the terms asked were not prohibitive, he believed that, with the influence and resources of the Council, the undertaking would prove to be a wise and safe investment of public money, that it would be an improvement, public convenience, and eventually a great commercial success. Alderman Bowkett seconded the resolution. The Lord Mayor said he thought he could save the time of the Council considerably by saying, on behalf of the General Purposes Committee, that they were prepared to adopt the suggestion of Mr. Fletcher, and he hoped the members of the Council would refrain from further discussion until they had the whole matter before them. Mr. Fletcher's resolution was then put and carried *nem. con.*, those members pecuniarily interested in the Electric Supply Company, of course, abstaining from voting.

PROVISIONAL PATENTS, 1897.

APRIL 26.

10295. An electrical advertising balloon. James Bussby, 8, Goulding-street, Chorley, Lancs.

10320. Improvements in the manufacture and production of bodies for use as filaments in electric incandescent lamps or for making hoods or mantles for incandescent gas-lighting or for like purposes. Michel Sheftel, 47, Lincoln's-inn-fields, London.

10339. Improvements in connection with telephones. John Anton Mödel, 37, Chancery-lane, London.

APRIL 27.

10411. A patent "ball light" fitting for use in connection with incandescent and other electric lamps. R. S. Keep and Co., Adams-street, Birmingham.

10429. Improvements in underground conduits or trenches for electric railways and the like. John David Griffen and George Sumner Small, 62, St. Vincent-street, Glasgow. (Complete specification.)

10439. Improvements in secondary batteries. Charles Eugene Lee, 46, Lincoln's-inn-fields, London. (Complete specification.)

10444. Improvements in portable electric batteries. Richard Robert Moffatt, 321, High Holborn, London.

10451. Improvements in separating stable salts by means of diffusion and generating electricity direct out of chemical energy. Frederick Sydney Brown and Llewellyn John Davies, 103, Bute-road, Cardiff.

10458. Patent electric light glass abat-jour. Angelina Goetz, 18, Hyde Park-terrace, London.

10484. Improvements in or connected with electric batteries. John Laskey Dobell, 57, Chancery-lane, London.

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10494. Improvements in electric gas lighters. Lewis Lane Borrodaile, 24, Southampton-buildings, Chancery-lane, London. (Complete specification.)

10505. Improvements in electric arc lamps. Henry Vincent James, 6, Bank-street, Manchester.

10521. Improvements in means and arrangements for exhausting incandescent electric lamps, vacuum tubes, and similar articles. Robert Burn, 50, Old Broad-street, London.

10530. Improvements in electrical conductors. Gorham Gray, 53, Chancery-lane, London.

APRIL 28.

10582. Improvements in brushes for dynamos and electric motors. Frederick Guy, 1, Oak-road, Crumpsall, near Manchester.

10612. Improvements in or relating to electric stations and apparatus employed therein. Alfred Julius Boult, 111, Hatton-garden, London. (Xavier Marie Roux, Belgium.)

10629. Improvements in or relating to prepayment electricity meters. Charles Orme Bastian and Francis Malger Staunton, 31, Southampton-buildings, Chancery-lane, London.

APRIL 29.

10654. Improvements in electric fittings. Edward Jesse Pipes, 34, Victoria-street, Westminster, London.

10680. An improved holder for contact brushes, carbons, or other devices used in electrical apparatus. William John Poole, 18, Buckingham-street, Strand, London.

10705. An improvement in plates for secondary voltaic batteries. Ludwig Epstein, 28, Southampton-buildings, Chancery-lane, London.

10708. Improvements in and connected with magnetic compasses. Edward Ayearst Reeves, 77, Chancery-lane, London.

APRIL 30.

10719. Improvements in primary batteries. Walter Rowbotham, 24, Harleyford-road, Vauxhall, London.

10732. Improved portable electric lamp for use in explosive atmospheres. Alfred Charles Wilson and William Henry Roberts, Borough Hall, Stockton-on-Tees.

10737. Improvements in electric arc lamps. Amos William Richardson, Skew Bridge Works, Worsley-road, Patricroft, near Manchester.

10757. Multiple electric switch controlling one or more circuits. Alfred Wiechmann and Henry Wiechmann, 26, Ennis-road, Finsbury Park, London.

10758. Improvements in means for connecting electric conductors to lamps, switches or other electrical fittings. Thomas Herbert Marsh and Albert Vandam, 47, Lincoln's-inn-fields, London.

10767. Improvements in phonographs, Theodore van Heemstede Obelt, 1, Broad-street-buildings, Liverpool-street, London. (Complete specification.)

10772. Improvements in the generation of steam by means of electricity. John Henrique Dunn, 28, Parkhurst-road, Wood Green, London.

10778. Improvements in electrical time-indicators. Samuel Powers Thrasher, 11, Southampton-buildings, Chancery-lane, London.

10792. Improvements in apparatus for distributing electricity. Henry Pengelly, 24, Southampton-buildings, Chancery-lane, London.

10822. Certain improvements in apparatus for the electro-deposition of metals. William Evans and John Walter Smith, 128, Colmore-row, Birmingham.

MAY 1.

10830. An electric alarm for oil pumps. Walter Fletcher, 97, Merefield-street, Rochdale.

10864. Improvements in electric rail contacts or treadles for railway signalling and other purposes. Frederick Thomas Holline, Liverpool-street Station, London.

10872. Improvements in and relating to electric batteries. John Sime, 96, Buchanan-street, Glasgow. (R. Jamieson Browne and John Gourlay Dobbie, India.)

10908. Improvements relating to the transmission of signals through submarine telegraph cables. Francis Lauder Muirhead, 323, High Holborn, London.

SPECIFICATIONS PUBLISHED.

1885.

3379.* Distributing electricity. Thompson. (Zipernowsky and Déri.) (Amended specification.)

1896.

7760. Double-pole switches for electric lighting. Heaton and Smith.

7928. Electric signal indicator. Mercier.

8067. Magneto-electric governing appliance for steam-engines, waterwheels, and such like apparatus. Wilson.

8068. Magneto-electric apparatus for indicating and recording purposes. Wilson.

8080. Electrical accumulator under pressure. Commelin and Viau.

8134. Electrical welding or forging process. Breuer.

8185. Method of raising or lowering electric light fittings, gas fittings, and the like. Ebbutt.

8320. Support or bearing for electrical accumulators or other apparatus having for its object the minimising of vibration. Fabbro.

9233. Prepayment mechanism for gas, electricity, and other meters. Willey and Simpson.

9362. Dynamo-electric machines. Sayers.

9517. Electric locking and block signalling on railways. Sykes and Hollins.

9758. Floor cloths or carpets for the purpose of electrical distribution. Fanta.

10497. Electric traction. Perry and Tomlinson.

10803. Apparatus for heating by electricity. Davies.

10948. Automatic gear for making or breaking or both making and breaking electrical contacts at given times, which times may also be varied at will. Brown and Offord.

11730. Apparatus for producing galvanic or electrolytic depositions. Thompson. (Elektra galvanoplastische Anstalt, H. Feith, und A. Floeck.)

11732. Plate for storage batteries. Grunwald.

12390. Form of integrating watt or ampere hour meter for continuous or alternating currents. Staveley, Parsons, and Murday.

12959. Arc lamps, specially applicable for lantern purposes. Branson.

19218. Manufacture or production of chemical products by electrolysis. Constam and von Hansen.

19290. Electrical furnaces. Boult. (Patin.)

1897.

483. Electric arc lamps. Stockwell.

1465. Perforators for telegraph transmitting ribbons and the like. Storm.

4051. Underground conduits for electric wires. Lake. (Perot.)

4427. Telephones for domestic use. Anders, Wedekind, and Miller.

6155. Electrical road traction installations worked by means of both alternating and continuous currents. Deri.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	9¼-9½
Brush Company, Ordinary	3	⅞ 1⅛
—— Non. Cum., 6 per cent. Pref.	2	1⅞-1⅞
—— 4½ per cent. Debenture Stock	100	104-108
—— 4½ per cent. 2nd Debenture Stock	100	95-99
Callender's Cable Company, Debentures	100	108-113
Central London Railway, Ordinary	10	9¼-10
——	6	5¼-6
Charing Cross and Strand	5	10¼-11¼
Chelsea Electricity Company	5	8¼-9¼
—— 4½ per cent. Debentures	100	112-116
City of London, Ordinary	10	22-23
—— 6 per cent. Cumulative Pref.	10	16¼-17¼
—— 5 per cent. Debenture Stock	100	130-135
City and South London Railway, Consolidated Ordinary	100	58-60
—— 4 per cent. Debenture Stock	100	137-139 xd
—— 5 per cent. Pref. Shares	10	15¼-16
County of London and Brush Provincial Co., Ordinary	10	12¼-12¾
—— 6 per cent. Cum. Pref.	10	14¾-15¼
—— 4½ per cent. 2nd Debenture Stock	10	14¼-15
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	1¾-2¼
—— 5 per cent. Debentures	—	90-95
Edison and Swan United Ordinary	3	1¾-2¼
—— 5 per cent. Debentures	5	3-4
—— 4½ per cent. Debentures	100	105-110
Electric Construction, Limited	2	1¼-1¾
—— 7 per cent. Cumulative Pref.	2	2¼-2½
Elmore's Copper Depositing	1	¾-1
Elmore's Wire Company	2	2-2¼
W. T. Henley's Telegraph Works, Ordinary	10	18¾-19¼
—— 7 per cent. Preference	10	18¾-19¼
—— 4½ per cent. Debentures	100	105-113
House-to-House Company, Ordinary	5	7¼-7¾
—— 7 per cent. Preference	5	9¼-9½
India Rubber and Gutta Percha Works	10	20⅝-21⅛
—— 4½ per cent. Debentures	100	104-107
Kensington and Knightsbridge Ordinary	5	11¾-12¼
—— 6 per cent. Pref.	5	8-8½
London Electric Supply	5	1⅛-1⅜
Metropolitan Electric Supply	10	16¾-17⅛
—— 4½ per cent. First Mortgage Debenture Stock	100	120-124
National Telephone, Ordinary	5	6¼-6½
—— 6 per cent. Cum. First Pref.	10	15-17
—— 6 per cent. Cum. Second Pref.	10	15-17
—— 5 per sent. Non. Cum. Third Pref.	5	6-6½
—— 3½ per cent. Deb. Stock	100	102-105
Notting Hill Company	10	12½-13½
Oriental, Limited, £1 shares	1	1⅛-1⅜
—— £5 Shares	5	8¼-9
—— £4½ shares	4½	7¼-8
Oriental Telephone and Electric Company	1	⅝-¾ xd
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	102-104
St. James's and Pall Mall, Ordinary	5	15-16
—— 7 per cent. Pref.	5	9¼-10¼
Telegraph Construction and Maintenance	12	34-37
—— 5 per cent. Bonds	100	103-106
Waterloo and City Railway, Ordinary	8	10¾-11¼
Westminster Electric Supply, Ordinary	5	13¾-14¼
Yorkshire House-to-House	5	8¼-9

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NOTES.

The Junior Engineers.—The summer visit of the Institution of Junior Engineers to Ireland will begin on August 14.

Obituary.—The death is recorded of Mr. Edward James Stone, F.R.S., observer and director of the Radcliffe Observatory, Oxford.

North-East Coast Engineers.—It is announced that offers to read papers before the North-East Coast Institution of Engineers and Shipbuilders during next session should be sent in to the secretary not later than August 31 next.

The Pacific Cable.—It is stated that Mr. Spalding has withdrawn from his contract with Hawaii for the construction of a cable to the American coast, having failed to secure the expected assistance from the United States. If this, the first link of the American Pacific cable, is not constructed, it looks bad for the prospects of the further ones.

Motorcarts.—It has been announced in reference to the competition for the *Engineer* prize that the judges have decided to make their preliminary examination of the vehicles entered for competition on Friday, the 28th, and Saturday, the 29th, May, at the Crystal Palace, and that they will start the competitors on the long-distance run on Tuesday, June 1. Mr. H. Graham Harris, M.I.C.E., will act as secretary during the trials.

Northern Electrical Engineers.—Mr. S. V. Clirehugh's paper on the transmission of power in factories by electricity is down for Monday next, before the Northern Society of Electrical Engineers at Liverpool. "As the subject is one of considerable interest and importance, the council are desirous of having a good meeting and a full discussion on the subject. Copies of the paper may be had on application to the secretary."

Physical Society.—The programme of the Physical Society for this (Friday) afternoon comprises (1) "An Instrument for Comparing Thermometers with a Standard," by Mr. W. Watson; (2) "An Experiment in Surface Tension," by Mr. A. S. Ackerman; (3) "The Effect of Temperature on the Magnetic and Electric Properties of Iron," by Mr. D. K. Morris; and (4) "The Formation of Mercury Films by Electric Osmosis," by Mr. Rollo Appleyard.

Vacuum Tube Work.—Prof. A. Battelli has published in the *Nuovo Cimento* a note on his experiments as to the difference of the action of the cathode and Röntgen radiations and other discharges on a photographic plate inside or outside of the vacuum tube. He finds the effect about 10 times greater when the plate is inside the tube, which was to be expected. Also that the amount of exhaustion to obtain the maximum effect diminishes, *cæteris paribus*, with the size of the tube.

A Glow-Lamp Fire.—The exact circumstances under which an incandescent electric lamp may set its surroundings on fire when it collapses from overheating are not by any means well made out. According to a case reported in America (in the New Orleans *Times-Democrat*), a man, for purposes of his own, tied a lamp up in a pocket-handkerchief, and, leaving it, found it had set the handkerchief on fire. It seems curious, but probably belongs to that class of phenomena that you cannot make happen twice if you try ever so.

The Brussels Exhibition.—The "official opening" of the Brussels Exhibition took place on Monday. The exhibition has, of course, been open some time, though, as usual with exhibitions, is by no means complete. After the ceremony was over, King Leopold inspected the most advanced of the industrial sections. At the British Court Sir Francis Plunkett presented to his Majesty the chief officials, Sir Albert Rollit, chairman of the British commission, and Mr. Dredge, the executive commissioner, and Mr. Spielmann, the honorary secretary, who was presented to his Majesty as representing Sir Edward Poynter, P.R.A., and the British Fine Art Committee.

Sir David Salomons.—In a note last week relating to Sir David Salomons's views as to the best way of driving a motorcart—*i.e.*, by a steam-engine or electromotor—there is an unintentionally ambiguous sentence which might be, and as a matter of fact has been, read to mean that Sir David had practically given up electrical work. This is, of course, quite incorrect, as he has been giving much more time of late to electricity than to motorcarts. It will be heard with regret, however, that, as a result of overwork, Sir David has been ordered by his medical man to give up all except unavoidable work for the next six months or so. Few things are more irksome to the busy man than enforced idleness.

The River Plate Telegraph Dispute.—It is stated that the River Plate Telegraph Company's claim against the Argentine Government for damages sustained by the closing of its offices is piling up in a way which, if the interdict is not removed, will seriously affect the symmetry of the forthcoming budget. But then the question is, will it be paid? Legally, the Government cannot be got at without the previous consent of the Congress—that is, practically of itself; and failing legal means, there is nothing left but to solicit diplomatic action. It is stated that not only is the company prevented from using its cable and so earning a revenue, but it is prevented even from testing it; and for aught that is known to the officials of the company the cable may have been destroyed or greatly injured.

South Kensington.—A memorial, signed by a number of well-known people "practising various branches of the arts as a profession" (the list is headed by Sir E. J. Poynter), has been presented to Sir John Gorst on the subject of doing something to complete the South Kensington Museum. It is urged that extraordinarily valuable collections, which have been enriched by gifts and bequests valued many years ago at more than £1,000,000, cannot be properly arranged or seen, much less studied, owing to want of space; while the external appearance of the museum is a discredit to the nation. A memorial to the same effect has been addressed by the same signatories to the Duke of Devonshire. This contained an additional suggestion—namely, that the completed buildings should be "hereafter named the Victorian Museum."

Wire or Conduit.—One of the troubles of a conduit system of electrical tramways is the difficulty of maintaining insulation owing to the position of the wires, within a confined space beneath the ground. For this reason *Cassier's Magazine* goes so far as to say that "it has been found impossible (in New York) to employ the usual voltage of the overhead systems—namely, 500 volts—300 volts being as high as anyone dare go. In the Lenox-avenue conduit system, in New York City, the voltage at the generators is 350, and at the further end of the line—2⅝ miles away—the drop, or loss, when 12 cars are running, is 35 per cent. In the overhead construction, under similar conditions, except as to voltage, the drop would not be over 10 per cent. The New York road is, therefore, throwing away 25 per cent. more energy than would be necessary or allowable in the overhead system." They have more experience

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with overhead than conduit lines in America, and it is a little premature to condemn the latter off-hand in this way. The experience of New York will be watched with interest.

Royal Society.—The papers down for reading at the Royal Society on Thursday were all physical, unless exception be taken that Mr. Shelford Bidwell's subject lies on one of the borderlands between physics and physiology. Prof. Ramsay, F.R.S., and Mr. M. W. Travers described the results of an attempt to cause helium or argon to pass through red-hot palladium, platinum, or iron. Mr. Shelford Bidwell's paper was on the negative after-images following brief retinal excitation. Dr. J. Larmor communicated a further instalment of his dynamical theory of the electric and luminiferous medium, and its relation with material media. Among connoisseurs of ethers, it is understood that Dr. Larmor's particular variety is, so far as can be judged from the samples exhibited up to the present, about the best going. The other papers were by Mr. E. B. H. Wade, on a new method of determining the vapour pressures of solutions; by Mr. T. E. Stanton, on the passage of heat between metal surfaces and liquids in contact with them; and by Mr. H. Wilde on the magnetisation limit of wrought iron.

Electricity in War.—Our cousins across the Atlantic being in the happy position of freedom from the possibility of foreign war, appear to delight in speculating on how much better they could do the thing than those nations to whom it is a condition of existence that they should be able to undertake a campaign at any moment. The *Electrical Age*, for instance, has just informed the world that "it is not unlikely that the advance of an army through a series of wire networks would be accompanied with a great sacrifice if the death-dealing current passed through it." And our contemporary seriously suggests that such arrangements will be used in the future. Even if one can imagine the addition to the field train of an army of alternators and all the paraphernalia necessary for the production of a "death-dealing current," it would hardly require the services of the Electrical Engineers Royal Engineers (Volunteers), or some kindred body, to cut the wire or put it to earth. In fact, the wire would be a much greater nuisance than its "death-dealing" current; but the wire entanglement is a known and approved thing.

An Economy.—Few people would think of adding a clock to the fixtures of a lamp-post in order to save lamp-lighters' wages, but according to *Cassier's Magazine* it pays to do so with an arc lamp. "To what extent a labour-saving device can be made to effect economy has been very strikingly demonstrated in the case of one of the large electric illuminating companies which recently concluded to fit up each one of its arc light poles with a clock-switching device designed to automatically throw into and out of circuit each of the lights at certain hours of the evening and morning, and thus to supplant the service of the men hitherto employed to make the rounds of the poles and do the same thing by hand. The company had at the time 600 arc lights in use for street illumination. The lights were 400ft. apart, and the city contract specified that they all had to be turned on not later than 15 minutes beyond a certain hour of the evening, and might be again turned off not earlier than 15 minutes before a certain other hour in the morning." The desired result of extinguishing the arcs is usually attained in other and, to an electrical mind, less clumsy ways.

Wireless Telegraphy.—Mr. Sydney F. Walker has written to the *Western Mail* to enlighten the inhabitants of South Wales on the subject of Mr. Marconi's wireless telegraphy. Mr. Walker has not any information to communicate as to what has been the experience in the matter of the trials of the system in signalling to Flat Holm, and as he is not one of the exceedingly select few who have seen what is inside the box which contains Mr. Marconi's receiver, our knowledge of the apparatus is not materially advanced. If it were quite as easy a thing as Mr. Walker thinks it to devise a relay which would work with the microscopic current of the spark across the Hertzian loop, and to get that spark with certainty at a distance of some miles instead of some metres, the merit of Mr. Marconi's invention would not be very great, and the admiration of those that have seen his apparatus would be rather misplaced. Mr. Preece is down to explain the whole matter in exactly three weeks from to-day, and it is not an unreasonable exercise of patience to wait till then for further details. Meanwhile it is believed that more or less successful experiments have been carried on with other forms of transmitter and receiver besides what has been done by the Post Office. Apart from its scientific interest, the actual value of this method of signalling—for it belongs to signals rather than telegraphy—can only be determined by practical considerations.

Liquid Air.—In the second of Prof. Dewar's lectures on the use of liquid air in research at the Royal Institution on the 6th inst., it was explained that the critical pressure was the lowest pressure at which liquefaction could be produced. With regard to some things, enough pressure could not be obtained to get them in the liquid state, and the theories which applied to ordinary things were used to find out their critical pressure as nearly as possible. The substance with the highest critical pressure was probably carbon, which boiled in the electric arc at 3,600deg. C. By applying the ordinary theories, carbon was found to have a critical pressure of 2,000 atmospheres. After a digression on the possibility of the presence of carbon in quantity in the sun, and the condition in which it would be there, Prof. Dewar came back to experiments. There were shown the preparation of liquid oxygen, and how a spark from a coil would at ordinary temperatures pass through a Crookes tube rather than the leads. But when the tube was cooled by liquid air, the spark went through the leads rather than the tube. The great experiment, however, was the liquefying and solidifying of argon, a bulb of which gas had been borrowed from Lord Rayleigh. The argon when solidified looked like ordinary ice. After the lecture, Prof. Dewar showed how a crystal of sulphur loses its colour when cooled down to the temperature of liquid air, and regained it as it gradually became warmer again.

The American Association.—Owing to the death of Prof. E. D. Cope, the president of the American Association for the Advancement of Science, the succession to the office, under the constitution, devolves upon the senior vice-president, who is Prof. Theodore Gill, of Washington, vice-president for the section of zoology. As the late president had not prepared his annual message for the approaching Detroit meeting, a vote of the council has been passed requesting Prof. Gill to deliver the annual address in the form of an obituary of President Cope. At a meeting of the council letters were read inviting members of the American Association to attend the Toronto meeting of the British Association on the same terms as British members—namely, a guinea subscription; but the officers of the Detroit meeting of the American Association for the Advancement of Science will be made honorary members of the Toronto meeting. The American Association meets at Detroit on Monday, August 9, and the British Association at Toronto, Wednesday, August 18. The secretary was authorised to thank the British Association for their courtesy in extending the privileges of the meeting to the

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American Association, and also was requested to call the attention of the British Association to the provision which entitles all members of foreign scientific societies to honorary membership at the meetings of the American Association without payment of dues, and to invite them to attend.

Wator Power in America.—Mr. William Baxter, writing in the *Scientific American* on the utilisation of water power by electric transmission, gives some statistics as to the water-power plants at present existing in North America. One of the first installations of magnitude was the Hartford Electric Light Company, which was commenced in 1892. The capacity of this plant is over 1,500 h.p., and the power is transmitted over a distance of about 11 miles. Among the large plants installed since that time are one at Sacramento, California, which has a capacity of nearly 11,000 h.p.; one at Plezer, South Carolina, of 7,600 h.p.; Salt Lake City, Utah, about 7,000 h.p.; Columbia, South Carolina, 4,230 h.p.; Bakersfield, California, 3,420 h.p.; Montreal, Canada, 12,000 h.p.; Ogden, Utah, 11,000 h.p.; Hookset, New Hampshire, 3,000 h.p.; Fresno, California, 2,300 h.p.; Portland, Oregon, 4,600 h.p.; Minneapolis, Minnesota, 12,000 h.p.; and others. These plants are of large capacity, and represent in the aggregate nearly 80,000 h.p., but there are a great many smaller installations, ranging from 2,000 h.p. down to as low as 50 h.p. or 60 h.p. The total number of water-power plants now at work, or in process of construction, cannot be ascertained with accuracy, but it is known that there are over 200 light, power, and electric railway stations that depend exclusively upon this source of energy, and many others in which it is used in connection with steam-engines. As to distance of transmission, at Sacramento the length of line is 22 miles; at Fresno, it is 35 miles; at Ogden, 36 miles. The distance from Niagara to Buffalo is 21 miles. As to voltage, Mr. Baxter says in a large number of cases the pressure of the line current is 10,000 volts, and in Ogden, Utah, 15,000 will be used, and he considers that in the future still higher pressures will come into use.

Electric Ploughs.—Further particulars have been given in *L'Energie Electrique* as to the use of an electric motor instead of a steam-engine for hauling a steam-plough (for that is what it comes to) at Enguibaud. There is an electric lighting installation at the Château, so that what farm work is done may be looked upon in the light of a day load. The current is generated at 375 volts, and at this pressure 35 amperes are used when the share is working and 16 amperes when the plough is simply moved across the field with the share lifted. (This efficiency is not very brilliant.) It seems that 50 volts are lost in line drop with the 35-ampere and 25 volts with the 16-ampere current; but it is stated that 3·5 amperes (at 375 volts) are sufficient to run the motor unconnected. The soil was a sandy clay, and the plough seems to go fast and draw a deep furrow, but the nature of the work was evidently so different to ordinary English ploughing that it does not seem possible to compare it in any way either with horse ploughing or steam tackle as used in this country. Moreover, there is a roundness about the figures. Our Parisian contemporary, however, works out the figures to show 21 h.p. taken by the dynamo, which is driven by a turbine. Of this, 17 h.p. is transmitted to the overhead conductor, which has fallen to 15 h.p. by the time the current gets to the hauling windlass, and 12 h.p. on the plough rope. But, as has been remarked before, the motor is in the wrong place. It should be on the plough, and not at the headland, in which case there would be a great saving. According to the French figures, something like 5 h.p. of the 12 h.p. are wasted in cable friction when the plough is running light, and, of course, this would be greatly increased when the strain of the share was on the hauling rope. As, however the work is a day load on a water-driven generating station, the expenses are practically only the wages of the workmen and the interest and depreciation on the extra electrical tackle, so that it appears that Mr. Prat is able to make a success of the work from a financial point of view. At any rate, that is the belief of *L'Industrie Electrique.*

The Secrecy of "International" Telegrams.—It has not been necessary to commit the Eastern Telegraph Company, or its Board, or even its secretary to the Clock Tower, and the South African Committee has got its telegrams. The committee tried to trace the telegrams, and get them from the holders—not with success. In the alternative it went to the company for copies. The company naturally refused to disclose the secrets of its clients, and last Friday Mr. Moulton, Q.C., attended the committee to state the company's case. Mr. Moulton pointed out that under the Telegraph Convention originals and copies of telegrams could only be communicated to the sender or receiver or to their authorised representatives. The company had received letters from the agents of the sender and receiver directing them not to deliver the telegrams. Constitutionally, the powers of the House of Commons in a matter of this sort are pretty despotic, and in times of old have brought it into conflict with the Courts. (It was usually the unfortunate sheriffs of London and Middlesex who suffered.) But nowadays that sort of thing would be recognised as an anachronism. (We think more of common sense and less of the glorious British Constitution.) When in doubt ask the Attorney-General. The Attorney-General held that it was well established by the law of England that courts of justice were entitled to order a telegraph company or Post Office officials to produce telegrams or letters, and an order of a committee of the House of Commons had the same authority as an order of the highest court in the country. The objections taken by the Eastern Telegraph Company therefore ought not to prevail. The chairman of the committee then called for the telegrams, and they were handed over. The chairman said that nothing of them would be disclosed that was not material to the enquiry. As the persons involved are all British, there is hardly any question of a conflict of English law and treaty rights under the Telegraph Convention. But if we should ever have cause to protest against tampering with the inviolability of international telegrams, it may be quoted against us by the offending power; for where there is no court to decide, any "case," bad or good, is sufficient for a diplomatic justification.

An American View.—So much attention has been given of late to the progress of electric tramway work on the Continent, that it may be well to test our ideas on the subject by a comparison with the way in which the matter appears to the Americans with their larger experience of electric tramway work. The *Street Railway Journal* has devoted some considerable space to the subject. It expresses the opinion the electric practice in Europe ought to be the best in the world, so we have clearly in our contemporary a critic who will not be too easily contented with a low standard. To the American eye it would appear that on European tramlines the rails are generally too light. Many of the rail sections would not be tolerated in American streets because of the deep and wide grooves, which can hardly help being dangerous to carriages or even wagons. Often the fishing angles are poor, but this difficulty is more common with the older than with the newer types of rail sections, and may be trusted to cure

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itself as new rails are purchased. The joints, however, are in many cases distinctly poor, particularly where attempts are made to make three fits with the fishplates—a thing which can rarely, if ever, be accomplished in ordinary commercial rolling. "From the general appearance of the sections and from the replies received to the questions asked by us of the managers as to the expected life of rails and road-bed, it would seem that the joint difficulties found in electric railroading in this country have not been understood or appreciated abroad, but that more attention has been paid to providing sufficient wearing material in the head of the rail than to properly supporting the joints. Many of the companies are experimenting with a combination rail which has a large number of separate parts, including bolts and nuts and where seven fits are required. Such a complicated construction would hardly find favour in this country. As far as the substructure of the road-bed is concerned, this is usually very good. Beds of concrete or concrete stringers are used far more generally than in America, and metal ties are also occasionally met with. The result is, of course, an exceedingly solid and unyielding construction which answers well when car speeds are low. With higher speeds, however, it is generally conceded by American engineers that greater elasticity is needed in the road-bed in order to prevent disagreeable jarring vibrations of the cars. The overhead construction in foreign cities is undeniably good. The use of rosettes instead of poles for the span wires does away with the sidewalk obstructions, and as far as is known, there are no compensating disadvantages. The poles wherever used in the cities are of iron, and are more ornate in design than are commonly to be found in this country."

The Change Over at Montreal.—Mr. Browne's description of the transformation of the Royal Electric Company of Montreal's central-station plant, to adapt it to water power, generating from the Chambly dam, has been concluded in the *Canadian Engineer*. The change at the central station was made first, the dam being not yet complete, and the machines are still run by steam. The new generators are of the two-phase system, that being considered to afford the greatest facilities for a mixed service of incandescent lights, arc lights, and motive power. The generators, which are at present operated by the steam-engines, are intended to be operated by the electric current from the Chambly water power as motors, which will work the arc light dynamos for all the arc lights in the city streets and public places, as well as working direct-current generators supplying current for motive power. The circuits for direct-current motive power will be maintained, so that customers having direct-current motors available need not change them. Within the west station will be placed transformers to reduce the high voltage on the lines from Chambly to that used for distribution throughout the city. The other east-end station will be maintained in its present condition as a steam-generating arc station to be used as a relay or emergency station only. The steam-engines in the west-end station, which are doing the work until the transmission line power is available, will also be retained in their present position, and in the extremely remote contingency of an interruption from any cause in the delivery of the current from Chambly, the motors will immediately again become generators and perform the functions they are now fulfilling. With this arrangement there will exist a water-power plant and a steam plant, entirely independent of each other, thus ensuring absolute continuity of service. The change from the old system to the new was made without the interruption of the service to the 60,000 lights served. This entire change from the old system to the new (from the old to the new switchboard), was made within the period of 10 hours. The Chambly dam is still under construction. The hydraulic machinery there is to supply, if required, 20,000 h.p. to the generators when it is completed.

The Synchronograph.—In a paper read before the American Institute of Electrical Engineers, Messrs. A. C. Crehore and G. O. Squier described a proposal for a new method of rapid telegraphy, by which they hope to send and receive at something like 3,000 words per minute (over a land line). The proposal practically amounts to using alternating currents of a comparatively high periodicity and adopting some mechanism which makes it possible to make or break the circuit only when the current is (or should be) at its zero value, and thus entirely do away with "tailing." The "element" of the signals may thus be any odd or any even number of half waves. As a matter of fact, the breaks in the current used for transmitting the signals are made by covering portions of a metal wheel running synchronously with the alternator with paper or some other insulating material. (The precise mechanism adopted is evidently independent of the principle.) As a receiver, it is suggested by the authors that the rotation of the plane of polarisation of light under the influence of a magnetic field might be utilised to produce a "massless" receiver (whether it would be free from lag is another matter); but for practical purposes a chemical receiver is used, the prepared paper passing between a metal disc and a needle electrode. One needle would be sufficient if only whole waves are used, but if half waves are used there must be two needles side by side (needle-wheel-needle in series), so that the record comes on one side of the strip for the direct and on the other for the reverse current. So far, all is comparatively straight away. The authors, of course, know that the line has something to do with the possible speed of signalling, but the theoretic treatment of the matter is not gone into. What the authors have done is to try an experiment over 13 miles of land line. The experiment was made at the United States Artillery School at Fort Monroe, in Virginia. "In order to test this system over as long a line as was available, the land telegraph and telephone lines upon the military reservation at Fort Monroe were joined in series, making about 13 miles of iron wire having a resistance of 320 ohms. Not only was no difficulty experienced in transmitting and receiving messages over this line, but resistance was introduced making about 1,500 ohms total, including the polarising receiver coil of 390 ohms. This trial was at a frequency of about 200 complete periods per second. With the chemical receiver a coil of 10,900 ohms was used in the laboratory, and the record was plainly received at a frequency of about 545 complete periods per second." There is just a passing mention of the possibility of neutralising the effects of distributed capacity by introduced inductance, but the question of the effect of leakage (which may be variable) is not mentioned. The paper finishes with some remarks on the transformation that would take place in telegraphic business when such speeds as 3,000 or 6,000 words by duplexing became possible. The authors' idea is that the perforating and reading the strip will be done by customers at their offices as an adjunct to typewriting, instead of at the telegraph office, the latter merely transmitting the prepared strip. But one may wait for the adjustment of the apparatus to a really long line under ordinary working conditions before going into these matters.

Capacity and Time.—The results of the investigations of Dr. Hopkinson and Mr. E. Wilson into the specific

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inductive capacity of glass, ice, glycerine, and other dielectrics published in the *Philosophical Transactions* have been already noted. There is an introduction dealing with the nature of the quantities involved in the measured results—that is, the capacity proper, the residual charge, and the conductivity. When a thing is stated in the language of the integral calculus, it is not possible to go much further in the way of compression or give a summary. An expression for the electric displacement in the condenser, a glass flask (under a periodically varying E.M.F.) is obtained. On the assumption that $\psi(\omega)$, the coefficient determining the displacement which has reference to the residual charge, varies inversely as a fractional power of the time (t^m), the result comes out that if m is near unity capacity is almost entirely affected, but otherwise the effect is divided between the capacity and the conductivity, and there is dissipation of energy. "It is interesting to consider what sort of conductivity a good insulator—such as light flint glass—according to this view of capacity, residual charge, and conduction, would have at ordinary temperatures if we could measure its conductivity after very short times of electrification; if, in fact, we could extend the practice used for telegraph cables and specify that the test of insulation should be made after the one hundred millionth of a second instead of after one minute, as is usual for cables. The capacity of light flint measured with alternating currents with a frequency of two millions a second is practically the same as when measured in the ordinary way; that is, its capacity will be 6·7. Its index of refraction is 1·57 or $\mu^2 = 2{\cdot}46$, or, say, 2·5. We have then to account for 4·2 in a certain short time." The current is an alternating current, and it is assumed as an approximation that it will be the residual charge which comes out in one-sixth of the period which produces this effect on the capacity; therefore, taken over the period of one twelve millionth of a second $\int \psi(\omega)\, d\omega = \frac{4\cdot2}{6\cdot7} \times$ capacity of the flask as ordinarily measured. The capacity of a fairly thin flask may be taken to be 1/1,000 microfarad to 2/1,000 microfarad; hence we may take the value of the integral to be 10^{-9} farad; if $\psi(\omega)$ were constant during this time its value must be $12 \times 10^6 \times 10^{-9} = \frac{1}{80}$ oh^{1}ms$^-$ about. "The value of $\psi(\omega)$ is far from constant, and hence the apparent resistance of that extraordinarily high insulator, a flint-glass flask, must be for very short times, but still for times enormously large compared with the period of light waves, much less than 80 ohms. Somewhat similar considerations are applicable to conduction by metals. Maxwell pointed out that the transparency of gold was much greater than would be inferred from its conductivity measured in the ordinary way. To put the same thing another way—the conductivity of gold as inferred from its transparency is much less than as measured electrically with ordinary times; or the conductivity of gold increases after the application of E.M.F. Suppose then we have a current in gold caused by an E.M.F. which is increasing, the current will be less than it would be if the E.M.F. were constant, by an amount approximately proportional to the rate of increase." Prof. J. J. Thomson gives as a result of some experiments by Drude that the capacity of all metals is negative. This conclusion is just what we should expect, if we assume, as Maxwell has shown, that the conductivity of metals increases with the time during which the E.M.F. is applied.

Local Authorities and the Telephone Company. The ramifications of the Telephone Company's disputes are unending, but it is clear that the company has powerful friends. In the House of Commons last week, Mr. Lough, one of the members for Islington, asked the Secretary to the Treasury, as representing the Postmaster-General, whether he was aware that some want of agreement between the Post Office and the Commissioners of Sewers in London was causing great inconvenience and expense to private persons and firms, who were unable to get telegraph wires introduced or transferred to their premises by reason of the refusal of the Commissioners to allow the ground to be opened; and what the Postmaster-General would do to overcome the results arising from the disagreement. Mr. Hanbury admitted a knowledge of the inconvenience on the part of the Postmaster-General. After stating the answers of the Post Office in the matter, Mr. Hanbury said the Postmaster-General was "considering." This brought up Mr. A. Gibbs, who represents the City, to ask whether the Treasury would grant the enquiry into the matters in dispute that the Commissioners of Sewers had asked for. Mr. Hanbury did not think an enquiry was necessary. It really was a legal question. All this was more or less preliminary skirmishing. It is not till the next question that we come to what is really the matter or supposed to be by one of the parties to the quarrel. Mr. A. Gibbs asked whether it was not a fact that the disagreement arose from the Post Office having obtained permission to break the streets for their own purposes and having used it for the purposes of the National Telephone Company, and having refused to undertake that they would not again do so. Mr. Hanbury knew all about this, because he had made special enquiries. The position was that by an agreement made when the trunk wires were taken over from the National Telephone Company by the Government, it was stipulated under that agreement that the Post Office, should lay the main wires between the exchanges of the National Telephone Company at their own cost. That agreement was sanctioned by Parliament. If any wires in connection with the company were so laid by the Post Office the arrangement was strictly limited to those main wires. Then Mr. Lough cut in again with the remark that the difficulty of the Commission of Sewers was not confined to telephone wires. His question concerned telegraph wires. To this, Mr. Hanbury's answer was to lay down the proposition that if two sets of wires had to be laid, it was an advantage to the local authorities that they should be laid at the same time. But there are some people in this world who like to judge for themselves what is good for them, and however true Mr. Hanbury's proposition may be in the abstract, it is hardly an answer to a charge of asking permission for one thing and then doing another also. So far as the matter goes at present, the Commission of Sewers seems to display an inclination to stick to its guns, for at their meeting on Tuesday, when a letter was read from the Postmaster-General relative to applications for permission to open streets for telegraphic purposes, stating that he was unable to accept as a condition of the Commission's consent any restrictions as to the object for which the wires were to be used, on the motion of Mr. A. C. Morton, it was resolved that the Post Office authorities be again informed that the Commission would not object to their opening the streets for laying down telegraph wires for their own purposes, but that they still objected to giving any consent to wires being laid for the use of the National Telephone Company unless the latter were prepared to provide an improved service at a reduced cost, and so forth. The whole dispute is instructive in many ways. The position of the Post Office is one which it is hardly possible to come out of with any credit. If you ask a man or a commission for leave to lay down a wire for your own use, it is no "restriction" to say that it is for your own use, and not really for the use of somebody else with whom the man or commission happens to have a quarrel.

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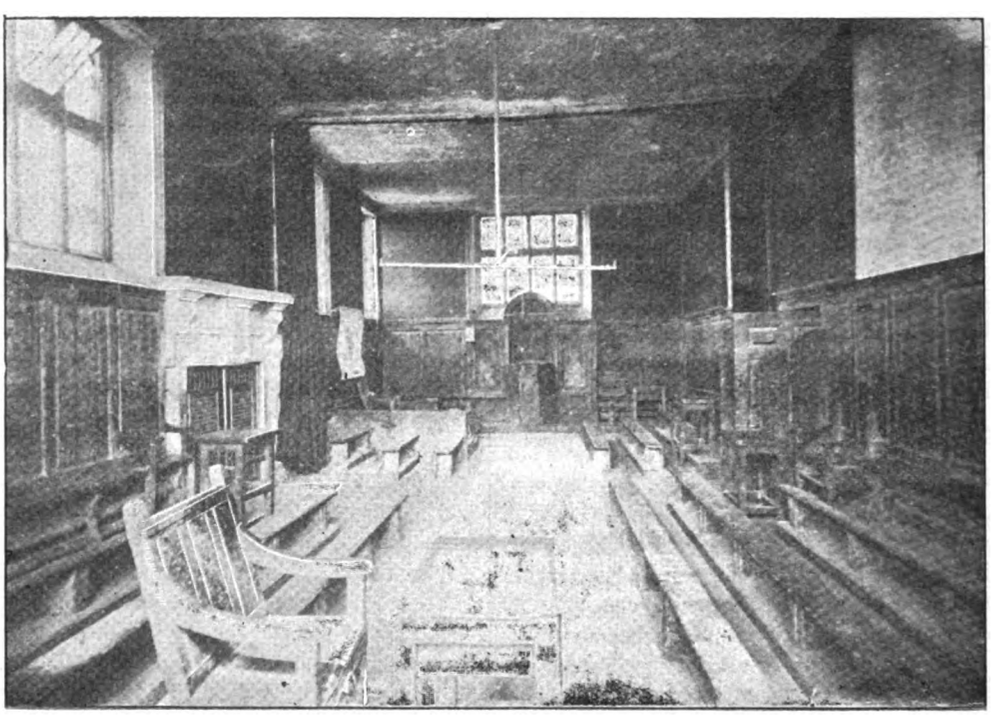
HARROW ELECTRICITY WORKS.

The Harrow School, founded in 1571 by John Lyon, has been for centuries the mainstay of Harrow-on-the-Hill. Even now the population of the town is under 9,000, although some high-class residential property has increased the population above that of past years. The schools have risen in popularity till it is now a matter of difficulty to get boys in unless very early application is made. The fourth-form room, which we illustrate, has at different times been used by some of our most prominent statesmen and public men.

MR W. C. C. HAWTAYNE, CONSULTING ENGINEER.

MR. C. D. BRADDON, RESIDENT ENGINEER.

The electric light question at Harrow has been for several years of burning interest, and has passed through many phases. Thus, in June, 1893, a company gave notice to the Local Board that they intended to apply for a provisional order. Dr. Stiven and two other gentlemen looked into the matter, and it was decided that the Local Board should itself apply for an order. This was done, but opposition at once became felt. One promising feature of the proposal to supply electricity in Harrow was that many of the housemasters of Harrow School had desired to give their boys the many benefits of the electric light, and two of them had for some years done so by private installations of their own. But the houses and school buildings are scattered, and overhead wires are very properly disallowed. The public streets could not be utilised for mains, except by a company properly authorised by statutory power and able to supply the current to the public in general. The school authorities were therefore glad to promise their support to the enterprising members of the Harrow Local Board who, in 1894, proposed to put their provisional order in force. Advice and a carefully-prepared estimate was then obtained from Mr. W. C. C. Hawtayne, now engineer to the present company, who recommended a scheme for a central station, to be worked by the municipal authorities, near the Metropolitan Railway, capable of lighting the streets, the schoolhouse, and the town in general. That the scheme was a sound one, beneficial to the town, and sure to be profitable, is now proved by the success of the present company and by the remarkable correspondence between the figures



The Fourth Form Room at Harrow before the introduction of Electric Light.

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supplied by the facts with those of Mr. Hawtayne's estimates. Mr. Hawtayne said, for instance, that electricity at 8d. a unit was a little cheaper than gas at 4s. 3d. (the Harrow price), and wherever the electric installation has been confined to replacing gas points by incandescent lamps the electric light bill has been lower than the previous gas bills. Mr. Hawtayne estimated the cost of coal at rather more than 1d. per unit; at the Harrow station, when the output exceeds 1,000 units a week, the cost averages less than 1d. Mr. Hawtayne said the total cost of production, exclusive of rent and maintenance, would be 2·88d. per unit; the cost works out at Harrow at 2d., when the output rises to 1,200 units a week.

The scheme of the Board was, however, emphatically rejected by the ratepayers, who were led by wiseacres who, acquiring a little knowledge of many subjects, are apt to form a completely erroneous judgment upon them all. Dr. Stiven had taken a most active part in trying to get the Local Board; Mr. E. R. Bartley Dennis, a well-known resident, late chairman of the Hendon Local Board, and member of the Middlesex County Council; and Mr. F. S. Winkley. The secretary and solicitor is Mr. R. E. H. Fisher, and the engineer Mr. W. C. C. Hawtayne, to whose ability and advice the success of the company is largely due. The capital of the company is £25,000, of which £10,000 in ordinary shares and £5,000 in 4 per cent. debenture bonds have been issued. The directors were advised to adopt the low-pressure direct-current three-wire system, having secured a site in the centre of the town within less than a mile radius of all the quarters of the district. By July, 1895, the necessary capital was promised locally and an estimate accepted from Messrs. Crompton and Co. for station and mains, and the directors hoped to have the installation complete within the year. Unfortunately, it seemed good to the party in the town which had successfully opposed the scheme promoted by

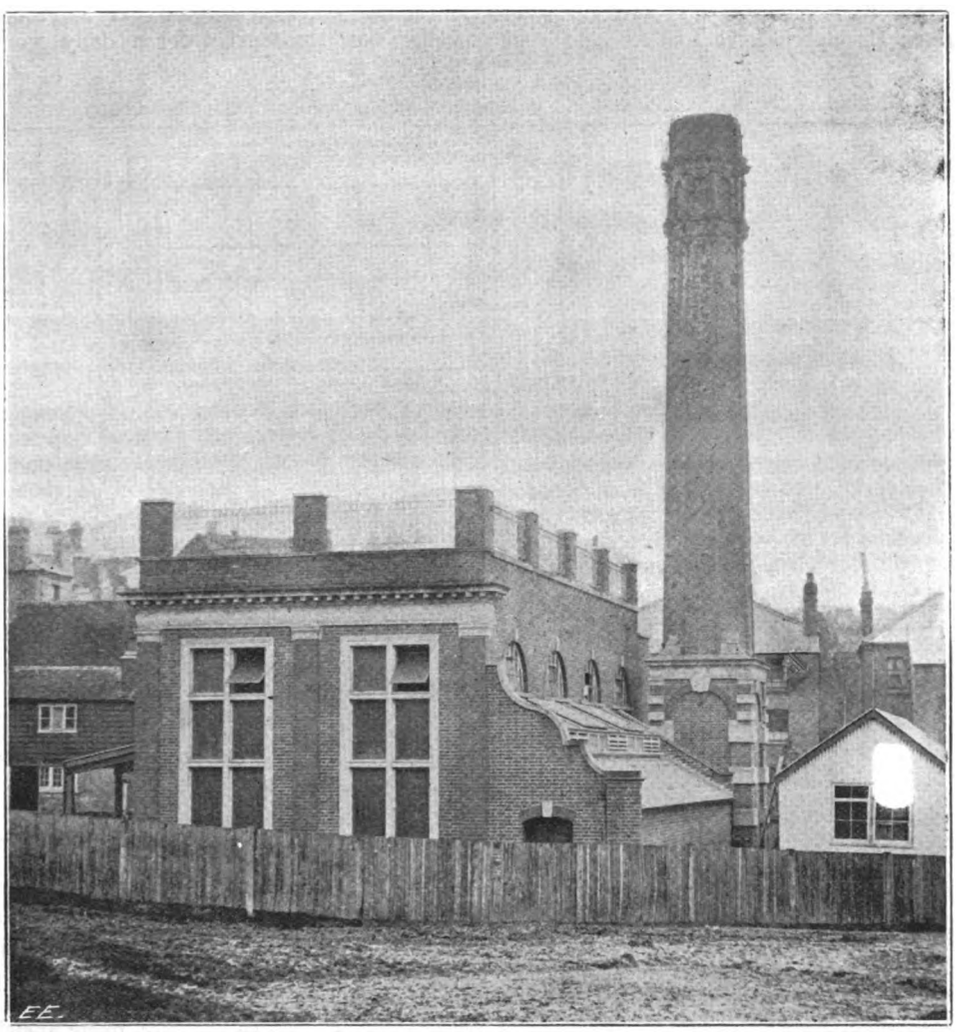

FIG. 1.—View of the Harrow Electric Light and Power Company's Station.

matter through, and on his advice being thus rejected, he resigned his seat on the Board. The points taken up by the opposition are too numerous to give at length, but one cry was that the undertaking could not pay, and that the ratepayers would be providing the schools with light at a loss. Another leader of the opposition said that he would prefer a company to take the risk. The next move was an offer made by Messrs. R. E. Crompton and W. C. C. Hawtayne to the Local Board for the order. It was eventually agreed to transfer the same for the exact expense that had been incurred, subject to repurchase in 21 years of the undertaking as a going concern by the Board.

The present company was then formed to take over the provisional order, and to carry out for the benefit of the shareholders the enterprise which ought to have been worked for the benefit of the ratepayers at large. The directors of the company are Messrs. C. Colbeck (chairman) and R. C. Gibson, two of the assistant masters at Harrow School; Dr. E. W. F. Stiven, late chairman of the Local Board to object also to the proposed supply o electricity by a private company. The reasons put forward by this party were to most men incomprehensible, and were set aside after a courteous hearing by the Board of Trade. But their proceedings entailed great expense and delayed the operation of the company for a year, so that the station was not in working order until September, 1896. In the meantime the Board of Trade, by the alteration of their rules, had allowed a pressure of 440 volts in low-pressure mains instead of only 220, and this double pressure was adopted by the company. As is well known, the saving on the copper in the mains on this system is large, nor has any difficulty been found in insisting upon the special fittings which the high pressure necessitates in the houses using the light. The company started with a demand equivalent to some 3,600 8-c.p. lamps, and the demand has grown since at the rate of some 40 lamps a week, so that over 4,000 lamps are now connected. We understand that about 1,000

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more are on order. The earnings for the first quarter amounted to £644 without meter rents, and, so far as can be judged, the earnings for the supply of current alone will amount this year to at least £2,000, with every prospect of a steady increase. The company have adopted a system of wiring houses up to 40 points themselves on a hire system, charging 1s. per annum for each point as rental, the fittings remaining the property of the company. The work is done for the company by a well-known contractor at a price he has every reason to be satisfied with, and as a result the workmanship can be depended upon. There are already a large number of consumers taking the light who have adopted this system, and who would not have come on so soon had initial outlay been required. The demand for light has exceeded all expectations, and the station plant will shortly be doubled in capacity. The mains are in the meanwhile being rapidly extended. The whole of the work has been done by Messrs. R. E. Crompton and Co., under their able engineer, Mr. H. Hew Stevenson, the other firms mentioned below being sub-contractors. Messrs. Crompton have had as local superintendent of the work Mr. E. C. Mann, while Mr. C. D. Braddon is now acting as resident engineer for them.

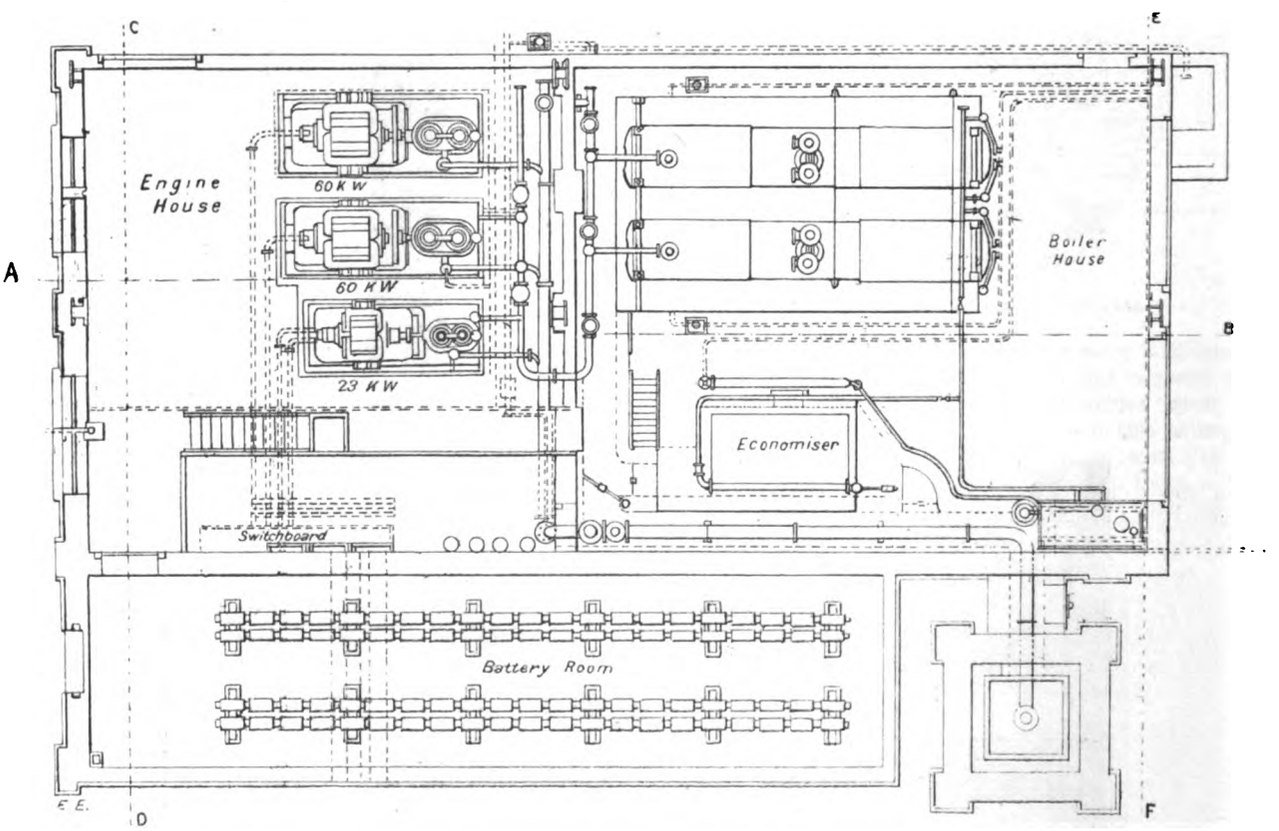

FIG. 2.—Plan of the Harrow Electricity Works.

Buildings.

A most convenient site at the foot of the hill on which the schools are built was chosen and acquired for a reasonable figure. The only stipulation in the use of the site was that a handsome building and chimney shaft should be erected such as would not detract from the view from the hill-top. The architects, Messrs. Hesketh and Stokes, are to be commended for the good appearance of the station. Fig. 1 shows the general outside view of the buildings, which are of red brick faced with stone. The roof of the building is flat, and is constructed of iron girders and concrete. The upper surface is asphalted and is used as a water-reservoir. The arrangement of the station and plant can be seen in Fig. 2. Sectional elevations of the boiler and engine rooms are also given later on. The shaft is some 80ft. high, and is lined with Stourbridge firebrick for the first 20ft. inside. The coping, etc., at the top is of brown Portland stone, while the chimney is capped by sectional iron castings weighing some 9cwt. The engine-room is provided with an overhead traveller, which will be even more useful when the additions now in hand are completed. The chief features of the building are perhaps, after all, their unobtrusiveness and their convenience for the purpose intended.

Boilers.

These were supplied by Messrs. Babcock and Wilcox Limited, and are of their water-tube type. Two boilers are at present installed, as can be seen in Fig. 2 (the plan of the station) and in Fig. 3 (the elevation). The boilers have each 735 square feet of heating surface and 16·33 square feet of grate area. Each boiler is composed of 40 tubes, 4in. internal diameter and 14ft. long, connected to a steam and water drum 36in. diameter and 19ft. long, made of $\frac{11}{32}$ steel plate. The tubes are arranged in five sections, and are connected at the ends by continuous staggered headers. The mud drum is 8in. diameter and 39in. long. The two boilers are supported on wrought-iron columns, so that the weight is not taken by the firebrick seatings. Each boiler is provided with the following fittings: a Turnbull dead-weight safety-valve, steam-gauge, two water-gauges, two check-feed valves, a blow-off cock, and stop-valve, etc. The boilers are constructed for a daily working pressure of 180lb. per square inch, and were tested by hydraulic pressure, before setting to work, to 270lb. per square inch. Each boiler is guaranteed to evaporate 2,000lb. of water per hour at the above pressure, using Welsh coal. As will be seen in the drawing, the flues to the shaft are above ground. This is so arranged on account of the large amount of surface water found when putting up the buildings. The hill on the side of which the station is placed consists chiefly of clay, and hence in wet weather there is a large amount of surface water descending through the upper layers of the ground. On a 7½-hour test these boilers were found to evaporate 10·93lb. of water from and at 212deg. F. per pound of Welsh coal, of which some 9¼lb. were burnt per hour per square foot of fire-grate.

In the main flue is placed a Green's fuel economiser, such as have often been referred to in our columns when describing other electricity works. The economiser consists of 72 4½in. tubes 9ft. long, arranged in 12 sections of six each, and is of the strengthened high-pressure type, the top boxes being fitted with patent internal lids. The scrapers are in this case driven by a Crompton motor, placed on a bracket on the boiler-house wall. The speed is reduced by two steps by the use of a countershaft, as can be seen in Fig. 3. The two feed-pumps were manufactured by Messrs. Henry Watson and Son, of Newcastle-

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on-Tyne. The pumps are of the vertical duplex type, and are well made throughout, most of the parts being of gun-metal. They are each capable of supplying 4,000lb. of water per hour against a pressure of 180lb. per square inch with a piston speed under 75ft. per minute. The con-

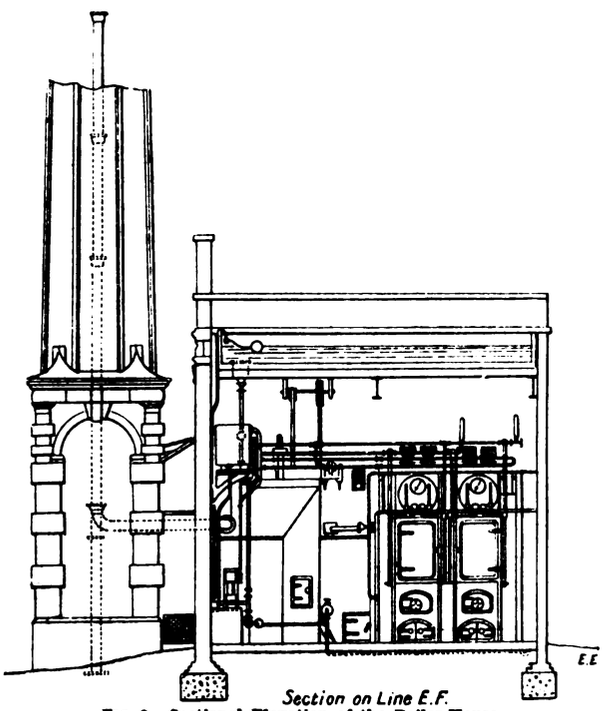

FIG. 3.—Sectional Elevation of the Boiler-House.

nections to these pumps are arranged in duplicate, so that either pump can supply water to the boilers drawn either through the economiser or direct from the tank on the roof referred to previously.

Steam and Exhaust Pipes.

The steam-pipes are designed on the ring system, and the plant is conveniently arranged to suit this. The main steam-ring is of 4in. pipes, and these pipes are of copper throughout, with steel flanges. The valves, which are of the Hopkinson type, provide ready means for isolating a leaky joint, should one occur. The method of hanging the pipes is good, as the suspending on brackets allows of free expansion in any direction. We are informed that the spring between the supporting rods and the bracket has given no trouble due to vibration when the engines are running. The steam-pipes are well lagged. The exhaust-pipe is 8in. diameter, and at present delivers directly up the shaft. Arrangements are, however, being made to instal a Ledward evaporative condenser on the flat roof of the buildings. The exhaust-pipes are of cast iron. All the pipes were tested before being accepted, the steam-pipes being subjected to a pressure of 300lb., and the exhaust-pipes to 100lb.

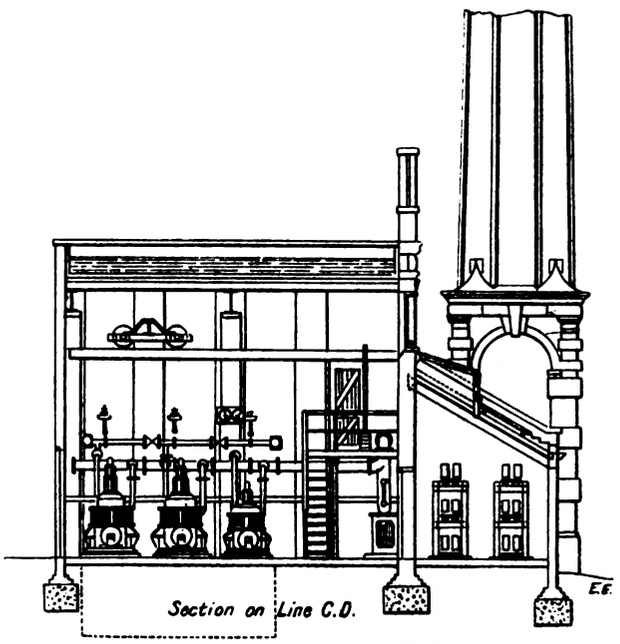

FIG. 5.—Sectional Elevation of the Engine-Room.

Engines and Dynamos.

The engines at Harrow were supplied by Messrs. Willans and Robinson, of Rugby, while the dynamos were manufactured by Messrs. Crompton and Co., of Chelmsford, the contractors for the whole of the station. The first contract was for two sets—one of 23 kw. output, and the other of 60 kw. When the load was found to increase so rapidly in the autumn, the directors, under the advice of Mr. Hawtayne, decided that a stand-by must at once be installed, and hence a second-hand Willans-Elwell-Parker set was bought, as it could be delivered promptly. This set is also of the 60 kw. size, and the dynamo is likely to be replaced by a new one by Messrs. Crompton and Co. at an early date. The largest engine in the original contract is the G.G.S. type, with three cylinders 7in., 10in., and 14in. in diameter respectively in each line. The length of

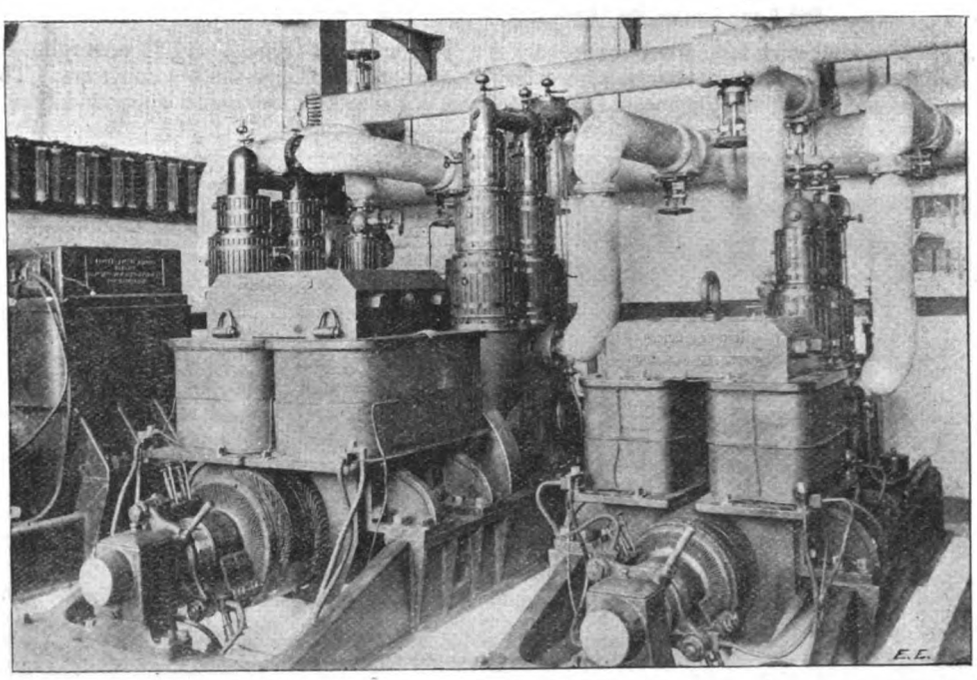

FIG. 4.—General View of the Steam Dynamos at Harrow.

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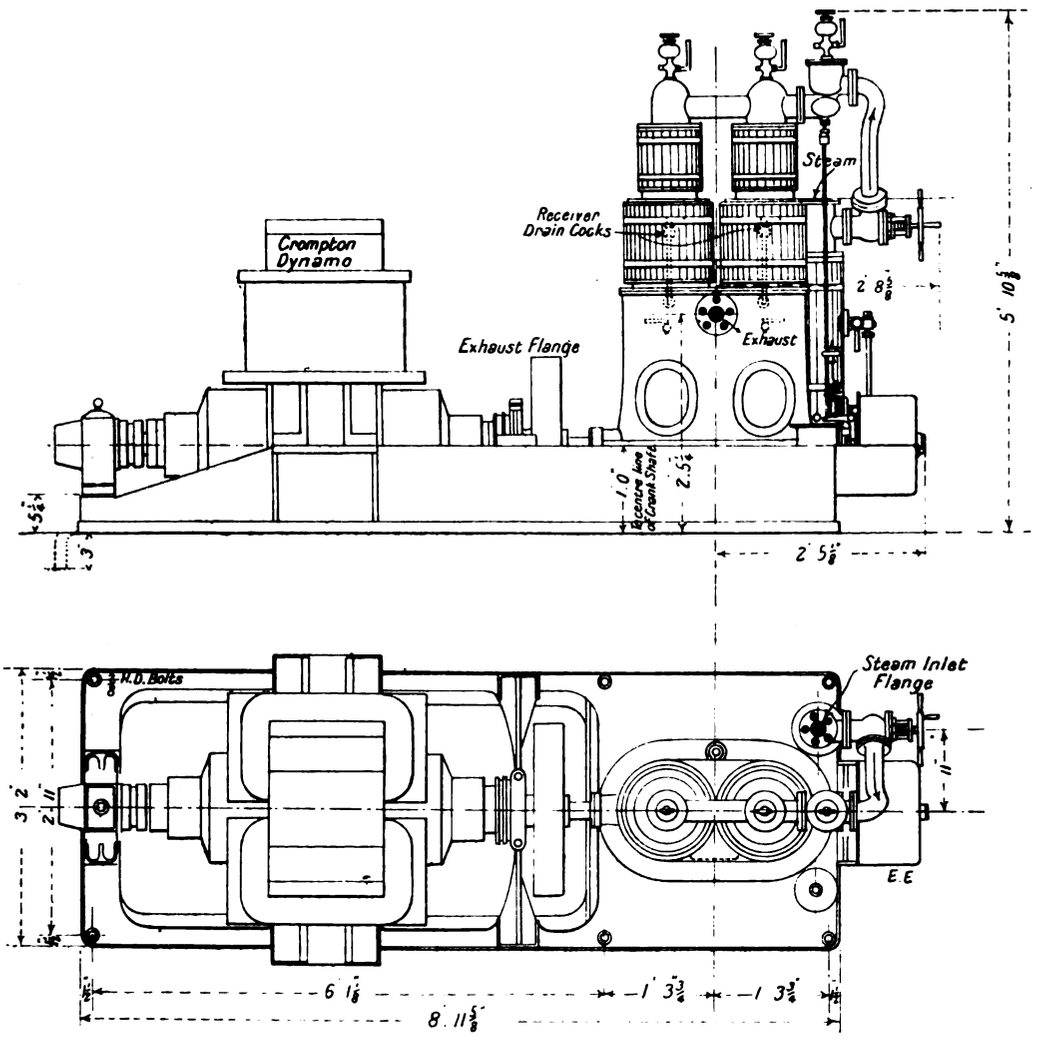
stroke is 6in. At 460 revolutions this engine is capable of indicating 100 h.p. when supplied with steam at 180lb. and condensing. It is coupled direct to a Crompton drum-wound dynamo, having an output of 132 amperes at 470 volts. The armature is wound with laminated conductors, which are bent round to form end connections after the "cylinder" fashion. The commutator is so connected that the brushes are horizontal, as can be seen in Fig. 4 and in Fig. 5, which gives a detailed elevation of the engine-room. This set, when tested, was found to have an over-all efficiency of 83 per cent., and the temperature limit of 70deg. F. was not exceeded after the 7¼ hours' run. This unit of plant is used to supply the two outside wires of the three-wire network



FIGS. 6 AND 7.—Plan and Elevation of the 23-kw. Duplex-wound Steam Dynamo.

The small set (Figs. 6 and 7) is employed to balance the system and to charge the accumulators. The engine is of the Willans E E two-crank compound type, with cylinders 10in. and 7in. respectively. The stroke of the piston is 5in., and the engine runs at 520 revolutions, indicating when condensing some 38 h.p. The dynamo coupled to

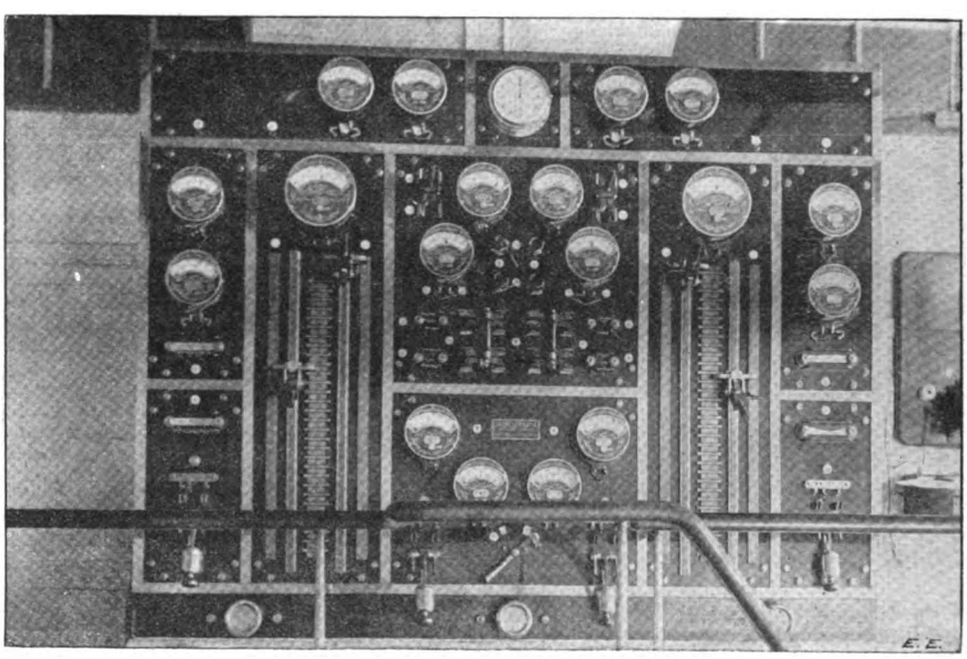


FIG. 8.—General View of the Harrow Switchboard.

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this engine has a duplex-wound armature and two commutators, so that each circuit can supply one side of the three-wire system or can charge one set of accumulators. The capacity of each armature circuit is 37 amperes at 310 volts. There are two pairs of 1½in. brushes to each

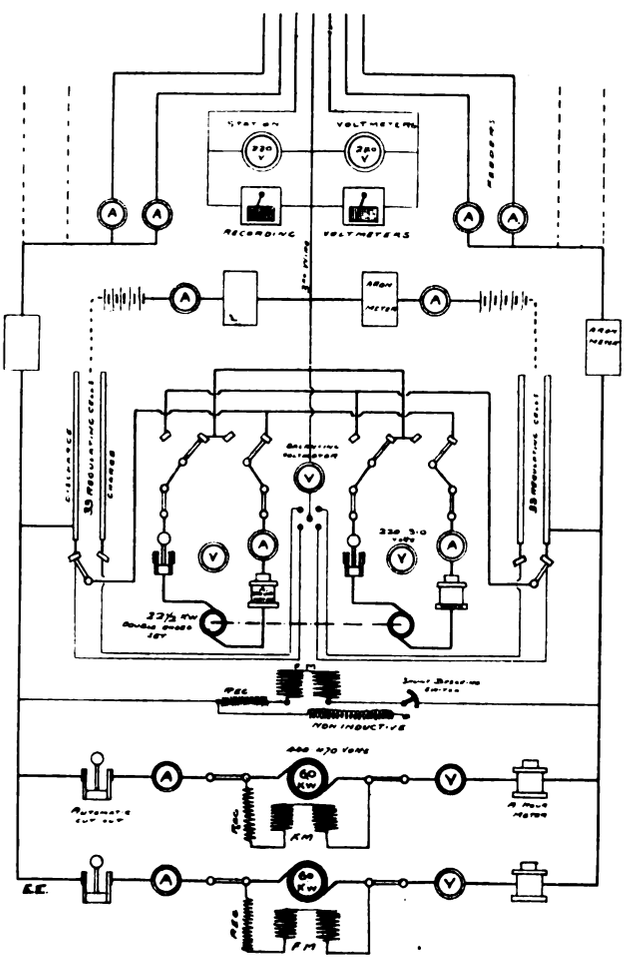


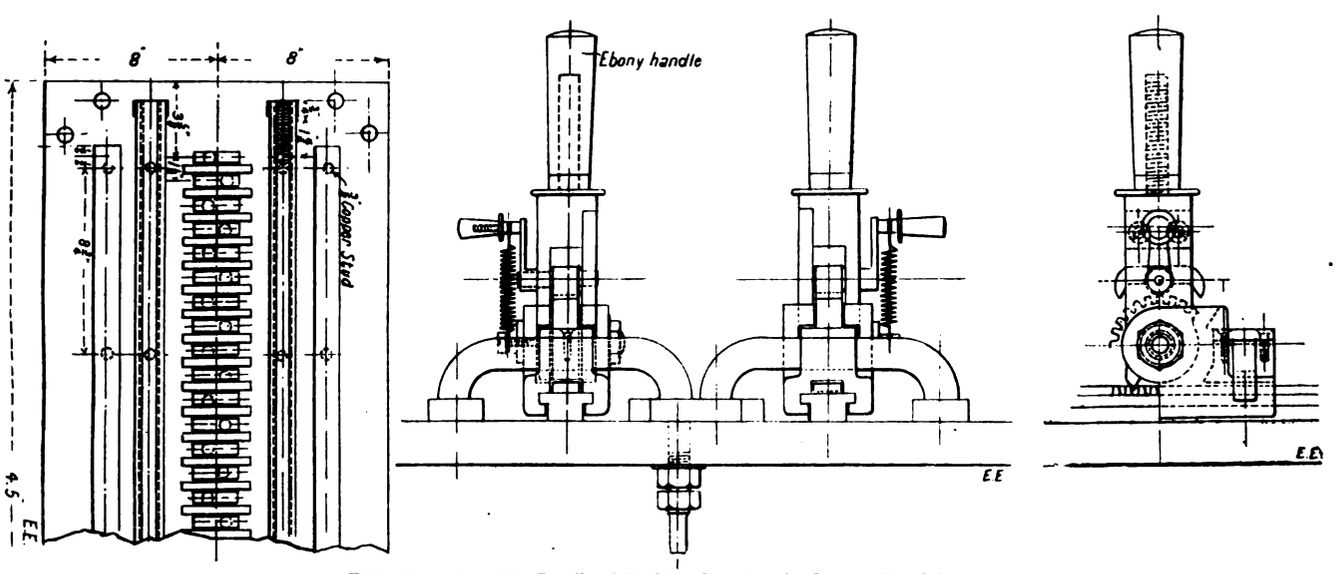
FIG. 9.—Diagram of Switchboard Connections..

commutator, and on this machine also the axis of commutation is horizontal. The efficiency of this set $\frac{\text{E.H.P.}}{\text{I.H.P.}}$ was found to be 82 per cent. on trial, although only 77 per cent. had been guaranteed.

proof. The main frame is of heavy iron strip, and to this are riveted angle irons to form supports for the slate slabs. The junctions between adjacent slabs are covered by polished brasswork, as can be seen in the illustration (Fig. 8). The whole board is placed on a concrete footing. The four automatic switches are placed at the bottom of the board. The instruments used to measure the various

FIG. 13.—The Accumulator-Room at Harrow.

voltages and currents are of the Weston type. The racking gear for regulating the charge or discharge circuits of the accumulators is very neat. We give details of this gear in Figs. 10 to 12. The panel shown to one side of the handle can be set to gear either way, so that one stroke



FIGS. 10, 11, AND 12.—Details of Racking Gear for the Battery Regulators.

Switchboard.

The switchboard (Fig. 8) is placed in the gallery in the engine-room so that the operator can conveniently see all that goes on below. The diagram of connections (Fig. 9) will be interesting to all our readers as showing how the duplex or balancing generator is connected up. The switchboard itself is well designed, and is absolutely fire-

of the handle shifts the contact bar one step either up or down. Between each pair of contacts for two adjacent cells there is placed a long thin brass strip, which is connected by a resistance to one of the contacts. This reduces the spark on shifting the bar. The whole of the instruments are at a convenient height for reading, and the board generally is exceedingly well arranged.

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Accumulators.

There are two sets of accumulators at Harrow, each set containing 122 cells. Each cell consists of seven plates contained in a glass box 6½in. long, 14in. wide by 12in. deep. The capacity of the cell is 210 ampere-hours when discharging at 42 amperes, and they will also give 105 amperes for one hour on emergency. Fig. 13 shows the arrangement of the cells and stands, together with the lead-covered leads going from the regulating cells to the switchboard.

Mains.

The map (Fig. 14) shows those streets in Harrow in which mains have been laid, and from it the central position of the station can be seen. Two feeders now run from the works to the points marked A and B in the plan, while another feeder to C will shortly be put down.

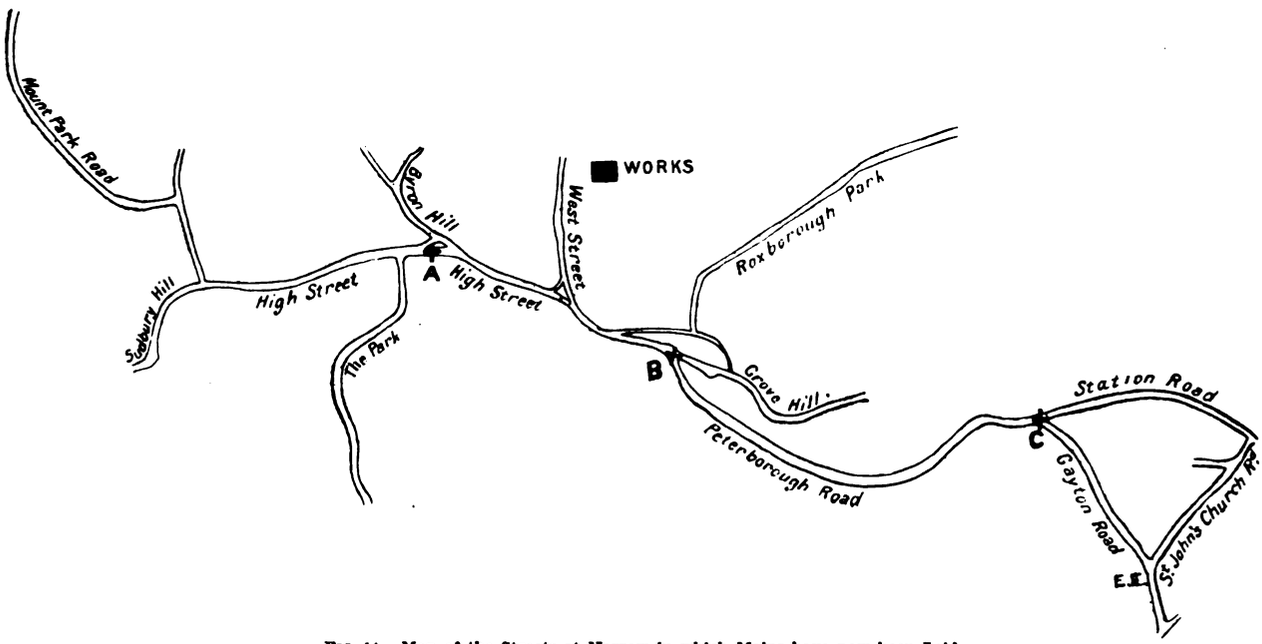

FIG. 14.—Map of the Streets at Harrow in which Mains have now been Laid.

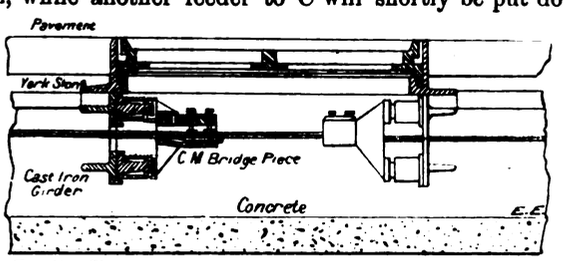

FIG. 15.—Street Box and Straining Gear of the Crompton System of Bare Copper Mains.

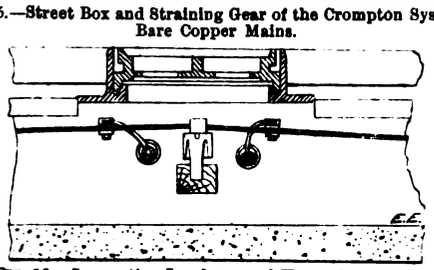

FIG. 16.—Supporting Insulator and House Connections.

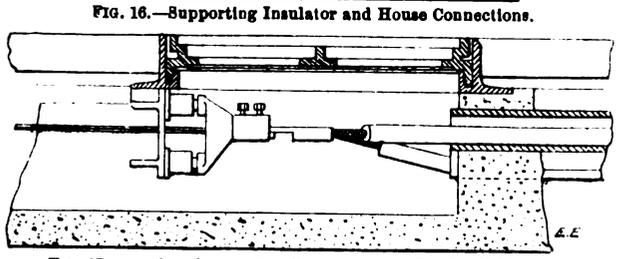

FIG. 17.—Section showing the Change-over to Insulated Mains in Crompton-Davis Culverts.

These feeders are two-wire only, and the balancing between two sides is done wholly at the station end of the network. Wherever there is room under the pavements, Crompton culverts have been laid with the well-known Crompton system of strained bare copper mains. In other places, Callender cables have been drawn into Crompton-Davis iron conduits. The culverts are arranged for three, five or seven conductors, varying in width from ·9in. and ·15in. up to ·20in. respectively. Sections of the bare copper system of mains as improved and laid at Harrow are shown in Figs. 15 and 16, while Fig. 17 shows the change over from the conduit to the insulated wire. Fig. 18 is a general view of a length of the main. The concrete culverts are substantially constructed, have walls 6in. thick of 6 to 1 concrete, and the bottom 4in. deep with the same material. The conduits are finally rendered with fine cement and covered by York stone. It will be noticed that the insulators taking the strain are of novel form. These were made by

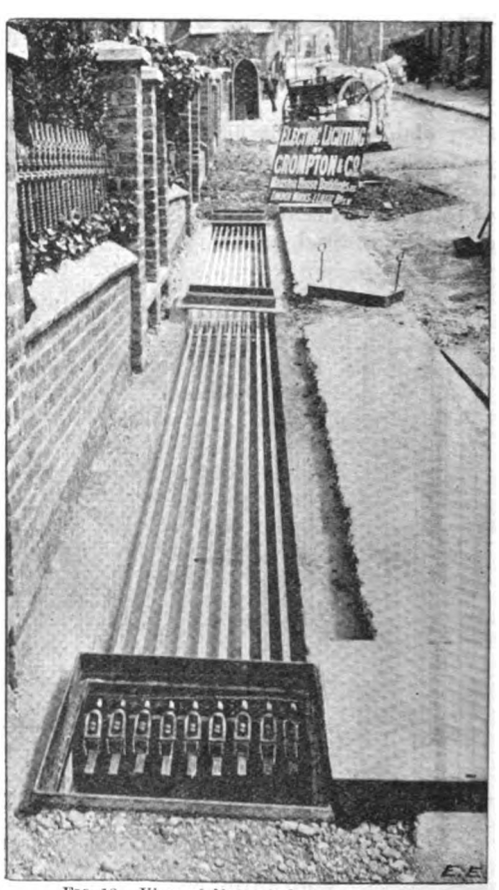

FIG. 18.—View of Mains before covering in.

Messrs. Doulton and Co., of Lambeth, and give great strength as well as good insulation. Then the average crushing pressure of a set of these insulators was found to be 18,200lb., although the section taking the strain is only 1¼in. diameter, or 1·23 square inch. Similar insulators were supplied for a section of mains in Manchester last

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year, and Mr. Wordingham wrote in February to Messrs. Crompton and Co., giving the insulation resistance after eight months' working. The length tested was 78 yards, and this was of a five-wire section. The following are the figures of the test:

	+ pole of battery to earth.		− pole of battery to earth.	
+ wire	163·3	megohms	122	megohms
2nd ,, ...	73·9	,,	57	,,
O ,, ...	42·3	,,	34·1	,,
4th ,, ...	36·5	,,	36·1	,,
− ,, ...	28·5	,,	23·4	,,

The method of taking off house connections is shown in Fig. 16. The insulators supporting the copper strip at intermediate points are not supported on wood bearers, as shown in the section. Galvanised iron bearers with projecting pins are used instead. A petticoat insulation is then slipped on the iron after a rubber tube has been put on to give adhesion. A gunmetal cup on the top of the insulator then forms the groove to hold the copper strip in position. The straining insulators rest against cast-iron girders on rubber pads. The details of the surface boxes can also be seen in the sectional views.

The insulated wires supplied by the Callender's Cable and Construction Company are of the vulcanised bitumen type. The insulation resistance guaranteed was 150 megohms per mile, and the cables were warranted for a pressure of 500 volts. The following lengths of different sections have been supplied up to the present: of ·250 square inch section, 1,110 yards; of ·125 square inch, 6,900 yards; of ·062 square inch, 1,100 yards; and of ·032 square inch, 1,000 yards. These cables are drawn into Crompton-Davis culverts. The ends in the boxes have the ends of the insulation tapered down to a long cone, and then painted over with box compound. The Callender Company also supplied 600 yards of triple-core pilot cable. The cable had three cores of $^{7}/_{\cdot 038}$ diameter wires laid together and packed up circular. The whole was then braided together and lead covered. These cables are used to indicate the pressures on the network at the feeding points. At present the farthest consumer is a mile from the station. In the opposite direction three-quarters of a mile of mains have been laid.

Working.

The station is at present being worked by Messrs. Crompton and Co. on a five years' agreement on the following terms: The units measured at the consumers' meters are added up, and the company pay the contractor 2d. for every unit thus sold, together with a lump sum of £450 per annum. These are most reasonable terms, and yet we understand that the contractors are by no means dissatisfied with their bargain, which of course includes the necessary repairs to plant. The photographs illustrating the above description are from negatives taken by Mr. H. Senier on Eastman films.

As we mentioned above, Mr. R. E. H. Fisher, the secretary, had a large share of the work in promoting the company. We consider that the results already obtained justified the course taken, and that the fact of the company's shareholders being local men removes a great objection to the electric lighting undertaking being out of the hands of the municipal authority. As a local office for the company, a cottage adjoining the station was taken, and the first floor removed. It was then found that the building was an old court of justice, called the "Pye House" in ancient documents. The oak beams and roof details are worth inspecting. We are sure, from the names of the directorate, that the company will uphold the associations of their offices. Mr. W. C. C. Hawtayne is also to be congratulated on the results obtained by this his first complete scheme for town lighting, and we trust that the other commissions he has in hand for lighting Barking, Maidstone, etc., will be equally successful.

Society of Arts.—Sir David Salomons's paper on Wednesday was a long one, and besides motor vehicle dealt with some questions of patent law. Mr. Fletcher Moulton presided, and there was as much discussion as time allowed. It is hoped to deal further with the matter next week.

THE MECHANICAL CONSTRUCTION OF ELECTRICAL MACHINERY.

BY F. M. WEYMOUTH.

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The Dynamo.

(Continued from page 584.)

Foundations (continued).—Having treated so far on the holding down of electrical machinery on land, we may now give some consideration to the fixing of such on board ship. The conditions in this latter case are, of course, very different to those in the former. On the land it was a question of obtaining a foundation of sufficient mass and rigidity to overcome vibration, set in ground that might contrariwise be comparatively more or less soft and unstable, and bolted up to the bed-plate (to express it inversely) so that it might, as it were, form part of the same general structure with the bed-plate and machinery.

Now in the case of a dynamo and engine on board ship, we find that the vessel itself already constitutes an approximately rigid structure, though exposed to all manner of motion, and liable to shocks and vibrations from a variety of causes. These may be said to be commensurable with the size of the ship, such as the working of its propelling machinery, or the firing of the heavy guns on a battleship; or there may be other causes, such as large waves, which are more incommensurable, inasmuch as their size and power render the inertia of the vessel in comparison of no account. Yet sources of vibration, which, in respect of the size of the ship, are of quite minor consequence, its inertia due to its total mass as one complete structure, is quite able to overcome. In other words, in the case of a dynamo and engine, the ship is itself a more than sufficient foundation. The necessity alone remains, therefore, to bolt the plant, whether combined or belt driven, direct to some portion of the ship in such manner as may be most convenient.

On board a modern man-of-war it is usual to set apart a room somewhere especially to contain the electrical apparatus; and therein consequently all, or nearly all, this machinery is installed, together with the main switchboards and meters and so forth. If not below the water line, it is at least behind the heavy armour. On merchant vessels the electrical machinery is perhaps most commonly to be found either in the main engine-room, or in some recess leading therefrom. In all cases, however, that at least have come under the writer's notice, the electrical generating plant has been bolted down either to the deck or to some bridge or shelf of corresponding nature. This latter remark is added inasmuch as the feasibility appears to be becoming gradually recognised in practice of making dynamos and motors (the latter more especially, perhaps) with the armature rotating on a vertical or inclined axis, and having, of course, a footstep bearing at its lower end. Such a machine is then affixed by bolting or clamping to a side wall or a column. It would thus at least seem reasonable to suppose that in many cases on board ship it would save space—always a great point at sea—if the electrical generating plant, at any rate when small, were so designed that it could be bolted directly to the side of the ship, or to some sufficiently rigid bulkhead, after the manner of a donkey pump, and with an armature rotating not necessarily on an horizontal axis.

In Figs. 186 and 187 herewith are indicated two methods of bolting the bed-plate of a combined plant to a ship's deck. In these the thin plating, *a a*, shown in section, is the deck, supported by rolled Z angles below, all of which form part of the structure of the ship. To prepare a seating for the bed-plate, a plate about $\frac{1}{2}$in. thick is put down as shown, *c c*; and above and around the periphery of this plate a frame is placed made of L angle iron, say about 6in. by 3$\frac{1}{2}$in. by $\frac{1}{2}$in., bent round, and the joint where the ends meet, welded. This frame and the plate are riveted or bolted to the deck, the fastenings passing through the upper flanges of the Z angles below. Within this frame a pitch-pine bedding, *n n*, about 3in. thick, is laid down, cut and carved to an exact fit. On the wood is laid lead "flashing." This is sheet lead about $\frac{1}{8}$in. thick laid flat all over the wood, and

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the edges brought up over the edge of the iron frame, as shown, *e e*, and all corners and joints soldered up. The bed-plate is deposited on the lead; and the bolt holes having been prepared in due course, the bolts are passed through, and all made secure. It will be noted in Fig. 186 that the bolts pass through, and take their purchase from, the upper flanges of the deck beams, as at *b b*. The lead flashing over the edge of the iron frame thus forms a trough all round to catch waste oil, and prevent it running over the deck. To this end, and to deter the oil from

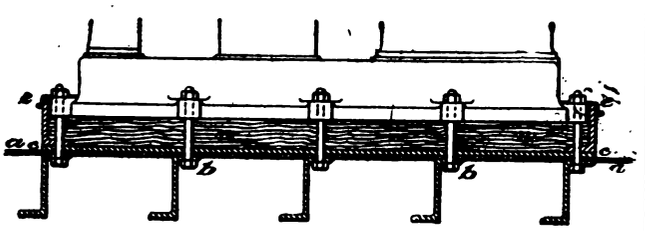

FIG. 186.

getting down the bolt holes, it must be seen that the joint between the bottom of the bed-plate and the lead is made oil-tight. A small tap is put through the frame and lead flashing at one side or end where convenient, to enable the oil to be drained away.

The above arrangement, however, has the disadvantage that either the bosses on the bed-plate for the holding-down bolts may not agree with the angle irons below; or else, a template must be prepared beforehand on which the positions of the bolt holes may be marked off to suit the deck beams, and then with this template as a guide, the bosses can be placed on the pattern of the bed-plate before casting, so as to correspond. This latter method, however, is not convenient if there is a possibility of the position on the ship's deck being subsequently altered. A modification thus is shown in Fig. 187, which gets over these difficulties. As will be seen, this consists in bolting a plate, *m m*, about ¾in. thick, to the undersides of the Z deck beams. The bed-plate—its position having been marked off so that none of the bosses come exactly over the vertical webs of the deck beams—is then bolted down to this plate. Pieces of gas-pipe are first slipped over the bolts, as shown in section respectively at *r*, *s*, and *t*. These are made a tight fit between the plate below and the deck or flange above. The effect of this is to cause the grip of the nut when tightened to come on surfaces in contact exactly between the bolt head and the nut, and permits the nut to find a hard rigid seating without spring. Otherwise, without the tubing, in the case of bolt *t*, its pull would tend to distort the deck beam, *v*; and at *r* the bottom plate would give upwards. It may be remarked that with the tubes on, the bolts *s* and *t* have a more solid grip on the deck than the bolt *r* on account of their proximity to deck

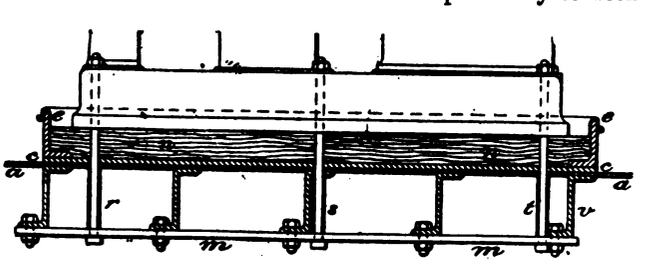

FIG. 187.

beams. This comparison may hold good, and yet the holding down at *r* be quite sufficient. With any upward pull over *r* due, for instance, to the rolling of the ship, not only the bottom plate, *m m*, but also the deck plating, and the plate *c c*, would all have to spring together; and also the bed-plate, being held down rigidly at the middle to the deck beam below, would have to yield. It is thus doubtful if such an amount of give would ever take place. Viewed in this light, however, it will be seen that the former method (Fig. 186) is decidedly the better one, wherewith each bolt takes directly on to a deck beam, and has a solid grip without the use of piping. Further advantages apart from the points already discussed, attributable to these methods, are that they are simple, and do not require means for carrying them out but such as are easily applicable on board ship, under circumstances of bustle and turmoil, where every part is crowded with men, and all space is cramped.

Bearings.—With dynamos, as with all other machinery, the bearings are very important parts. The success and efficiency of a machine as a whole may be greatly marred by a bad design of bearings: and only recently, in fact, the writer has become acquainted with a case wherein, owing to the bearing at the pulley end of a belt-driven

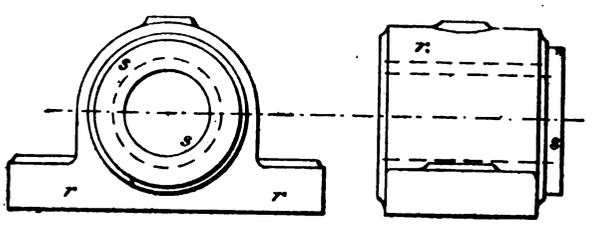

FIG. 188.

dynamo being too short, and its brasses consequently always getting worn out and cut up, it has been necessary to fit a further adjustable bearing on the shaft end which had been left projecting beyond the pulley fortunately, in this case, to a sufficient length.

Bearings may perhaps be divided into two main classes—namely, solid bearings and split bearings. Of the former a simple specimen is illustrated in Fig. 188. It will be observed to consist of a casting, *r r*, in one piece, with a hole through

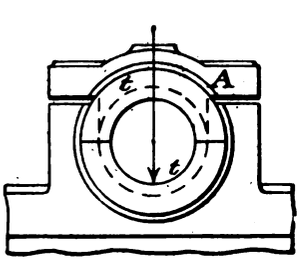

FIG. 189.

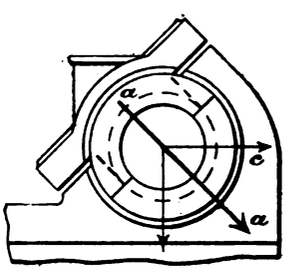

FIG. 190.

it which is fitted with a gunmetal bush, *s s*, also in one piece. This can, of course, only be used in cases where it can be put in position by being slipped over the end of the shaft, which limits its utility as compared with the other class. A simple outline of this latter is shown, Fig. 189. One half, A, is removable in the form of a cover or cap, and each half is fitted with a "brass," *t*, so that

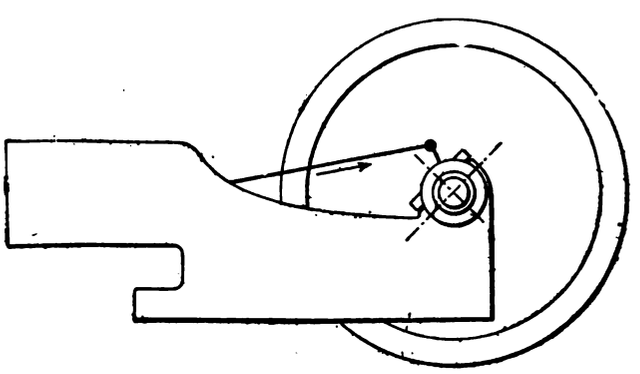

FIG. 191.

the two together are equivalent to the bush in the foregoing type. In practice the joint of the cover with the solid portion is made normal, or perpendicular, to the mean direction of the pressure of the shaft. Thus in Fig. 189 the load is assumed to be quite vertical, as indicated by the arrow. But in Fig. 190 the mean pressure is assumed to be slanting, as shown by the stout arrow, *a a*. This latter in practice is usually a resultant of two components—the weight of the shaft and flywheel acting downwards, and the pull or thrust of an engine connecting-rod, or else of a belt, acting horizontally, as indicated by the small arrows. The main object herein aimed at is to as much as possible preclude the mean load from acting on the joint between the brasses: but

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to keep it central on these, either entirely on one (or alternately on the upper and lower), as shown by the stout arrow in Fig. 190, and the single arrow in Fig. 189. It is thus to be observed in practice that in the case of gas and oil engines, the bearing is inclined toward the cylinder, as shown in Fig. 191. For these engines are single acting; and the explosion at the back of the cylinder behind the piston puts the connecting-rod into compression, thus creating a pressure on the bearing corresponding to the arrow *c* in Fig. 190. With the constant downward pressure of the flywheel and shaft, there is thus a resultant such as *a a*. In horizontal steam-engines, which are double acting, and the horizontal component is reversed in direction at each stroke, the design Fig. 190 becomes not so applicable; and we consequently find that the type shown in Fig. 189 is then more usually adopted.

To turn now to the consideration of bearings as applied to dynamos, it is noticeable that great variety in design is apparent in practice. It may, indeed, almost be said that the advent of the dynamo into the sphere of mechanical engineering has given a fresh impulse to invention in respect of bearings. The high speed of rotation demanded, and the very essential item that no oil must be allowed to creep from the bearings on to the other parts of the machine, are points which, the latter especially, have required much renewed attention. Various methods and improvements in respect of lubrication have also been brought out; and it is to be observed how that gradually up to this present time, what are termed self-oiling bearings, are coming more and more to the fore. It is our purpose to consider some of these various designs.

(To be continued.)

ELECTRICAL RAILWAY SIGNALLING.

BY L. G. FERREIRA.

At a meeting of the Institution of Junior Engineers held at the Westminster Palace Hotel on the 7th inst., the chairman, Mr. H. Bloomfield Vorley, presiding, a paper on "Electrical Railway Signalling" was read by Mr. L. G. Ferreira (member), who is electrical engineer to the North London Railway. The following is a brief *résumé* of the paper:

After summarising the history of the development of the single needle by Varley and Spagnoletti (which system formed the basis of nearly all visual signalling apparatus), and briefly describing the various instruments for transmitting messages, the author proceeded to consider the working of the "absolute block system," mentioning the various block instruments in use. As instancing the great amount of work required to be done by the instruments on an urban railway, it was stated that on some lines 16 beats were given and received on the bells and three movements of the needle made to signal the passage of each train, and where there were four sets of rails the number of trains per 24 hours might run into four figures. It was of the highest importance, therefore, that the instruments should be of sound mechanical as well as electrical design to stand wear and tear, and for the parts to be interchangeable, so that in case of failure they could be easily and quickly replaced.

A detailed description was then given of the block instrument designed by the author in conjunction with Mr. H. J. Pryce, the locomotive superintendent of the North London Railway, which line was now worked throughout by it. A pair of instruments were shown in actual operation at the meeting, and the various parts open to examination. In this instrument the needles had an angular movement of nearly 90deg., instead of the usual 30deg., and when the circuit was opened they resumed the normal position, not only by gravity but by magnetic attraction. The needle arbor carried a cylinder of soft iron slotted at diametrically opposite points. A permanent magnet had its poles brought close to the cylinder at the extremities of the vertical diameter, and an electromagnet had its poles similarly arranged horizontally. When there was no current flowing through the electromagnet, the cylinder took up a position with the slots, central to the permanent magnet poles, owing to the two halves tending to arrange themselves in the direction of the lines of force, and the needle was thus held in a vertical position; but when a current was passing through the electromagnet the direction of the lines of forces was altered, and the cylinder turned through an angle of 45deg. In order to minimise the effect of any residual magnetism in the electromagnet, the cylinder was reduced in width for some distance midway by the half circumference between the slots. By so doing, less of its area was exposed to the action of the electromagnet when the needle was in a vertical position, and a differential effect was produced, the permanent magnet having a greater effect on the cylinder when within a few degrees of its normal position, and the electromagnet the greater effect when the cylinder had revolved sufficiently to bring the full width near its poles. To prevent the needles being moved without giving an audible signal, the ringing key was arranged to lock the commutator, so that at least one ring must be given on the bell before the needles could be moved. The ringing key was so arranged that all the contacts were made by rounded pins rubbing on springs with cylindrical tops, which ensured a perfectly clean surface for the actual contact, as any sparking or oxidation occurred on one part of the same, and the point of contact travelled round as the key moved and finally rested at another place on the surface of both pin and spring. The actual duration of the contact was also much longer than with a butting contact, and thus allowed the instrument to be worked much quicker. There was a special arrangement for junctions so as to lock one instrument with another, that trains could not be accepted from two cabins on converging lines at the same time.

The paper then dealt with repeaters and light indicators, and described the form and arrangement of circuit mostly in use, after which the step-by-step train describer was briefly referred to. Telephones, and methods of grouping them so as to obtain inter-communication between each and all the cabins on a railway or section of a railway, were then considered, special mention being made of the conditions necessary to arrive at the best acoustic results. The method recommended was an arrangement by which the telephones were grouped between two wires in "multiple" in sections of six or eight, with special switches to join up one section to the next, the relays being wound to a high resistance (varying in proportion to that of the line wire and their relative distances apart) also in "multiple."

In the discussion which followed the reading of the paper, the Chairman, Mr. J. G. Sneath, Mr. Smith, Mr. L. Rugg, Mr. A. H. Stanley, Mr. A. W. Marshall, and Mr. Evans took part, and a vote of thanks to the author concluded the proceedings.

It was announced that the summer meeting of the institution would this year be to Ireland, commencing August 14.

INSTITUTION OF ELECTRICAL ENGINEERS, May 13.

At last night's meeting of the Institution the following were the candidates balloted for:

Members.—William Worby Beaumont, Outer Temple, 222, Strand, W.C.; Edmund Arthur Norman Pochin, The Arc Works, Chelmsford.

Associates.—Arthur James Brooks, 33, Camden-park-road, London, N.W.; George William Cooper, Pevensey-road, Eastbourne; Arthur William Higgs, 24, Kitto-road, St. Catherine's Park, Hatcham, S.E.

Gas v. Electricity.—At the annual meeting of the Institute of Gas Engineers, Mr. Corbet Woodall, the president, in his inaugural address, said that he had held from the first, and still held, the opinion that electric lighting would not do more than affect the fringe of the gas industry; yet, in referring to the future gas engineer, he suggested the inclusion of electrical engineering among the studies of the rising generation of gas managers' assistants, who would in due time become gas engineers and managers themselves, for common prudence dictated that in gas engineers' offices and in every considerable gasworks there ought to be a capable assistant with a knowledge of electrical science.

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TO CORRESPONDENTS.

All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notice of Meetings, Issue of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

All communications intended for the Editor should be addressed C. H. W. Biggs, *139-140, Salisbury Court, Fleet Street, London, E.C Anonymous communications will not be noticed.*

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BOUND VOLUMES.

Vol. XVIII. of new series of "The Electrical Engineer" can be had bound in blue cloth, gilt lettered, price 8s. 6d. Subscribers can have their own copies bound for 2s. 6d., or covers for binding can be obtained, price 2s.

ELECTRICITY AT THE IRON AND STEEL INSTITUTE.

The president of the Iron and Steel Institute in his inaugural address on Tuesday last referred to a possibly extended utilisation of furnace gas. It seems that at the Cockerill Works in Belgium, after successful experiments, two 150-h.p. engines are to be installed for which the furnace gas, and not coal or coke directly, will furnish the heat, and it was suggested that, excepting for the locomotives, a similar method might come to be employed for all the stationary engines. Indeed, Mr. Martin went so far as to imagine that in the future the principal work of the ironmaster might be to furnish furnace gas and to get pig iron as a by-product. When we come to consider the vast quantities of fuel consumed in blast furnaces and the number of units of heat that remain unutilised, it is something more than a dream to imagine ironworks as central installations for the generation and supply of electrical energy. The idea is too recent—the method of economical employment not yet determined, the amount of heat energy which might be available is uncalculated—for exact statements, but for imaginative purposes the theme is very taking.

This, however, is not the topic to which we desire to direct attention, but rather to another which arose during the discussion of Mr. Jeremiah Head's paper on charging open-hearth furnaces by machinery. In this paper Mr. Head described Mr. Wellman's apparatus, which is worked by means of electric motors, and also pointed out that our American cousins were largely increasing their use of electrical energy for power purposes. Every large ironworks there has its central station. In the discussion we were surprised to hear a doubt raised by Mr. Riley as to the certainty of action of electricity. He seemed to think that it had not been sufficiently tried to be proved able to fulfil every requirement of such machines. Subsequently he explained that he did not condemn electrical apparatus generally, but only as applied to the type of machine under discussion. That such doubts are held by a small minority only was shown by the fact that speaker after speaker referred specially to the value, and the American speakers, not only to the value, but to the extensive and rapidly-increasing use of electrical energy for power purposes in various works. We cannot understand the doubts of Mr. Riley, but when they are publicly put forward by so prominent and experienced an engineer it shows that much prejudice still exists, and a good deal of education has to be done. The transformation of any kind of energy into another kind of energy requires apparatus, and in no case is such apparatus perfect—nor is there any machine which may not give trouble, but we are prepared to assert that the mechanical apparatus connected with the transformation of electrical energy is as perfect, if not more so, than any other class of machinery; that it is as much under control and no more liable to accidental breakdowns than any other machinery. Of course it is impossible to directly controvert a doubt, and Mr. Riley gave no particular reason why he did not agree with the use of electricity. Mr. Lauder said that when first proposed he was just as sceptical

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about the value of electricity, but familiarity with its use had made him a complete convert, and he knew that great economies had been effected by its aid. Mr. Winsor Richards candidly admitted that we were too conservative: that the Americans were much quicker to adopt new things than we are. It is high time we changed our tactics if we are not to be beaten in the race of competition, and we must not be so slow in the future as we have been in the past to take up improvements. We are inclined to think that the doubts existing about the use of electricity are due very largely to the manner in which the whole subject has been brought before practical men. They are used to deal with things they can see and handle. Till recently electrical writers made too much of a to-do about its being unknown and unknowable. They have invented strange terms to designate quantities—terms that do not commend themselves by internal interpretation. Tell the hydraulic engineer that the dynamo is a kind of pump keeping up a difference of level of electricity between two points, just as his pump does with regard to water, and he begins to have an inkling that he has to deal with something that at any rate has some analogies to water; and his knowledge of the one subject helps him to a better understanding of the other. Mr. Riley would not object to the use of a hydraulic ram. At any rate, as we say, the discussion on Mr. Head's paper conclusively showed that there still exists a hesitation among ironworks engineers to "go nap" on electricity, hence an hesitation to install electrical apparatus.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

ELECTRIC POWER IN WORKSHOPS.

SIR,—*Re* "Local Distribution of Electric Power in Workshops," etc., we would like to point out a correction necessary on p. 585 of your issue for May 7. We notice you have given our name wrongly, and Mr. Scott has also omitted from our generating plant one 50-h.p. dynamo direct coupled to a Belliss engine running at 500 revolutions, which we have had running nearly three years. We have 28 motors at work (1 h.p. to 50 h.p.), and five cranes, not three, as stated.—Yours, etc.,

DANIEL ADAMSON.

May 10, 1897. (*Joseph* Adamson and Co.)

REVIEWS.

Electricity and Magnetism. By ERIC GERARD. Translated from the French by R. C. DUNCAN. New York: The W. J. Johnston Company. Royal 8vo, 392 pp.

The work of Prof. Gerard, of Liège, has already run to four editions in as many years, and has been translated into German. A translation of it into English will therefore be welcome, more especially in America, where a working knowledge of French is less common among electrical students than in this country. But the present book is something more than a mere translation. The original design was to produce a book which should go some steps beyond the elementary manual, which shirks anything really difficult, or at the best gives a mere statement unaccompanied by the proof which is in almost every case not so much necessary for the acceptance of the result (that may in many cases be obtained experimentally), but rather for its proper comprehension. At the same time it was desired to avoid producing something which would be practically a sealed book to those who are not mathematicians. This means, as a matter of fact, that the reader must understand elementary integrals. That owing to the intense conservatism of schoolmasters in this country most lads are turned out into the world without that knowledge is to be regretted; it is exceedingly difficult to treat much of electrical theory properly without them. It has been said that the book is something more than a translation. Prof. Gerard's work contained chapters on such practical matters as storage batteries, transformers, and other electrical machinery. This has been all omitted, so that the book becomes one of pure theory. As it would be impossible to cover the whole field of the application of the theory to electrical engineering, and as the types selected in a progressive industry naturally rapidly become obsolete, this is an improvement. In place of the omitted chapters we have much new matter which is almost wholly good. Dr. Cary Hutchinson contributes an excellent chapter on units, which were somewhat shortly dealt with in the original. One notes in this a theoretic preference for Mr. Heaviside's rational system. Mr. C. P. Steinmetz and Dr. A. E. Kennelly contribute chapters on hysteresis and impedance respectively. The *lacunæ* in the original work are thus to a great extent filled in. There is a short treatment of the oscillatory discharge and Hertzian waves. It is curious, however, to read right through a book on electricity and find not the slightest hint of the problems that have been introduced by polyphase currents and the induction motor. The words never occur, and nothing is contemplated but the simple alternating current. Mr. R. C. Duncan is responsible for the translation, and he has had the assistance and supervision of Dr. Louis Duncan, the president of the American Institute of Electrical Engineers. The book is, like most American books, so far as appearance goes, beautifully printed, but, by some strange mischance, on the first page there is a totally wrong heading, and the title-page and the preface are at variance as to the proper initials of the translator. The reviewer does not pretend to have made the microscopic examination which would enable him to say whether the book is or is not free from less obvious and more dangerous misprints.

The Alternating-Current Circuit: An Introductory and Non-Mathematical Book for Engineers and Students. By W. PERREN MAYCOCK, M.I.E.E. London: Whittaker and Co. Small 8vo, 102 pp. Cloth. Price 2s. 6d.

In this book the object is to convey an idea of the phenomena of the alternating-current circuit to the minds of those new to the subject, avoiding, so far as possible, anything but the most elementary mathematics. The reader is, however, supposed to have some electrical knowledge, including the ordinary units, and also to understand the principles and use of the more familiar instruments. Assuming, then, that there is already a definite mental conception of the steady current, Mr. Maycock carries one through the effects of induction (self and mutual), capacity, lag and lead, and the power factor, using generally the hydraulic analogy. This, which is equivalent practically to a single-fluid theory, is probably the best means for the author's purpose. Occasionally, where it breaks down, he adopts kinematic analogies, such as those Prof. Forbes has made us familiar with. This is a straightforward way of looking at the thing, which is preferable to talking of an alternating current going "through" a condenser, or generally to apply the language of a continuous stream to a wave motion. It is assumed in all cases that a sine wave current is sent down, and the considerations which cluster round the form factor are of course not touched upon, but, on the other hand, some amount of space is spent upon the wattless current and the power factor. Polyphase currents are formally mentioned as outside the scope of the work. In order to pass any kind of judgment upon a book of this sort it would be necessary to place oneself again in the position of the learner, to whom the ideas of the alternating current are completely new. When one has anyhow acquired the conceptions it is impossible to divest oneself of them, or to say definitely to what extent such explanations and analogies as are given by Mr. Maycock help the learner over his initial difficulties in the study of

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alternating currents. Of necessity, most of us have had to surmount them in quite a different way. And the experience of the schools would be useless, because it is not altogether for the needs of the electrical schools that Mr. Maycock is writing, but rather, one would judge, for those who have not the constant verbal explanation of the teacher to supplement their book knowledge, or to nip a wrong conception in the bud.

Railway Technical Vocabulary: French, English, and American Terms. By LUCIEN SERRAILLIER. London and New York: Whittaker and Co. 8vo., 222 pp. 7s. 6d.

The title of Mr. Lucien Seraillier's "Railway Technical Vocabulary of French, English, and American Terms," credits our cousins across the Atlantic with a language of their own. This is, in the matter of railway work, no mere affectation, for the different system under which the railroad has developed in the United States has resulted in the technical terms, the railway professional "slang," so to speak, being very different from the British variety. Of course, there is not a separate column devoted to the American language, but the Transatlantic terms are given marked with an asterisk. Occasionally there is no real correspondence; for instance, a note is necessary to show that the "train despatcher" is a telegraph operator, and does not correspond to the platform foreman, with whom he is bracketed. The French equivalent runs to about a dozen syllables, and indicates that there is no special name for the functionary in France. The vocabulary is not arranged dictionary-wise, but by categories with an index. When it has become familiar, consultation may not take much longer by this method than by the old and approved way of alphabetical arrangement, and it certainly cuts down the size of the book by one-half. The book is confined to railway terms strictly—*i.e.*, it does not deal with what the Americans call street railways and we call trams—but within these limits it seems pretty full. There are useful tables for conversion of metric quantities at the end.

CITY AND GUILDS OF LONDON INSTITUTE.

ELECTRIC LIGHTING AND POWER TRANSMISSION.

PRELIMINARY EXAMINATION.

The following are the questions set by the Examinations Department of the City and Guilds of London Institute, 1897:

1. What are the points to be specially attended to in fixing an electric light switch to a wall, and in connecting up the wires to the switch? (15 marks.)

2. What is a flux? What is the disadvantage of using zinc chloride? (10.)

3. Having wired one floor of a house, how would you test the insulation to ascertain whether it complied with the specification? About what insulation resistance should the wiring of one floor of an ordinary house possess? (20.)

4. Explain in detail how you would wire a ship so as to avoid the compasses being disturbed by the electric lighting currents. (15.)

5. What is your opinion regarding the ordinary method of stapling electric bell and telephone wires to walls? (10.)

6. Is it desirable to use fuses on electric light ceiling roses and switches? Give your reasons. (15.)

7. Show by a sketch how you would connect up an energy meter, such as the Elihu Thomson meter, on a two-wire circuit. (10.)

8. What is the difference, as regards construction and use, between an ammeter and a voltmeter? (8.)

9. Describe an electric fire-alarm in detail, with sketches. (20.)

10. Define an ampere, 10,000 volts, one megohm, a kilowatt, 40 Board of Trade units, and 100 h.p. (10.)

11. At 6d. per Board of Trade unit, how much about does it cost for electric energy to keep 10 lamps, each giving 15 candles, glowing for five hours. (15.)

12. Describe, with sketches, a single-stroke bell, and a trembling bell. (15.)

13. Why are incandescent lamps generally arranged in parallel, while arc lamps are frequently joined in series? (10.)

14. Describe the construction of a Leclanché cell, and state what are its advantages and disadvantages. Under what circumstances would you employ Leclanché cells? (10.)

15. Describe, with sketches, the kind of casing or conduit which you would recommend for protecting the electric light wiring to be run in a house. Mention what you consider to be its chief advantages. (20.)

16. A drum armature has an invisible contact between two neighbouring armature conductors; how would you localise it? (20.)

17. A group of 25 16-c.p. 100-volt lamps, each taking 0·55 ampere, are to be run by a dynamo 50 yards away. What must be the cross-section of the cable if the drop is not to exceed ½ a volt? The resistance of a cubic inch of copper may be taken as 0·66 microhm. (15.)

18. How does the resistance of the following substances vary with the temperature: carbon, copper, glass, gutta-percha, iron, manganin, platinoid? (10.)

FORTHCOMING EVENTS.

The following are some of the announcements for the forthcoming week:

TO-DAY (FRIDAY).—Royal Institution (Prof. Harold Dixon on "Explosion Flames"), 9 p.m.—Physical Society ("Effect of Temperature on the Magnetic and Electric Properties of Iron," by Mr. Morris; "The Formation of Mercury Films by Electric Osmosis," by Mr. Appleyard; and other papers), Burlington House, 5 p.m.—Western and Brazilian Company's meeting.

TO MORROW (SATURDAY).—Royal Institution (The Greek Theatre), 3 p.m.

MONDAY, MAY 17.—Society of Arts (Mr. L. F. Day on "Design in Lettering"), at 8 p.m.—And at Manchester, Northern Society of Electrical Engineers (paper on "Transmission of Power in Factories by Electricity," by Mr. S. V. Clirehugh), at the Palatine Hotel, 8 p.m.

TUESDAY, MAY 18.—Royal Institution (Dr. Anderson on "Volcanoes"), 3 p.m.

WEDNESDAY, MAY 19.—Annual Conversazione of the Royal Society, 9 p.m.—Society of Arts ("London Water Supply," by Dr. Percy F. Frankland; Sir Douglas Galton, K.C.B., will preside), 8 p.m.

THURSDAY, MAY 20.—Royal Institution (Mr. Churton Collins on the "French Revolution and English Literature"), 3 p.m.—Chemical Society, Burlington House, 8 p.m.—Society of Arts ("Kerman and Persian Beluchistan, with Special Reference to the Journeys of Alexander the Great and Marco Polo," by Captain P. Molesworth Sykes), 4.30 p.m.

FRIDAY, MAY 21.—Royal Institution (Lord Kelvin on "Contact Electricity of Metals"), 9 p.m.—Also at Paris, the Ingenieurs Civils de France fortnightly meeting.

SATURDAY, MAY 22.—Royal Institution (Mr. J. A. Fuller Maitland on "Music in England During the Reign of Queen Victoria"), 3 p.m.—The Prince of Wales opens the Blackwall Tunnel, 3.30.

EXPERIMENTS UPON PROPELLER VENTILATING FANS, AND UPON THE ELECTRIC MOTOR DRIVING THEM.*

BY WILLIAM GEORGE WALKER.

Former Experiments.—In 1892 the author read a paper to this institution (*Proceedings*, p. 514) upon experiments on the arrangement of the surface of a screw propeller; and in the discussion he mentioned (p. 561) some experiments which he had made with air propellers, in order to try the effect of the thickness of the blades. In 1893, at the Nottingham meeting of the British Association, he read a note on some experiments which he had made with ventilating fans having blades of various cross-sections. Those preliminary trials led him to undertake the further experiments described in the present paper, which have been carried out during 1895-6 in his laboratory in Westminster. The primary purpose was to ascertain (1) whether this kind of fan follows the ordinary laws respecting the mutual relations of speed of fan, power absorbed, and amount of air discharged; (2) the general characteristics regarding the speed of fan, power absorbed, and quantity of air discharged, with different angles of the blades; (3) the effect of fans differing from one another only in the cross-section of their blades. As he was not acquainted with any systematic experiments upon this

* Paper read before the Institution of Mechanical Engineers.

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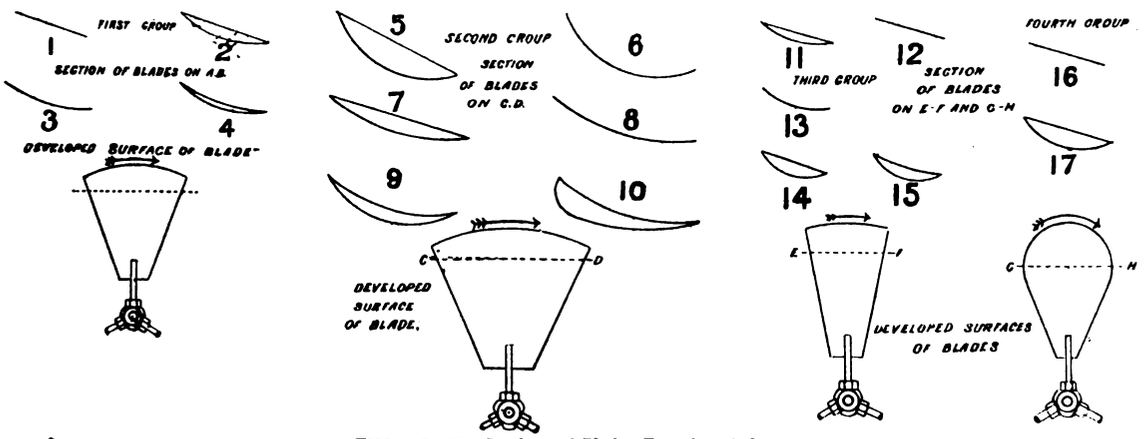
kind of fan, the investigation of the relations of speed, power absorbed, and air discharged was a necessary preliminary to the modification arising from different angles and shapes and cross-sections of the blades. The knowledge already acquired on the subject is confined principally to the centrifugal form of ventilator, and may be said to consist of a tolerably accurate and complete determination of those characteristics of performance which are common to all centrifugal fans of ordinary pattern, together with a somewhat vague appreciation of the character of the difference in design upon which the efficiency of a centrifugal fan depends.

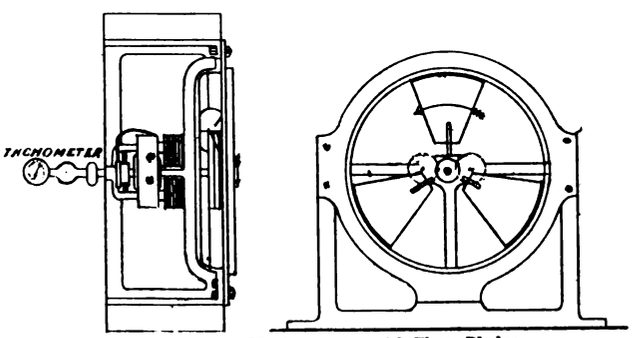
avoid giving any shock to the air; the outlet and inlet should be as free as possible; sharp turns or blocking in the delivery pipe may reduce the efficiency to a considerable extent, owing to the fact that the flow of air is not assisted by any static pressure, but is due only to its velocity.

Experimental Apparatus.—Seventeen three-bladed fans were tried, all 22¾in. diameter, specially constructed for these experiments; they are shown double full size in Figs. 1 to 17. The fans were driven by an electric motor, fixed centrally to a cast-iron frame in the rear of the fans (Figs. 21 and 22) which were keyed to the spindle of the armature, and were thus driven



FIGS. 1 TO 17.—Sections of Blades Experimented on.

Propeller Ventilating Fans.—The experiments on the propeller ventilating fans showed that, in fans tried under the same conditions, the relations of speed of fan, power absorbed, and air discharged, are in accordance with the ordinary laws. The propeller, or helical form of fan, as it is sometimes called, is



FIGS. 21 AND 22.—Electric Motor with Three Blades.

essentially a ventilator, its principal object being to move large volumes of air at atmospheric pressure. It is unable to maintain a static pressure of air, which would be absolutely necessary if the air were met by opposing resistances. The propeller ventilating fan is of use where comparatively large quantities of air have to be exhausted from a building; its volumetric efficiency is therefore of much greater importance than its pressure efficiency, and in many cases is also of greater importance than its mechanical efficiency. All the results given in the present paper are with fans having a free discharge, the outlet being practically equal in area to the inlet of the fan.

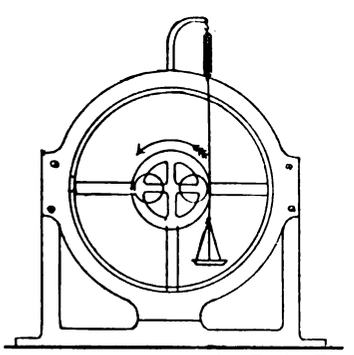


FIG. 23.—Brake Dynamometer used in Testing Fan Motors.

The ordinary centrifugal blowing fan generally works with a contracted outlet, its static pressure is comparatively high, and its mechanical efficiency is a maximum at a certain contraction of the outlet which gives a certain static pressure, while its volumetric efficiency is correspondingly low. The converse is the case with the propeller ventilating fan; its volumetric efficiency is a maximum with free discharge, and rapidly falls off with any baffling of the outlet pipe. It is important to

direct at the same speed as the motor. The latter was a continuous-current series-wound machine of about ½ e.h.p. The current was taken off the 100-volt mains of the Westminster Electric Supply Corporation. The air was delivered through a tube 24in. bore and 4ft. long (Fig. 24 and 25), made of stiff sheet iron and placed concentric with the fan axis and at the end of the frame. The speed of the fan was indicated by a tachometer, which was attached by a hook-joint to the spindle of the motor, and was read to two revolutions per minute. The usual meters were employed for registering the number of volts and amperes. The speed of the motor was

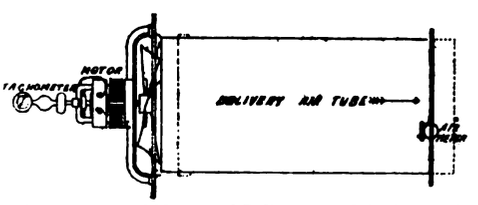
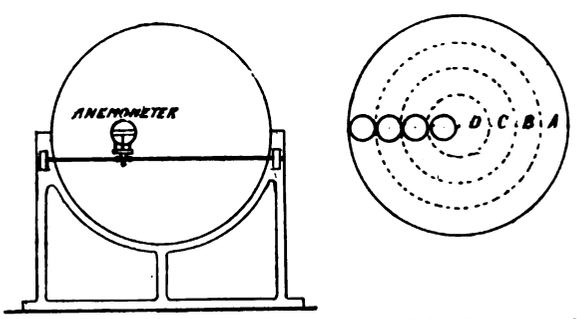


FIG. 24.—Arrangement of Motor and Delivery Air Tube for Testing Fans.

varied by means of electrical resistances. In most of the experiments the fans were run at a speed of 600 revolutions per minute; the speed was kept constant during each experiment by the adjustment of a suitable form of resistance. The volts in the supply mains were found to vary somewhat, which had an effect on the speed of the motor; during certain times of the day an almost continuous process of adjustment of the electrical resistance was necessary, in order to keep the volts quite constant. The velocity of the air was measured by an anemometer of 2¾in. diameter, placed at the outer end of the delivery tube,



FIGS. 25 AND 26.—Air Meter, showing End View of Air Tube with radii at which velocities were taken. Area of Ring—A, 1·275 square feet; B, 0·945 square feet; C, 0·614 square feet; D, 0·307 square feet. Total area of Tube, 3·141 square feet.

as shown in Figs. 24 and 25. The velocity varied greatly in different positions in the same cross-section of the tube; a smooth brass rod 5-16in. diameter was placed horizontally across the end of the tube, to which the anemometer was attached, so that it could be tried at different positions on the rod. The centre of the anemometer moved in the horizontal diameter of the tube for all positions on the rod, and the instrumental ways moved in the same plane across the current,

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TABLE 1.—Experiments on Propeller Ventilating Fans Nos. 1 to 10, of 23⅜in. Diameter, all Revolving Inside Delivery Air-Tube of 24in. Bore, except those marked * Revolving 4½in. out of Tube. Blades set at Angle to Plane of Revolution. Anemometer placed at Radius of 1⅛—5⅛—7⅛—10⅝ inches from Axis of Tube.

No. of fan.	Angle of blades.	Revs. per min.	Motor. Volts.	Motor. Amps.	Velocity of air per min. at radius. 1⅛	5⅛	7⅛	10⅝	Air discharged per min.	Weight on brake pulley.	Horse-power. Brake.	Horse-power. Air.	Efficiency. Mechanical.	Efficiency. Volumetric.	Pressure.
No.	Deg.	Revs.	V.	A.	Feet.	Feet.	Feet.	Feet.	Cubic ft.	Ounces.	H.P.	H.P.	P.c.	P.c.	P.c.
1	17	890	69·7	1·50	762	767	688	607	2,128	11·0	0·0458	0·0097	21·2	38·2	0·7
2	17	860	81·5	1 92	880	917	920	930	2,888	21·5	0·0866	0·0241	28·0	54·0	1·4
3	17	645	60·0	1·58	690	730	690	675	2,172	14·2	0·0430	0·0103	23·9	53·0	1·4
4	17	525	54·5	1·58	617	713	730	645	2,139	14·2	0·0350	0·0098	28·0	65·0	2·1
5	27	610	80·0	2·33	723	804	913	951	2,790	29·0	0·0829	0·0218	26·3	73·0	2·7
6	27	490	78 3	2·53	423	690	880	903	2,536	33·5	0·0770	0·0164	21·3	82·0	3·4
7	17	758	80·8	2·07	703	785	805	760	2,427	18 5	0·0650	0 0144	22·2	51·0	1·3
8	17	650	78	2·28	645	780	805	700	2,330	22·2	0·0677	0·0127	18·8	57·0	1·6
	27	600*	85	2·45	910	1,115	1,145	1,050	3,385*	31·7	0·0894	0 0390	43·0	89·8	4·1
	27	595	77	2·20	670	780	875	990	2,773	26·6	0·0742	0·0214	29·9	74·0	2·8
	40	495*	100	2·70	735	970	1,147	1,070	3,265*	39·4	0·0916	0·0350	38·2	105·0	5·6
9	17	600	69	1 91	320	365	530	635	1,633	20·6	0·0590	0·0043	7·4	43·3	0·9
	27	600	79	2·23	600	650	755	825	2,348	27·3	0·0768	0 0130	16 9	62·0	2·0
	27	600*	86	2·47	740	890	1,030	960	2 965*	32·3	0·0892	0·0262	29·4	78·0	3·1
	40	570	88	2·75	745	810	910	960	2,870	37·7	0·1075	0·0237	22·0	80·0	3·2
10	27	600*	81	2·31	805	930	950	930	2,891*	28·7	0·0809	0·0243	30·0	76·7	3·0
	17	600*	88	1·85	260	405	555	645	1,675*	19·7	0·0550	0·0047	8·5	44·4	1·0
11	17	850	74	1 70	640	745	850	990	2,720	15·5	0·0620	0·0202	32·6	50·9	1·3
	27	610	63	1·66	645	725	860	930	2,641	16·0	0·0458	0·0185	40·4	68·9	2·4
	27	600*	64	1·75	765	895	870	850	2 699*	17·6	0·0489	0·0190	40·4	71·6	2·6
12	27	600	63	1·70	590	635	740	745	2,222	16·8	0·0473	0·0110	23·3	58·9	1·7
13	27	600	74	2·06	655	745	860	995	2,737	23 8	0·0671	0·0200	30·0	72·6	2·6
	17	600	61	1·63	430	525	640	680	1,926	15·3	0·0431	0·0070	16·7	51·0	1·3
14	17	604	53	1·40	415	540	605	640	1,846	10 7	0·0300	0·0063	21·0	48·6	1·2
	40	605	85	2·40	780	940	1,110	1,105	3,272	31·0	0·0874	0·0348	39·8	86·0	3·7
15	40	600	84	2·40	775	965	1,120	1,085	3,270	30·6	0·0862	0·0350	40·9	86·7	3·8
16	35	600	65	1·77	720	780	860	830	2,580	18·1	0·0510	0·0172	33·7	68·4	2·4
17	35	600	67	1·87	685	830	920	875	2,705	19 1	0·0538	0·0199	37·0	71·7	2·6

TABLE 2.—Experiments on Propeller Ventilating Fan No. 17 with Blades set at Different Angles to Plane of Revolution. Fan 23⅜in. Diameter, Revolving Inside Delivery Air-Tube of 24in. Bore; Speed, 600 Revolutions per Minute. Anemometer placed at Radius of 1⅛—5⅛—7⅛—10⅝ inches from Axis of Tube.

Angle of blades.	Motor. Volts.	Motor. Amps.	Velocity of air per min. at radius. 1¼	5⅛	7⅛	10⅝	Air discharged per min.	Weight on brake pulley.	Horse-power. Brake.	Horse-power. Air.	Efficiency. Mechanical.	Efficiency. Volumetric.	Pressure.
Deg.	V.	A.	Feet.	Feet.	Feet.	Feet.	Cubic feet.	Ounces.	H.P.	H.P.	P.c.	P.c.	P.c.
15	40	1 05	460	470	510	510	1,562	4·08	0·0115	0·0038	33·0	41·4	0·87
20	45	1·22	570	590	610	630	1,916	6·41	0·0181	0·0070	38·5	50·8	1·31
25	52	1·36	630	680	730	770	2,291	10·00	0·0282	0·0120	42·2	60·8	1·88
27	55	1·43	640	710	790	820	2,423	11·84	0·0334	0 0143	42·8	64·3	2·10
30	60	1·66	665	770	875	860	2,598	15·00	0·0423	0·0176	41·6	67·9	2·42
35	67	1·87	685	830	920	875	2,705	19·07	0·0538	0·0199	37·0	71·7	2·62
40	76	2·12	705	855	970	900	2 805	25·00	0·0707	0·0222	31·4	74·4	2·82
45	84	2·40	780	910	960	880	2,827	30·60	0·0858	0·0227	26 4	76 7	2·87
50	91	2 59	790	880	930	870	2,771	36·31	0·1024	0·0214	20·9	75·2	2 75
60	86	2·48	210	290	450	680	1,534	32·30	0 0911	0·0035	3·8	40·7	0·84

The brake horse-power of the motor was obtained by a dynamometric brake, of which the arrangement is shown in Fig. 23. The fan having been removed, the brake pulley was fixed in the same position upon the spindle. The brake was highly effective; it was sensitive, yet ran steady with no oscillation. The pulley was of cast iron, 9·4in. diameter, with smooth circumference; it ran true, and a fine silk cord was wound once round it, the lower end being attached to the scale pan, and the upper end to a salter's balance hung above the pulley and perpendicularly over the scale pan. The difference between the pull on the balance and the weight in the scale pan, multiplied by the circumference of the pulley and the number of revolutions per minute, and divided by 33,000, gave the brake horse-power. The pull and the weights in the scale pan were read in ounces. The silk cord was in direct contact with the surface of the pulley, and no cleats were employed to keep it on.

Measurement of Air Discharge.—It is difficult to conduct experiments with fans so as to obtain reliable results, especially in a long series of experiments extending over considerable time, when slight variations in the conditions may affect the results to a material degree. Changes due to slight variations in the position or condition of the apparatus, atmospheric changes of temperature and pressure and moisture, or alteration in condition of the room in which the experiments are made, all tend to affect the results. Having chosen the anemometer method for measuring the delivery of the air, the author made some experiments with a thin plate of small area, attached to the end of a thin well-balanced lever, and placed in the delivery tube so that the air impinged normally against its surface; it was adjusted at right angles to the stream of air by twisting by hand a wire, which formed the fulcrum of the lever, through an angle proportional to the pressure on the plate; the pressure being thus known, the velocity of the air can be calculated from it. This is somewhat similar to the Pitot tube method, which also measures the dynamic pressure of the air. With high velocity of air discharge through a delivery tube of small diameter, where it is necessary to explore the section of the tube to the very edges in order to get the mean velocity of the air, either the Pitot or the plate method is suitable. The anemometer was calibrated at Kew Observatory for speeds varying from 50ft. to 2,000ft. per minute; and the errors found were identical with those originally notified by the makers of the instrument. The author also made some experiments himself with the anemometer, and allowing for calibration errors found it to agree fairly well with the tube method. Mr. Bryan Donkin, to whom his thanks are also due for several suggestions, lent him a carefully-made brass Pitot tube, ¼in. internal diameter, which was fixed with its open end facing the current of air issuing from the delivery tube; the other end of the Pitot tube was connected to a U-shaped water-gauge, in which the height of the column of water was read by means of a strong light and powerful magnifying glass. The dynamic pressure of the air must not be confounded with the static pressure of its compression. The dynamic pressure is due to the impact of the moving air, transmitted from the face of the Pitot tube to the surface of the water column. In obtaining the static pressure it is necessary to eliminate the effect of the velocity of the air; for in a U-shaped water-gauge connected to a chamber of compressed air the static pressure is measured by the height of the column of water, which would be increased if velocity were imparted to the air so that it should impinge against the orifice of a tube connected to the gauge and facing the current. In the fans tested the static pressure was practically nil, because they were tried with free discharge and consequently at atmospheric pressure. If the face of the Pitot tube were reversed, to look in the direction

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towards which the current was flowing, so that the air would then act upon it by induction instead of by impact, an anomalous reading of the gauge might occur, showing zero pressure when compression was known to exist, the static pressure being neutralised by the induction of the moving air. For each experiment anemometer readings were taken at each of the four following radii of the delivery tube: $1\frac{7}{8}$, $5\frac{1}{8}$, $7\frac{7}{8}$, $10\frac{5}{8}$ inches. As shown in Fig. 26, the cross-section of the delivery tube was divided into four imaginary concentric rings, and each of the above radii corresponded with the centre line of one of the rings; each of the three outer rings was equal in breadth to the diameter of the anemometer. The velocity of the air in feet per minute, as ascertained at each of the four radii, was multiplied by the area of the corresponding rings in square feet; and the products being added together gave the number of cubic feet of air discharged per minute. The velocities obtained at each end of the four radii are given in Tables 1 and 2 for all the fans tried. It will

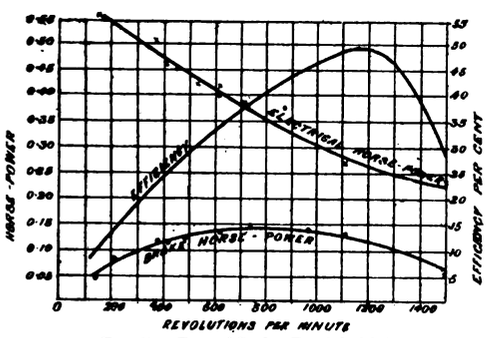

FIG. 27.—Test of Series Electric Motor.

be noticed that the velocity varied considerably at the different radii with different fans; and no mean radius for the position of the anemometer could be obtained. The areas of the four imaginary rings, making up the total 3·141 square feet area of the tube of 2ft. diameter, were 1·275, 0·945, 0·614, and 0·307 square foot. The mean velocity of the air was obtained by dividing the air discharge in cubic feet by the 3·141 square feet area of the delivery tube. Readings of the anemometer were taken for two minutes at each of the four radii for each experiment, together with the volts, amperes, height of barometer in inches, and temperature of the air. The condition of the experimental room remained unchanged throughout the experiments, with all doors and windows shut.

Measurement of Brake Horse-Power.—The electrical motor was calibrated, so that by simply reading the amperes and noting the number of revolutions, the brake horse-power was obtained. The torque, or turning moment, of an electrical motor is proportional to the current, and is nearly independent of the speed. A series of experiments were made with the motor running at 600 revolutions per minute, and the experimental readings are shown plotted in the diagram (Fig. 28). The weights on the brake in ounces are plotted as abscissæ, and the amperes as ordinates; the line drawn through the plottings is a straight one, showing that the weights are proportional to

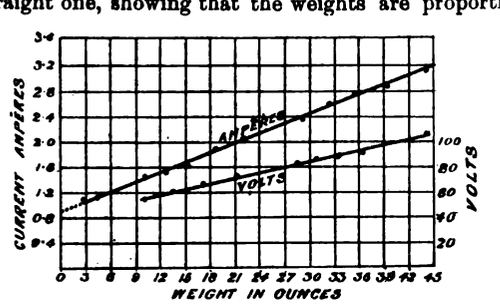

FIG. 28.—Test of Series Electric Motor, giving Current, Volts, and Torque at 600 Revolutions per Minute.

the amperes. The readings range from the motor running light until the resultant pull on the brake pulley was about 45oz. The majority of the fans were run at 600 revolutions per minute; the amperes being noted, the equivalent weight on the brake pulley was read directly off the chart from which the brake horse-power was calculated. With a given torque the amperes were not quite constant for all speeds of the motor; they increased slightly and uniformly with increase in the number of revolutions. It was easy, however, to frame a formula which gave the torque at any speed the motor might be running at, taking into account the small increase in the current due to speed. The small variation of current with speed for the same torque was probably due to the variation of the skin resistance of the armature. It required 0·5 ampere just to rotate the armature, and 0·6 ampere to drive it at 600 revolutions per minute with no external load on; this current was therefore spent in overcoming the friction of the motor; and it required 0·05 ampere to drive the tachometer at 600 revolutions per minute. In finding the brake horse-power, the skin resistance of the brake pulley was allowed for, which was obtained by running the motor light with the pulley off and on successively. The power required to overcome the friction of the motor was nearly constant throughout the whole series of experiments. The motor was frequently calibrated during the experiments, and any slight variation of amperes and torque was allowed for. The ampere-meter was read to one-hundredth of an ampere. It is sometimes convenient in testing different fans to run them so that the same horse-power shall be absorbed by each. In Fig. 29 is drawn a curve for 1-10 h.p., in which the revolutions are plotted as abscissæ and the amperes as ordinates. For a particular horse-power with fans of different kinds, the torque and revolutions are varying quantities in relation to each other, though their product will be constant. In using this curve, the speed of the fans must be adjusted by the electrical resistances until the co-ordinates of the revolutions and current meet on the curve; then the motor is transmitting 1-10 b.h.p. The

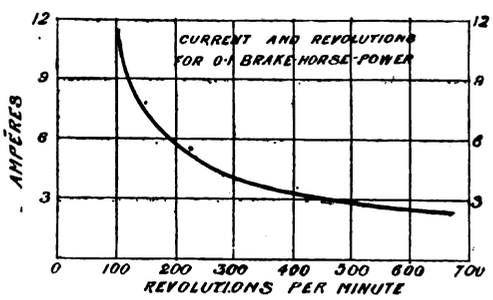

FIG. 29.—Series Electric Motor.

electric motor may, therefore, be used as a convenient form of transmission dynamometer for testing not only fans but also other machines, the ammeter giving after calibration the power transmitted to the machine that is being tested.

Speed Characteristics of Electric Motor.—Although not essential for the present experiments, it is interesting to determine at what speeds the motor should be run so as to give maximum brake horse-power and maximum efficiency severally. Its speed characteristics are shown in Fig. 27 for constant E.M.F.; the revolutions are plotted as abscissæ, and the ordinates of electrical horse-power represent the volts multiplied by the amperes and divided by 746. The three curves show the relation between the speed, the electrical and brake horse-power, and the efficiency of the motor. They were found by the brake, the scale pan being loaded with different weights so as to produce different speeds. The brake horse-power is also plotted as ordinates at the several speeds at which the motor was run, and the ratio of the brake horse-power to the electrical is a measure of the efficiency of the motor; this ratio was calculated for all speeds at which the motor was run, and being plotted as ordinates it gives the efficiency curve. Referring to Fig. 27, it is seen that the electrical horse-power was a maximum at zero speed of the motor, and fell off with increase in the speed; the voltage or potential difference was taken at the terminals of the motor. The brake horse-power increased from zero at zero speed to a maximum of 0·14 b.h.p. at 800 revolutions per minute, after which it fell off with further increase in speed; at 1,500 revolutions per minute it had fallen to 0·07 b.h.p. The efficiency, or ratio of brake horse-power to electrical, rose from zero at zero speed to a maximum of 48·5 per cent. at about 1,200 revolutions per minute, after which it fell off rapidly with further increase in speed; at the speed of 800 revolutions per minute, which gave maximum brake horse-power, the efficiency was about 40 per cent.

(To be continued.)

SHEFFIELD.

REPORT ON TRAMWAY TRACTION.

(Concluded from page 595.)

LIEGE.—Population, about 150,000.

The deputation are indebted to Ronald Menzies, Esq., vice-consul, and to the director of the Liège Tramway Company for the information obtained in Liège. Liège is a busy manufacturing town, and the streets are narrow. The electric tramways were not in work at the time of the visit, as the conversion from horse to electric traction was only just being completed. Running was to commence on October 1 last.

The systems in use are: (1) horses; (2) steam—suburban line only; (3) electric overhead. At present the tramways, with one exception, are worked by horses; but all of them,

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including the one steam line, are being converted, and will eventually be worked by overhead electricity. No special description of horse or steam lines is therefore necessary. The duration of the concession is 22 years. The tramway company pay the electric company 20 centimes (about 2d.) per unit, of which the electric company pay five centimes to the Municipality. The apparatus is of the usual type supplied by the Union Company of Berlin. The poles, however, are heavy and inartistic, and the overhead wires are very prominent, being cased. In one of the streets where there is a double track, with poles in the centre, the poles are too near the rails, and it is apprehended that there may be some danger on this account to persons leaning over from the cars. The power station was constructed by the International Electric Company. There are three engines of 240 h.p. each, which are to supply power and lighting. New cars are to be obtained, but the deputation did not see these. The Liège installation is not by any means the best the deputation saw. Cheapness has evidently been the first object, and the track did not seem to be solidly laid. As the working of the new system has not been commenced very full information could not be obtained, but if it is possible to run electric trams in streets as narrow as those forming the tramway routes in Liège, certainly there should be no practical difficulty in the way of so working the proposed new routes in Sheffield, where the streets are generally much better suited for the purpose.

PARIS.—Population about 2,500,000.

In Paris the deputation had interviews with the British Vice-Consul, the representative of the Serpollet Company, the general manager of the General Omnibus Company, Mr. Walton, and the director in Paris of the Thomson-Houston Company. The deputation found Paris a most important tramway centre, on account of the various systems of tramway traction which have been and are being tried. It also furnished an object-lesson of what should be avoided in the way of tramways. The tramway companies and others have made many attempts to deal more satisfactorily with the transport of the public, and as the authorities at present forbid the overhead electric system, various other forms of traction have been resorted to, of which the deputation saw no less than five in use, excluding horses and steam. The mileage of the tramways, intra and extra mural, is 230 miles.

There are nine different tramway companies working lines in Paris or the suburbs, and the systems in use are as follows: (1) horses; (2) steam; (3) steam, Serpollet system; (4) compressed air; (5) cables; (6) electric accumulators; (7) electric surface contact. The General Omnibus Company also experimented with gas traction, but it was not satisfactory on account of vibration and smell, and it was not, therefore, adopted by them. Gas traction does not seem to be used in Paris at all now, as although the deputation made enquiries in every direction they could hear of no gas motorcars. In December, 1893, there were 7,071 horses used on the lines of the three great Parisian tramway companies. The concessions are granted by the State, department, or commune, according to whether the greater proportion of the roads to be traversed is in the national, departmental, or communal domain, and at the end of the concession the lines revert to the authority granting the concession. The following are the chief conditions of the concessions: The omnibus monopoly and most of the concessions to tramway companies in Paris expire in 1910. The city of Paris receives no part of the actual receipts, but only a ground rent for offices, stations, and shelters erected on the highways, and a tax of about 3d. for each car starting from a terminus in Paris. In 1895 the revenue from these sources amounted to about £8,156—£3,456 being derived from the tax of 3d. on the journeys of the cars, etc., and £4,700 from the rentals of offices, etc. The Municipality also receives £2,000 per annum from the Belleville Funicular Tramway (endless cable), but the lines were constructed and the plant supplied by the city on condition the tramway was worked by the concessionaire. If the concessionaire of any tramway be negligent in repairing the track, the Municipality or department may do the work at his expense. The minimum daily service (number of journeys, etc.) is specified by the authority. The authorities can require cheap service on any special day not a Sunday or national holiday. The fares in Paris are generally about 3d. first class and 1½d. second class for the whole or any part of the line. They are fixed by the municipal authorities, who may from time to time revise them, but they cannot be altered without the sanction of the authorities. The first-class passengers are entitled without further charge also to travel over abutting or intersecting lines running in connection, using a ticket which they can obtain free from the conductor of the car or omnibus to whom the fare of 3d. is paid. The systems of tramways in Paris other than horse or ordinary steam are chiefly experimental, and not of any great extent, and none of them would be suitable for Sheffield. The following is a detailed description of each system of mechanical traction.

Steam Trams.—One of the steam tramways starts from near the Arc de Triomphe and runs to Neuilly and St. Germains. This is perhaps the least objectionable of any form of steam tram the deputation have seen, but still there was a disagreeable smell, and occasionally horses were frightened at the trams, though as a rule the horses in Paris have got quite accustomed to steam traction. The gauge is broad and the cars are long, clumsy, and obstructive. The route along which they run within the city is about 200ft. wide, and there are three parallel roadways, so that there is plenty of room for other vehicles which need not be near the trams. Outside the city, however, the width of the roadway is much less. The engines were built by Messrs. Lamm and Francq. The cars run about every six minutes; some of them are open, and there are two classes. This tramway belongs to the General Omnibus Company. There is also a steam tramway from Louvre and Versailles, which is really a railway running along the streets. The route is a very long one, and the trains consist of three or four double-decked cars and an engine. The Cie. du Tramway á Vapeur de Paris á St. Germain has paid a dividend of 4½ per cent.

Serpollet System.—The deputation inspected this system, which is the invention of M. Serpollet. An illustration of one of the cars is given herewith. The method of generating the steam is that known as "instantaneous evaporation." A thin layer of water is forced by means of a pump into a tube which is of special section, designed to keep the flow of water in the shape of a "layer." The consequence is that on entering this tube (which is heated) the water is immediately transformed into steam (superheated), and finally used in the ordinary way. A number of these tubes really form the boiler. Two small pumps are an essential part of the apparatus: one a hand-pump, by means of which the driver forces a very small quantity of water into the tubes to be transformed into steam to start the engine; the other, an automatic pump driven by the engine and taking the place of the hand-pump when the engine is started. The boiler is surrounded with asbestos to prevent any inconvenience from the heat it generates. The speed is regulated by the amount of water admitted to the tubes, and the regulation is by means of a pass-valve, controlled of course by the driver. The supply of water can be cut off and the steam pressure consequently decreased almost instantly. The engine is reversible. The advantages claimed for the system are: (1) the inexplosibility of the boiler or tubes; (2) the fact that no safety-valve, gauge-glasses, etc., are required; (3) the means of instantly varying the steam pressure, if necessary, from the maximum to zero; (4) the smallness and exceptional lightness of the apparatus, which in some cases only weighs one-tenth of the total weight hauled; (5) the simplicity of the driving apparatus, the driver only having four movements to control, one being sufficient to start or stop the car. The chief points in connection with the construction of the apparatus to which objection might be taken are said to be: (1) the difficulty of oiling some of the working parts; (2) the possibility of burning the tubes; (3) the choking of the tubes with deposit from the water on account of their narrow section. The inventor, however, states that these objections are more imaginary than real, and that none of them are serious. The weight of

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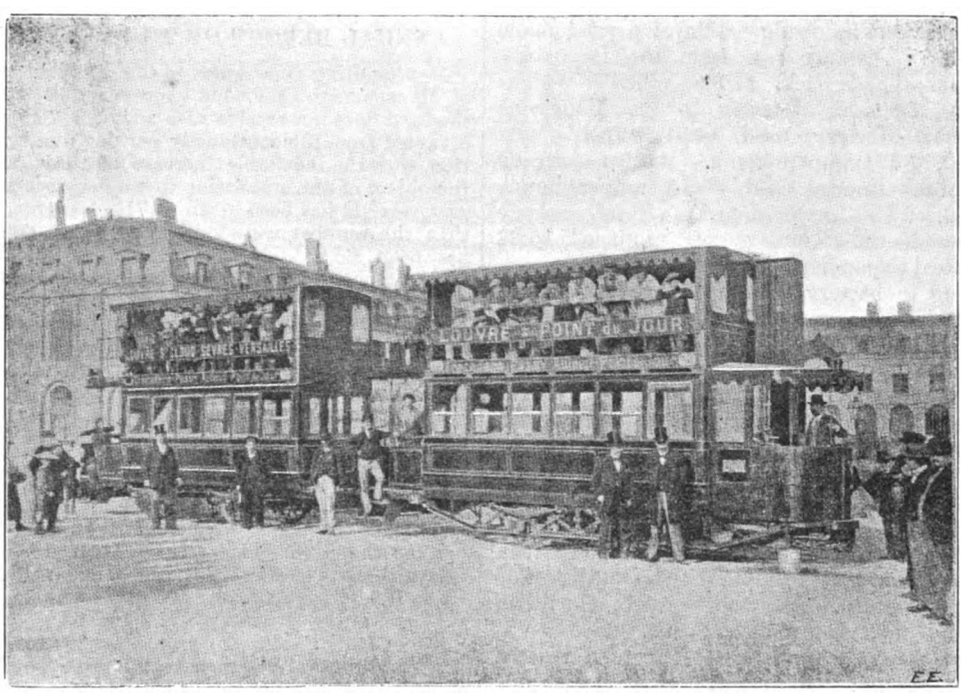
an "automobile" (Serpollet) car and engine carrying inside and out 50 persons, said to be capable of ascending a gradient of 1 in 20, with a trailer car also holding 50 persons attached, without reduction of speed is 41,300lb. = 18·4 tons. The height of the cars, which are two-storeyed, is about 15ft. The brake is an ingenious contrivance, consisting of a rope wound round a drum attached to the axle, one end being connected to a pedal controlled by the driver and the other to brakes acting in the ordinary way upon the wheels. The driver by a slight pressure of the pedal can tighten this rope, thus applying very great brake power. When the other end of the rope tightens, it applies the ordinary brakes to the tyres of the wheels. An additional hand-brake is also fitted. It is stated by the inventor that there has never yet been an accident with these cars in Paris. At the time of the inspection the motor was giving off steam. A smell of oil, too, was perceptible at times, and there was a noise like that made by an ordinary steam-engine, sufficient occasionally to frighten horses. There was constant vibration, and the cars made a grating noise when in motion and in stopping. The gradients of the routes upon which the Serpollet cars are used are similar to those on the Hillsbro' line (including one as steep as Fruitmarket), and the cars got up and down them satisfactorily, being always well under control. Uphill the speed was three or four miles an hour. The radius of the sharpest curve is 83ft. With regard to cost, the following was the result of a trial of a Serpollet engine of 4 h.p. working at a cut-off of 50 per cent., as furnished by the inventor: per brake horse-power per hour—coal, 4½lb.; water evaporated, 30lb.; lubricants used, 1oz.

Mekarski Cars (Compressed Air).—These cars are of the two-storeyed pattern, and had trailers attached. The steepest gradient on the route is about 1 in 13—*i.e.*, about the same as Snig-hill or Duke-street. More effort seemed to be required than with the Serpollet cars, and the vibration was greater. The weight of the car loaded would be from 18 to 20 tons, and the disadvantage of such a heavy weight on the steep gradients in Sheffield, especially as the control of the car when descending a gradient depends entirely upon mechanical brake power, will be readily understood. The pressure of the air is at 50 atmospheres. The Cie. des Chemins de fer Nogentais have a concession granted direct from the State until 1983, and have paid a dividend of 3½ per cent.

Cable.—This route is known as the Belleville Funicular Tramway, and is worked by an endless cable. No other example of cable tramways was met with throughout the deputation's investigations abroad. The length is about 1¼ miles. The gauge is narrow, and the line is single with crossing places. The gradients are steep, and there was great vibration and jar. The speed would be from five to six miles per hour. The cars, which had trailers attached, were dirty and uninviting. The line is said to be one essentially for the working classes. The maximum fare is about 1d., but during certain hours (summer, 5 to 6 a.m. and 7 to 8 p.m.; winter, 6 to 7 a.m. and 5 to 6 p.m.) the fare is only ½d. The services average 324 daily in each direction. The line is a very profitable one, a dividend of 11 per cent. having been paid.

Accumulator Cars.—The present accumulator cars, upon which the deputation travelled, run from the Depôt St. Denis to the Madeleine, Neuilly, and the Opera. The length of these lines is 9¾ miles, and they belong to the Paris Tramways Company. The worst gradient is about 1 in 27, or similar to Glossop-road above Wilkinson-street. Experiments with this form of traction were made in Paris as early as 1881, and on the first trials a speed of five miles per hour was obtained, but on account of the batteries wearing out the enterprise was abandoned. Several experiments have, however, been made since, with the result that the earliest of the present lines was opened in 1892. The motive power is electricity stored in batteries of accumulators carried on the cars. The charging is done at the depôt, and one charge is sufficient for from 27 to 37 miles. When the journey is over, the accumulators are moved bodily from the car and another set substituted, this process occupying from three to six minutes. There is an arrangement by which, when the car is ascending an incline, the motors act as dynamos, and thus to a certain extent (possibly as much as 18 per cent.) replenish the cells just after the greatest call upon them. The cars are very heavy, the weight loaded being from 12 to 14 tons, nearly three tons of which is accounted for by the accumulators. There are two 15-h.p. motors on each car. Powerful electric brakes are fitted, and also hand-brakes to comply with the regulations, but the latter are said to be unnecessary. In some of the cases the accumulators are placed under the seats, but it is considered better to put them under the car altogether, as otherwise the smell of acids is disagreeably noticeable, and there is also the risk of injury to clothing. The cars hold 52 passengers, and are said to be very expensive. The lighting is by electricity from the accumulators. The cars can attain a speed of about 12 miles per hour on the flat, but on the gradient named they slow down to about two miles per hour. The system as at present developed cannot be looked upon as suitable for heavy gradients, and, therefore, is not to be recommended for Sheffield. It is probably advisable here to observe that when new nearly all accumu-



Paris Tramways—View of "Serpollet" Car and Trailer.

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lators give about the same results, but in time the question of wear and tear has to be reckoned with. The mechanical strength of the cell becomes less, and the cost of repairs consequently increases. The cost of accumulator traction therefore cannot be fairly judged from the result of a few trials, and the calculation should be made on the cost of running over a long period, when the result might show a deficiency instead of a profit. Some of the advocates of the accumulator system in Paris admit the overhead electric system might be better outside the fortifications. It is not allowed inside. Mr. G. Pelissier, in his paper on electric traction by accumulators in Paris, published in the *Proceedings* of the Institution of Civil Engineers, gives the weight per car as follows: Car alone, 16,500lb.; battery of accumulators, 6,600lb.; passengers, 7,700lb.—total, 30,800lb. = 13·75 tons. The cost per mile run is as follows: Handling accumulators, 0·92d.; upkeep of accumulators, 1·54d.; upkeep of motors and trucks, 0·78d.; motive power, 2·77d.; wages and superintendence, 1·23d.—total, 7·24d. With new cars and accumulators the cost was said to be per car per mile: Upkeep and handling accumulators, 1·54d.; motive power, 2·00d.; upkeep of motors and cars, 0·46d.; wages and superintendence, 1·23d.—total, 5·23d. It is interesting to compare the Birmingham results with the above. Mr. J. Laffargue, also in the *Proceedings* of the institution, publishes the following result of a trial made on April 24, 1895: Distance run from the Depôt St. Denis to Madeleine and back, 11·82 miles. Weight of loaded vehicle, 12 tons. Journey to the Madeleine lasted 56 minutes. Energy used, 44·51 ampere-hours. Energy produced, 7·77 ampere-hours. Return journey lasted 55 minutes. Energy used, 43·13 ampere-hours. Energy produced, 9·05 ampere-hours. Total energy used, 87·64 ampere-hours. Total energy produced, 16·82 ampere-hours. Real expenditure of energy, 70·82 ampere-hours. Remaining in battery, 25 ampere-hours. Energy expended per train mile without allowance for energy produced, 0·616 ampere-hour. Energy expended per train mile with allowance for energy produced, 0·497 ampere-hour. Average potential difference, 105 volts.

Surface Contact (Claret-Vuilleumier) System.—This is an electric tramway about 4⅔ miles long. The route is along the Avenues de la Republique and Gambetta and through the Romainville Gate, terminating in the centre of the Romainville. The line is undulating, and the steepest gradient is 1 in 21·7, similar to the top part of Bow-street. There are curves with a radius of 98ft. The construction of the line was commenced in September, 1895, and it had only been working for a few months. The concession is at present for two years, but may be prolonged. Briefly, the system is as follows: The current is conveyed at 500 volts by means of cables under the footpaths to distributing boxes. From each of these boxes current is conveyed to metal studs fixed in the centre of the track. The studs are about 8ft. apart, and stand up about ½in. from the road level. By an ingenious but rather delicate moving apparatus fixed in each distributing box, only the studs over which the cars are passing are "alive," the current being cut off as the car leaves the stud. Beneath each car is a collector consisting of a narrow iron plate about 10ft. long. This is pressed down by means of springs upon the projecting studs, its length ensuring that it shall always be touching one stud, and the current is thus conveyed to the motor. As the collector leaves a stud the current is automatically cut off from the latter. The engines at the power-house are three in number, each of 200 h.p. Two work and one is in reserve. Each engine drives a 140-kilowatt four-pole dynamo. The car are two-storeyed, electrically lighted, and carry about 56 passengers. One of the drivers informed the deputation the line worked very well *in good weather*. The deputation are not in possession of any official statistics as to the cost, but probably it is a little less than that of the conduit system, and considerably more than that of the overhead. The advantage is that both the slot involved in the conduit system and the overhead apparatus are done away with. The disadvantages are: (1) The danger. The apparatus in the distributing box is of a very delicate nature, and if it failed to work, a horse stepping on one of the studs might be killed. (2) Leakage of the current in wet weather, and probable failure of the apparatus if the knobs or studs should become covered with wet or mud. (3) The constant and unpleasant noise caused by the knocking of the collector against every stud. (4) The fact that two cars following each other cannot be in the same section (about 90 yards) at the same time. The first car must be clear of the length worked by any one distributing box before the other enters. (5) The studs project above the paving, and as they are of iron, and the surrounding pavement of wood, the uneven wear of the two materials is liable in time to make the studs dangerous. In addition to lighting the cars, the company undertake the electric lighting of part of their routes.

The report continues with the visits of the deputation to the tramways at Blackpool, Bristol, Birmingham, Walsall, Wednesbury, and Edinburgh, full descriptions of which have from time to time appeared in our columns, and concludes with the general conclusions and recommendations of the deputation.

INSTITUTION OF CIVIL ENGINEERS.

ANNUAL REPORT OF THE BENEVOLENT FUND.

In presenting this report to the contributors, the Committee of Management cannot but express a deep sense of regret that the fund does not receive such augmented support as might be expected from the continually growing numbers of the institution, with the inevitable increase of those cases to which it is the object of the association to render assistance. During the past year aid has been given to 71 applicants, being four more than the number reported a year ago. The amount granted has been £3,533. 4s. 4d., against £3,581. 6s. 8d. in 1895. The committee has endeavoured to administer the available resources with uniform regard to the necessities of the recipients, but its efforts has been restricted by the fact that the funds at its disposal have in many cases not permitted it to exercise that reasonable liberality in grants which it would otherwise have desired to extend.

The ordinary income for 1896 has been: from annual subscriptions, £1,736. 10s.; from dividends, £1,589. 1s. 5d.; by return of income tax for the year, £54. 13s. 4d.; by bank interest, £7. 2s. 4d.; together amounting to £3,387. 7s. 1d. To this has to be added receipts of an adventitious character—viz., donations and a legacy, £172. 3s. 6d.; return of income tax for the three years ending April, 1895, £143. 9s. 1d.; a returned grant of £1, and a sum of 16s. paid on conversion of stock from 4 per cent. to 3 per cent., making the total receipts, as shown in the account, £3,704. 15s. 8d.

The expenditure, comprising grants as stated and £144. 16s. 3d. disbursed in expenses, has been £3,678. 0s. 7d. There is thus an apparent excess of receipts over expenditure amounting to £26. 15s. 1d.; but if the application for the return of the back years' income tax had not been successful the account would have shown a deficit of £171. 7s. 4d. in respect of the actual income from all sources; and the deficit in respect of income derived from ordinary sources upon the continuance of which alone any reliance can be placed would have been £345. 6s. 10d. The balance brought forward at the beginning of the year—£239. 15s. 8d.—and that carried forward at the end of it—£266. 10s. 9d.—are larger than usual, owing to a sale of reserve stock in 1895, the whole proceeds of which were not expended, and swell the account without betokening prosperity.

The result of the committee's appeal for further support, which was sent to every member of the institution at home and abroad a year ago, has been most disappointing. The total donations have been £259. 13s. 6d. less than in the preceding year, and the additional annual subscriptions have amounted to only £40. 1s.

Misconception, no doubt, prevails in some quarters in regard to the sources from which the fund is maintained, and it may be advisable to again state clearly that it is an association entirely distinct from the institution and under separate management; although the honorary officers by whom the executive work is performed hold appointments under the council of the institution. It has been observed by the committee that some of those to whom assistance has been rendered appear to have thought, and to have communicated to others a belief, that they have been recipients of grants, and even of pensions, from the Institution of Civil Engineers, a body which cannot lawfully engage in any such undertaking. It is possible that this impression may have prevented in some measure the benevolent fund from being so well supported as it might otherwise be. The committee therefore thinks well to

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restate here the constitution and aims of the fund. Its existence is largely due to the munificence of a number of members of the institution, who in the year 1864 subscribed very liberally to form a capital fund, which has during the last 33 years, by degrees, augmented to £38,749. 6s. 8d., the sum at which it now stands. The interest upon the investment of this capital sum is supplemented by annual subscriptions (from only 905 members in 1896 out of a total roll of 6,088 on the books of the institution), and by the interest upon the investment of a reserve fund of £6,004. 14s., which was accumulated in the earlier days of the fund before the claims upon its bounty became so numerous.

Whilst the Institution of Civil Engineers as a body has no control over the disposal of the fund, it is very distinctly interested in it, seeing that its benefits can only be conferred upon members or associates, or their families.

In the preparation of the balloting list, the committee has followed the custom approved by experience—the list of the previous year being taken as a basis, and certain alterations being made to ensure the prescribed rotation. Of the names that appeared in last year's list, Sir Frederick Bramwell and Sir George Bruce, having served three years in succession, are ineligible, and Mr. Greathead is dead. The vacancies in the balloting list thus created must be filled from among members of the council of the Institution of Civil Engineers, and the names of Mr. Edward Woods, Mr. J. C. Hawkshaw, and Dr. John Hopkinson are put forward in their places. The remaining names are those which appeared in the last list. It will be observed that the name of Dr. W. Pole no longer appears as one of the honorary secretaries, a position which he relinquished on ceasing to act as honorary secretary of the institution.

The statement of accounts is signed by the auditors for 1896, Mr. James Hutt and Mr. Wm. B. Peat. These gentlemen go out of office, and the business of the meeting includes the appointment of their successors. Mr. Peat, being again eligible, is proposed in conjunction with Mr. J. W. Biggs.

The committee resigns its trust with the hope that this appeal and explanation may stimulate interest in the fund among a largely increased number of the members of the institution.

(Signed) J. Wolfe Barry, Chairman.

ACCESSORIES FOR UNDERGROUND CONDUCTORS.

Messrs. Doulton and Co.'s new catalogue of accessories for underground electrical conductors has just reached us, and will form a book of reference for all consulting and contracting engineers. The use of porcelain and earthenware insulators for overhead telegraph lines is, of course, a well-established practice, but no one firm has done so much as Messrs. Doulton and Co. in introducing reliable insulators for underground work. The catalogue is well illustrated, and the views of work actually done in various towns add value to the book. Thus on the first page we see the conduits of hard-burnt stoneware used at Leyton. In these there are several ducts, and great care has been bestowed on the method of making the joints between the lengths of the conduit.

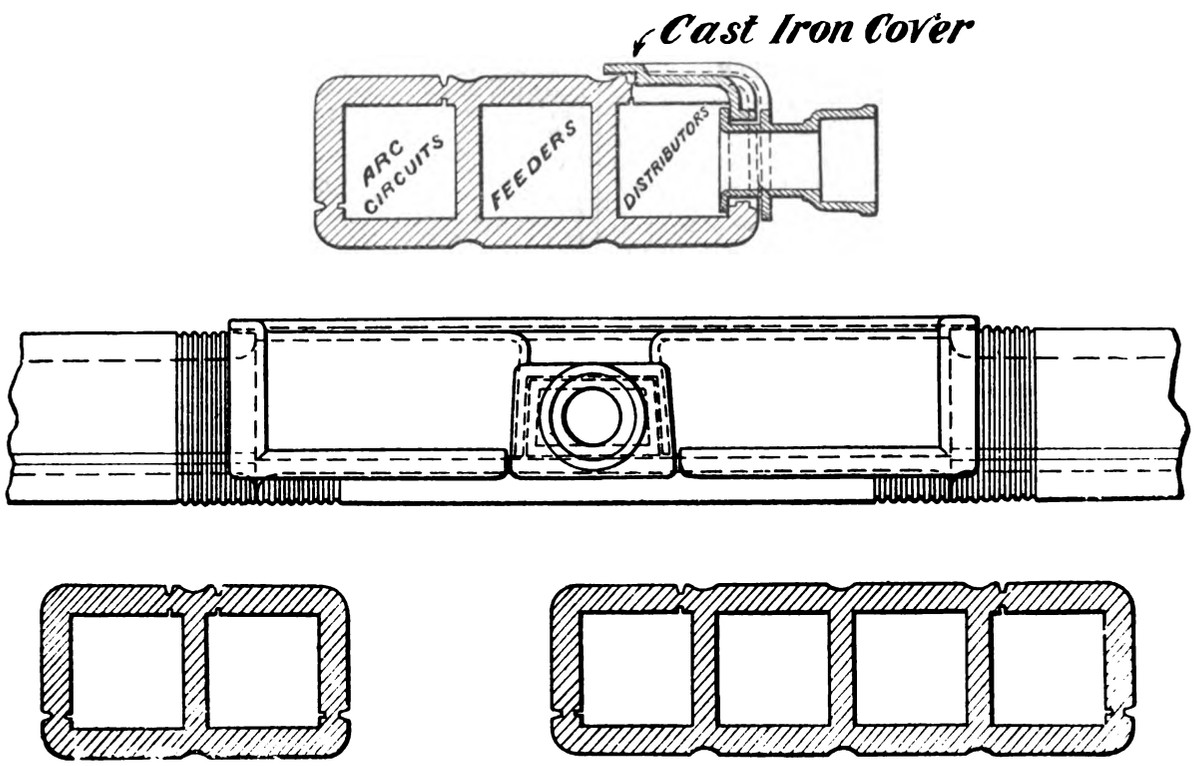

Fig. 1.

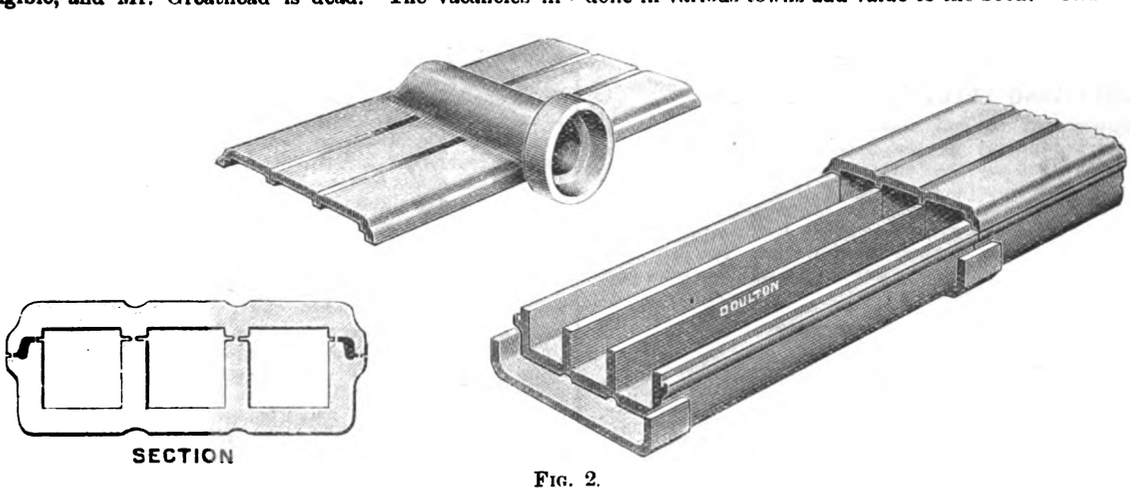

Fig. 2.

In the first type of conduit the material is of the same thickness throughout. Other sections are made in which during manufacture the substance is partially divided longitudinally, leaving sufficient material to preserve strength. The upper and lower portions may be readily separated by means of a chisel

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when required. This facilitates the removal of any length of casing from the line for the insertion of a box for house connections or any other purpose. In other cases, as in Fig. 1, this partial division is only made in such a way that the top and side of either of the outside ducts of any length may readily be detached by means of a chisel for giving access to certain mains. The cable T-joints having been made, the branch cables are carried through the cast-iron connector shown in the illustration, and the duct is closed by a cast-iron cover provided with a rebate around its edges to enable a watertight joint to be made between it and the stoneware.

Another type (Fig. 2) allows of access to any cable anywhere in the route. The catalogue also includes details of many types of street boxes made in vitrified stoneware, and also of glazed stoneware pipes with special self-fitting joints, etc.

LEGAL INTELLIGENCE.

CLAIM BY AN ELECTRICAL ENGINEER.

In the Westminster County Court, on Monday, his Honour Judge Lumley Smith, Q.C., had before him the case of Vaughan *v.* Veasey, in which the plaintiff, Mr. George Chas. Vaughan, an electrical engineer, and member of the Institution of Electrical Engineers, sought to recover payment in respect of electric work done to the order of the defendant.

The **Plaintiff** was called, and said that in October of last year his firm were engaged in carrying out certain electrical work at the Royal Music Hall, when they were approached by the defendant and his agent as to certain improvements which were desired in the working of a cinematograph machine which was being exhibited there. Witness took the matter in hand, and suggested that in order to work the machine satisfactorily it would be necessary to supply additional apparatus. This was done, and a man was sent down to the hall to look after the machine, and it was in respect of these two items that the present action was brought.

The defence was that the work was done on behalf of the management of the hall, and not for the defendant personally.

The **Defendant** was called, and absolutely denied having given or authorised the order.

His **Honour** said the plaintiff was clearly entitled to something, and gave judgment for £17.

THETFORD ELECTRIC LIGHTING COMPANY.

In the Queen's Bench Division of the High Court of Justice on Tuesday, before Mr. Justice Hawkins and Mr. Justice Wright, sitting as a Divisional Court, the matter of the Thetford Electric Light and Power Company, Limited (on the petition of Mr Jackson), came on for argument.

Mr. Grosvenor Woods, Q.C., said that this was an appeal for the dismissal by the judge of the Ipswich County Court of a petition for the winding up of the Thetford Electric Light and Power Company, Limited. Subsequently to the presentation of the petition a meeting of the company was held, at which the members present purported to pass a resolution. It was alleged on behalf of the company that the resolution was a binding one. The questions for their Lordships' determination were two—first, as to whether the resolution was valid, which counsel submitted it was not; and secondly, if it were, whether under the circumstances an order ought not to have been made upon the petition, having regard to the affairs of the company.

The hearing had not concluded when the Court rose.

RECEIVING ELECTRICAL APPLIANCES.

George Fowler, 36, on bail, was indicted before Mr. Justice Grantham on Wednesday at the Central Criminal Court, for receiving a quantity of cable and electrical appliances, the property of the Electrical and General Engineering Company, 36, Leadenhall-street. Mr. Muir prosecuted. The principal witness against him was an employé of the company named Jackson, who is now undergoing a sentence for stealing the property. The jury, after a lengthy hearing, convicted the prisoner, and the Recorder postponed sentence until next sessions.

COMPANIES' MEETINGS AND REPORTS.

BRAZILIAN SUBMARINE TELEGRAPH COMPANY,

The general meeting of the Brazilian Submarine Telegraph Company, Limited, was held on Wednesday at Winchester House, E.C., Lord Sackville A. Cecil presiding.

The **Chairman**, in moving the adoption of the report and accounts, said the receipts for the half-year ending December last were £88 973, showing a decrease of £3,098 on those of the previous half-year. The receipts from messages exhibited a decrease of £3,634, and those from interest, rents, transfer fees, and dividends on shares in other telegraph companies an increase of £536. Three causes had affected the income from messages. The first was an interruption of the route of the Western and Brazilian Company on the coast of Brazil from September 4 to October 2. They were informed by the Western Company that the interruptions of the cables were due to earthquakes or other disturbances of the ocean bed affecting the whole of the coast-line of Brazil. The second was the keen competition in the River Plate districts, and the third was a further and continued fall in the exchange value of the currency in Brazil. Notwithstanding the falling off in message receipts, they carried about 34,000 more words than in the previous six months. On July 1 next, under the Budapest revision of the International Telegraph Conference, changes were to be made in the basis of collection, which would lead to results more equitable as between the senders on either side of the Atlantic. After providing for debenture interest, sinking fund, and income tax, there was a balance of £63,214. Two quarterly interim dividends at the rate of 6 per cent. per annum had been paid, absorbing £39,000, a transfer of £20,000 had been made to the reserve fund, and the balance of the half-year's profits, £4,214, was carried forward. So far as the present half-year had gone, he regretted that he could not report any improvement in the receipts; on the contrary, they still had a decrease compared with the immediately preceding half-year. On the other hand, he was glad to say that they had not been called upon to meet any expenditure for repairs of cables. Referring to the international submarine telegraph memorial to the late Sir John Pender, the directors had felt that they could rely on the shareholders' support when the Board ventured to anticipate their wishes by putting this Company's name down for a contribution of £500 subject to the shareholders' confirmation. The German Submarine Telegraph Company's cable between Emden and Vigo was opened for traffic on December 25 last. It opened a new and direct route between the Brazilian Company's cables at Lisbon and Germany and the North of Europe. The Company assisted in bringing this cable into existence, and they had acquired a considerable interest in the German Company. The cable was laid under arrangements with the German Telegraph Department, which would, they believed, bring satisfactory results to the allied telegraph companies interested therein. The Pacific and European Telegraph Company had declared a small dividend for the year ended June 30 last. Owing to the continued depression of trade in Chile and Peru, with the consequent reduction in the income of the West Coast of America Company, coupled with the fact that it had to meet the payment of 8 per cent. interest upon its debentures, the company could not continue its operations upon the old basis, and it was necessary to bring about a reconstruction of the company on a sounder foundation if the alliance with it was to be kept. To this end the Brazilian Company had entered into an arrangement guaranteeing the principal and 4 per cent. interest on £150,000 of debentures of the reconstructed company. They believed the arrangement come to was a fair one. The Brazilian Company had close relations with the Eastern system, with the Western and Brazilian, and with the companies reaching places beyond, and they sought not only the continuance of fair and friendly relations among their company allies, but also good understandings with the foreign Governments, especially of Portugal and Brazil and the other Republics of South America, to all of whom they were in various ways indebted and bound.

Mr J. Denison Pender seconded the resolution, which was carried unanimously.

On the motion of **Mr. George Andrews**, seconded by **Mr. J. W. Burrow** a resolution was afterwards passed giving a donation of 100 guineas towards the Prince of Wales's Hospital Fund.

WEST INDIA AND PANAMA TELEGRAPH COMPANY.

The report of the directors of the West India and Panama Telegraph Company, Limited, for the second half of last year shows that the revenue was £34,053, against £33 558 in 1895, and the expenses £21,398, against £19 676. After paying the preference dividends and 6d. on the ordinary shares, £646 is carried forward. In reference to the partial competition of the Compagnie Française des Cables Télégraphiques, to whom the subsidies previously paid by the French West India Colonies to this Company—namely, £4 000 per annum—have been transferred, it is stated that this competition assumed a more active shape in December last, when the French company, in conjunction with its American associates, and supported by a large subsidy from the French Government, laid a cable from New York to Hayti, and thus completed the connection with the cables it had already laid in the West Indies. The material support granted to the Company's competitors by their home and colonial Governments enabled them to reduce the tariff to the West Indies, and this Company was consequently compelled to make similar reductions to retain its traffic for the route prescribed by the Legislative Acts of the Colonies. As, however, the French company's cable between Hayti and Martinique has been interrupted since December, 1895, the full effect of the competition has not yet been experienced.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY, LIMITED.

The report of the directors of this Company for the half-year ended December 31 last states that the total earnings amounted to £71,316, as against £80,315, showing a decrease of £8,999 compared with the half-year to December 31, 1895. The working expenses amounted to £38,161, as against £38,123, an increase of £38. With reference to the debenture reorganisation scheme, the Board point out that out of a total of £338,800 "A" and

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"B" debentures outstanding, assents have been received to the extent of £328,500, leaving only the small balance unexchanged of £10,300. Hitherto it has been the custom to place an annual amount to the credit of the debenture redemption fund, but it will in future only be necessary to set aside at the end of each year the annual sinking fund of £2,159 for the redemption of the new debenture stock, together with such small sum as may be required to pay off the remaining old debentures as and when drawn. After payment of the drawing of "A" and "B" debentures, amounting to £16,900, there remains at credit of debenture redemption fund a balance of £4,935, which it is proposed should be carried to the credit of the reserve fund. The directors regret that no dividend has been received on the shares held in the Platino Company during the past year on account of the heavy falling off in the traffic, together with the loss on exchange. There is an improvement in the traffic during the current year. Including £3,530 brought forward, the balance to the credit of the revenue account is £36,685, from which has been deducted £10,671 for debenture interest, leaving £26,014, of which £5,000 has been placed to the reserve fund. The directors now recommend the payment of 3s. per share, free of income tax, for the half-year on the ordinary shares, making, with the dividend paid in November last, £2 per cent. for the year, leaving a balance of £6,406 to be carried forward. In the case of shares which have been divided into "preferred" and "deferred," the 3s. per share now recommended will be payable to the "preferred" shareholders. The loss on exchange during the half year has been intensified, the average rate being lower than in any period previously recorded. There is no change in the position of affairs between the Government of Brazil and the Company as to the purchase of the cables. The Company's meeting takes place to-day (Friday).

LIVERPOOL GAS AND ELECTRIC FITTINGS COMPANY.

The annual meeting of this Company was held on Wedne-day at the offices of the Company, Liverpool, Mr. J. B. Smith presiding.

The directors reported that the net profit for the year was £405. 2s. 3d., which, with £137. 10s. 2d., the balance after paying last year's dividend and bonus, left the sum of £542 12s. 5d. to the credit of profit and loss. The directors regretted that in consequence of the unsatisfactory result of the electrical portion of business, and the large outlay on work in progress, they were unable to recommend the declaration of a dividend.

The **Chairman**, in moving the adoption of the report, said that the account was not very satisfactory. A large quantity of work was in progress, amounting to £3,640. as against £1,331 last year. Upon that work they hoped there might be some profit, but after past disappointment they were not prepared to calculate upon it, and could not therefore recommend a dividend. The electrical business involved a much larger outlay of capital than they calculated upon, and if they were to carry it on they would have to enlarge the capital of the Company. The directors had carefully considered the matter, and felt that they would not be prepared to advise an increase of the capital with a view to carrying on the electrical business, but had decided that the better course would be to get rid of the electrical business and fall back upon the gas fittings.

Mr. James Lister seconded the motion for the adoption of the report, and it was approved and the retiring directors and the auditor were re-elected.

CONTRACTS FOR ELECTRICAL SUPPLIES

CONTRACTS OPEN.

Dusseldorf.—Proposals will be received by the municipal authorities of Dusseldorf up to May 20 for the conversion of the horse tramways of Dusseldorf to electric traction.

Cologne.—Tenders will be received by the Municipal Authorities on September 3 for the working of about 12½ miles of electric tramway at Cologne. Particulars are obtainable for 3 marks (3s). Application to die Registratur B.

Bedford.—The Urban Sanitary Authority are prepared to receive tenders for the supply and erection at the sewage pumping works of two alternating current motors. Tenders must be delivered not later than Tuesday, June 8 (see advertisement).

Bucharest.—The Roumanian Government will want tenders on August 20 for the supply of 55,000 porcelain insulators (double bell), and other porcelain telegraphic fittings. Application should be made to the Direction of Posts and Telegraphs at Bucharest.

Belfast.—The Electric Committee are prepared to receive tenders for the supply and erection of switchboard, instruments, and connections, motor-generator, and boosters. Tenders must be in not later than noon on Thursday, June 3. Full particulars appear in our advertising columns.

Morecambe.—The Urban District Council want tenders for a chimney shaft (129ft.), engine and boiler houses for the electric light generating station. Plans and specifications can be obtained from the Surveyor, at the offices of the Urban District Council, and tenders must be in by June 7.

Paris.—Tenders will be received by the French Telegraphic Authorities (Paris, Rue de Grenelle 103) on May 25 for nine lots of telegraph instruments and fittings and materials for telephone batteries. Application must be made by May 15. Also on May 22 for installing the electric light at the Prefecture Archives, 30 quai Henri IV.

Santiago de Chile.—The Chilian Government Telegraphic Department will receive tenders on June 19, at Santiago, for the supply of galvanised iron wire, insulators, Morse instruments, paper for same, etc. Particulars (a summary only, and in Spanish) can be consulted at the Musée Commerciale, Brussels; otherwise application is to Santiago.

Cardiff.—The Corporation require tenders for the supply of about 2,000 tons of washed pea nut coal for the electricity works during 12 months ending June 30, 1898. Specification and form of tender may be obtained on application at the office of the Electrical Engineer, Town Hall, Cardiff. Sealed tenders, endorsed "Coal," to be delivered at the office of Mr. J. L. Wheatley, town clerk, Town Hall, Cardiff, by 17th inst

Rio de Janeiro.—The Secretary of State for Foreign Affairs has received a despatch from H.M. Consul-General at Rio de Janeiro enclosing a translation of an official notice setting forth the conditions under which tenders are invited for the telephonic service of that city and its suburbs. The tenders are to be presented by June 30, and the conditions may be inspected at the Commercial Department of the Foreign Office any day between 11 and 6.

Sunderland.—The Corporation require tenders for the supply of high-speed three-crank steam dynamo. Specification and schedule of quantities can be obtained from Mr. J. F. C. Snell, borough electrical engineer, Dunning-street, on payment of a deposit of £2. 2s , which will be returned on receipt of a bona fide tender. The persons or firms whose tenders are accepted will be expected to pay the rate of wages to the workmen engaged in carrying out the work which is payable by the particular trade affected by the contract in the district where the work is executed. Sealed tenders, addressed to the Chairman of the Highways Committee, Town Hall Sunderland, must be sent to Mr. Fras. M. Bowey, town clerk, Town Hall, Sunderland, by 26th inst. not later than 12 noon. Tenders to be endorsed "Tender for Steam Dynamo."

Wakefield.—The Guardians invite tenders for the following work at the new infirmary: (1) electric lighting plant, combined steam-engine and dynamo, belt-driven dynamo, motor-dynamo, motor, switchboard, storage cells, etc.; (2) complete system of wiring for the electric light, also bells and telephones; (3) vertical steam-engine, feed-water heater, tank, pumps, and pipe work, etc. Contractors wishing to tender for any of above sections must forward to Messrs. Shepherd and Watney, engineers, 71, Albion-street, Leeds, a deposit of £1. 1s. for such section, which will be returned on receipt of a bona fide tender. Specifications will then be forwarded to such applicants on or about May 13. Tenders must be delivered to Mr. H. Beaumont, clerk, Union Offices, Tetley House, Wakefield, in sealed envelopes, endorsed "Section No. 1, etc.," by noon on June 2.

RESULTS OF TENDERS.

Monmouth.—For electric lighting mains and accessories (two contracts), for the Town Council, the tender of Messrs. Siemens Bros , Limited, has been accepted.

Bath.—For supply of two electroliers to be fixed in the Roman Promenade, adjoining the Grand Pump Room, Bath, the tender of Verity's, Limited, London, at £73 each, has been accepted.

Reading.—The contract for the extension for electric light cables and mains has been given to the Fowler-Waring Cables Company, Limited. The approximate value of the cable now in hand is £1 540.

London, N.—For the supply of electric day plant for the Vestry of St. Mary, Islington, the tender of Messrs. Crompton and Co., for Brotherhood engine and Crompton alternator and dynamo has been accepted.

Bedford.—The Electric Light Committee have received the following tenders for the supply and erection of the following plant: two water-tube boilers, fitted with Vicar's mechanical stokers, alternating-current motor, and steam-piping:

Babcock and Wilcox, Limited (accepted)	£1,415
Hornsby and Sons, Limited	1,517
Brush Engineering Company	1,488

London.—The Metropolitan Asylums Board have received the following tenders for the supply and fixing of boilers for heating and electric lighting works at the Grove Hospital. The architect's estimate was £2,151:

J Fraser and Son, Millwall, E. (accepted)	£1,960
R. Taylor and Sons, Marsden Yorks	2,130
Davey, Paxman, and Co., Colchester	2,501
A. Anderton and Sons, Accrington	2,644
Yates and Thom, Blackburn	2,980
Leeds and Bradford Boiler Company, Limited, Stanningley, near Leeds	3,200

A New Telephone Cable.—On Saturday the telegraph ship "Monarch" laid across the English Channel a new telephone cable, making the second which now connects England and France. The cable is 24 miles in length, and contains two separate metallic circuits. The French end was landed at Sangatte, four miles west of Calais, the English end being landed at Abbots Cliff, three miles west of Dover. A third cable is to be laid by the French Government, and is now being constructed. The new cables are intended for general use in England and France.

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BUSINESS NOTES.

Western and Brazilian Telegraph Company.—For the past week the receipts were £2,226.

Thanet.—The Corporation have decided by a narrow majority to oppose the electric light railway scheme.

Book Received.—We have to acknowledge, from the offices of *Engineering*, the receipt of Mr. P. Dawson's "Electric Railways and Tramways."

Camberwell.—The Vestry propose to purchase extra fittings for electric light purposes for the baths in connection with the Diamond Jubilee illuminations.

Waterloo-with-Seaforth. — The Electric Lighting Sub-Committee of the Urban District Council has been reappointed with the addition of the name of Mr. Cookson.

Electrical Exhibition.—We understand that at the approaching exhibition at Sydenham the Edison and Swan Company will have an historic display of electric lamps and fittings.

Newington.—The Vestry discussed the electric lighting question for several hours at their last meeting, and adjourned without coming to any decision on the committee's report.

Wolverhampton.—At the Town Council meeting a letter was read from the Local Government Board enclosing the sanction to a loan of £1,097 for the purpose of electric lighting.

Wrexham – A Local Government Board enquiry has been held by Colonel Marsh into the application of the Town Council to borrow money for the erection of an electric light station.

Hanley.—Colonel Marsh has held a Local Government Board enquiry in respect of the application by the Town Council for sanction to borrow £15,000 for the extension of the electricity works.

Printing-Press Motors.—Messrs. Bergtheil and Young, of Camomile-street, London, E.C., are the sole agents of the "Card" electric motor, which is specially designed for driving printing presses.

Ayr. -The Police Commissioners have decided that the charges for the coming year shall be 6d. per unit for the first hour and 4d. per unit thereafter, and to adopt the Brighton system and the demand indicators.

The Institution Conversazione.—It is stated that the conversazione of the Institution of Electrical Engineers will be held this year in the Natural History Museum at South Kensington. The date is June 15.

Hampstead.—The Lighting Committee recommended at the Vestry meeting that electric lighting mains for the supply of current to private consumers be laid in Belsize-road and Kilburn Priory. This was adopted.

Sheffield Electric Light and Power Company.—The business of the Universal Electrical Fittings Company, Limited, Suffolk road, Sheffield, has been acquired by the Sheffield Electric Light and Power Company, Limited.

Liverpool Overhead Railway —The traffic receipts of this railway for the week ended May 9 amounted to £1,316, as compared with £1,162 in the corresponding week of the previous year, being an increase of £154.

Bristol Tramways and Carriage Company, Limited.—The traffic returns for the week ended May 7 were £2 271. 9s. 5d., compared with £2,196. 11s. 1d. for the corresponding period of last year, being an increase of £74. 18s 4d.

Darlaston.—Mr. Wynne has had his business premises fitted with an installation. The engine is of 4 h.p., and is by Tangyes. The contractors have been Messrs. Fellows, Wheatcroft, and Co., of Walsall, who have supplied the dynamos and plant.

Southport.—The electricity company have sent out a circular to the ratepayers calling attention to the prices and advantages of the electric light. The dissemination of such valuable information is a form of enterprise which other firms might well adopt.

Newmarket —A meeting of the Urban District Council is to be held to-day (Friday) to consider the offers for the purchase of the electric lighting provisional order. Offers have been received from Messrs. Edmundsons, Limited, and Messrs. Crompton and Co.

Ipswich.—In the House of Commons on Friday night the Electric Lighting Provisional Order (No. 1) Bill was read a third time. It confirms a provisional order made by the Board of Trade under the Electric Lighting Acts, 1882 and 1888, relating to Ipswich.

Price List.—The Phœnix Dynamo Manufacturing Company, of Bradford, have issued a concise and very useful price list of their dynamos and motors; and also handy card as to sizes of conductors, of tin fuse wires, of carbon for arc lamps, and a price list of electrical plant.

The Hull Trams.—The Hull Town Council have decided in favour of electric traction for the tramways. The estimate amounts to £225,000, which includes £125,000 for laying down permanently the roads, £60,000 in electrical appliances, and £40,000 in carriages, etc.

Newcastle.—A deputation, consisting of the chairman of the Lighting Committee of the Corporation (Mr. Barker Ellis), the vice-chairman (Mr. Matthewson), and other members, have visited Southport and Bolton for the purpose of inspecting the electric lighting of those two towns.

Paisley.—The Police Commissioners have decided to erect 61 arc lamps and posts for the principal streets of the borough, and the Lighting Committee will provide the current for £20 per lamp per annum. Mr. Teague is the electrical engineer, and he estimates that 400 gas lamps will be displaced.

City and South London Railway.—The returns for the week ended May 9 were £957 compared with £909 for the corresponding period of last year, being an increase of £48. The total receipts for the half-year 1897 were £19,503, compared with £17,936 last year, being an increase of £1,567.

London Lighting Extensions.—The London County Council have received notices of extensions of high and low tension mains, etc., from the London Electric Supply Corporation, the House-to-House Company, the Charing Cross and Strand Electricity Supply Corporation, and the Metropolitan Electric Supply Company.

Dudley.—Last week the Chairman of Ways and Means in the House of Commons had before him a Local Provisional Order Bill providing for an electric light supply to the borough. The Board of Trade made a report, in which it was said that the regulations had been complied with. Mr. Lowther in the result allowed the Bill to pass.

A Jubilee Holiday.—The directors of the National Telephone Company, Limited, have decided to give the staff a holiday on June 22 in commemoration of the Record Reign. Those of the employés who will be required on that day by the needs of the service will obtain a holiday at some other time or will receive an extra day's pay.

Exhibition of Motor-Cars.—There is an exhibition of motor cars and cycles at St. Stephen's Hall, adjoining Westminster Aquarium. The show will remain open until the 22nd inst. The exhibits comprise carriages for private use, vans for heavy loads, and cycles of different descriptions, the motive power being either oil or electricity.

The St. Mary Woolnoth Award.—The City and South London Railway Company, having paid over the Board of Trade award, have entered into temporary possession of the church of St. Mary Woolnoth. The building will, therefore, be closed until the company have completed their station, which is to be built under the floor of the church.

Monte Video.—Senor Jose Serrato, the Municipal Director of Public Works at Monte Video, has presented to the Municipality of that capital a proposition to the effect that the Direction of Imposts and Public Lighting take steps for the total substitution for gas of electric light in squares, making provisional installations in case the purchase of the necessary lanterns be found excessive.

Electric Lighting Bills.—There are again before Parliament this session a number of Bills to confirm orders provisionally made by the Board of Trade under the Electric Lighting Acts. Amongst the measures which have passed the committee stage without amendment, the Board of Trade orders being thus confirmed, are Bills relating to Barking Town, Tonbridge, Ventnor, Wimbledon, Lincoln, Darwen, and Leith.

International Inventions Exhibition.—In August and September of this year an international exhibition of inventions and improvements relating to science, industry, arts and crafts, hygiene and alimentation takes place at the Marlborough Hall, Polytechnic Institute, Regent-street, London, W. It is combined with an international prize competition and a special exhibition of dentistry and dental surgery.

Glasgow.—The *Glasgow Herald* understand that the Tramways Committee are unanimous in their recommendation to the Corporation to equip the Springburn route with the trolley or overhead system of electric traction. The Electric Lighting Committee have had under consideration three new sites for electric power and distribution stations, but they have delayed making a final selection pending the receiving of a report from Prof. Kennedy.

Appointment Vacant.—The Corporation of Leeds require the services of a competent person as chief electrical engineer, to take charge of the electric tramways, seven miles in extent, with probability of extension to 40 miles. Applications, stating age, experience, and salary required, to be sent, with copies of not more than three recent testimonials, to the town clerk, Leeds, marked outside "Electrical Engineer," so as to be received by 18th inst.

Dewsbury.—At the Town Council meeting, the Lighting Committee reported that the electric energy discharged was 3,400 compared with 2,596 units. The estimate of the expenditure for the coming year amounted to £745. The question of lighting the free library free of charge had been before the committee, but was referred to the General Purposes Committee. Alderman Fox moved, and Mr. Phillips seconded, the adoption of the minutes. The resolution was carried.

Blackpool.—The Corporation electricity works have made a profit of over £600 on the year's working. Mr. R. C. Quin is appointed borough electrical and tramway engineer, to have control and undertake the management of the electrical department of the Corporation tramway system. Mr. John Lancaster is appointed general manager of the tramways. The Board of Trade permits the altering of the standard pressure of supply of electricity from 100 volts to 200 volts.

Taunton.—At the meeting of the Market Trustees the Taunton and West Somerset Electric Tramways Company, Limited, forwarded circulars to the Trust requesting that they would inform the company whether they opposed the suggested tramways for Taunton or not. Mr. Easton said that that was a parliamentary matter which ought to be discussed by the Trust. It was decided to refer the matter to the committee, the names of the following gentlemen being added to the same: Messrs. Duder, Bruford, Easton, and Kite, to report thereon.

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Wakefield.—Councillor Atkinson reported at the City Council meeting that good progress was being made with the new sewage works, and Alderman Sherwood and Councillor Rhodes, who had paid a visit to Messrs. Fowler's works at Leeds, where the engines for the electric light works are being made, reported that good progress was being made in the construction of the engines. Alderman Sherwood said the electric light would be supplied by the Corporation in August.

Bury.—On the report of the borough engineer, the following resolutions were passed at the Town Council meeting—namely, that telephonic communication be established between Bank-street and the works, and that the matter be left to the chairman and the borough engineer to make the requisite arrangements; that the Lighting Committee be charged the sum of £20 per annum for each lamp supplied with electricity, this to include the supply of carbons and the necessary attention to the lamps.

City of London Electric Lighting Company.—The return for the quarter ended March 31 shows a gross revenue from sale of current for public lighting, £3,182, as against £3,161 for the corresponding quarter last year; private lighting, etc., £49,843, against £38,280; and from other sources, £1,500, against £750. The total receipts were £54,525, against £42,191, an increase of £12,334. The equivalent of 8-c.p. lamps connected on March 31, 1897, was 260,936, an increase during the quarter of 13,151. The increase during the corresponding quarter last year was 11,951.

Dumfries.—A conference of representatives from the district committees of Dumfriesshire County Council has been held with regard to an application by the National Telephone Company to erect a new line of poles from Courance to Lochmaben. Captain Yorstoun, who presided, stated that he had been informed by a Government official that by paying rent to the Post Office the Telephone Company could have the use of their poles; but he read a letter from the Telephone Company denying that such was the case. It was agreed to write the Postmaster-General on the subject.

Lincoln.—A discussion took place at the Town Council meeting with regard to the electric lighting scheme. Mr. Turner contended that they wanted the best installation possible for Lincoln, and that the trade of Lincoln ought to be placed in a position of equality in reference to certain portions of the work. He referred to the report of Dr. Hopkinson, who estimated the cost at £14,600. When their engineer was appointed, his first written report brought up the estimate to £17,000, and now they had an estimate that night of £20,000. Eventually it was decided to discuss the matter in committee.

Hastings.—The Corporation have resolved to buy the electric light works of the local company, and carry them on as a town concern; £58,000 is the price agreed upon, so that the shareholders will receive a premium of 15s. 8d. on each of their £10 shares. The plant includes the mains, standards, etc., utilised in the lighting of the parades, which are three miles in extent. It is estimated that if the first year's business is only equal to that of 1896 the profit to the ratepayers, after the repayment of principal and interest on the loan which will have to be raised, will amount to £1,500, which is equivalent to a penny rate.

London.—The Works Committee of the Metropolitan Asylums Board reported at the last meeting that, under the authority accorded them by the Board on the 13th ult., they had obtained from certain selected boilermakers tenders for the supply and fixing of the boilers required for the heating and electric lighting works at the Grove Hospital, and recommended that the tender of Messrs. J. Fraser and Sons, of Millwall, for the supply and fixing of the boilers at the Grove Hospital, at the sum of £1,960, in accordance with the plans and specification prepared by Mr. Tiltman, architect, be accepted, and this was agreed to.

Catalogues.—We have received from the General Electric Company, Limited, the May catalogue leaflet, which contains illustrations and prices of knife switches, fixtures and glassware, telephones, bells, galvanometers, motors, batteries, etc.—We have also received a handsomely designed catalogue of motor carriages, launches, etc., from the Daimler Motor Company, Limited, Coventry. The Book is well illustrated, and contains a great deal of very useful information.—The Crypto Works Company, Limited, of Clerkenwell-road, E.C., have sent us their catalogue of motors and dynamos, etc., which is well worthy of consideration.

Brierley Hill.—The Tramways Committee reported at the Urban District Council meeting that they had gone through and considered the proposed agreement between the Council and the British Electric Traction Company, Limited, which provided, *inter alia*, that the Council should forego its right to purchase the existing tramways for the period of at least 24 years, and also assent to the overhead system of electric traction. The committee recommended that the approval or otherwise of the agreement should stand over until the next meeting of the Council. The Chairman thought the committee would have to take the whole of the Council into their confidence on the matter and arrange for a special meeting.

Montreal.—An electric railway scheme is planned to connect Montreal with many near-by points across the river by means of the widened Victoria Bridge. The road will probably be called the Montreal and Southern Counties Railway. The idea is to connect Montreal and the south shore with the counties of Chambly, Vercheres, Ronville, St. Hyacinthe, Laprairie, Brown, Shefford, Stanstead, and Sherbrooke. From Montreal to Sherbrooke the main line and branches will form a system of 150 miles of track, and the road is to be constructed on the most approved methods. The trucks will be built in such a way that the cars run as fast as 40 miles an hour. The capital of the company is 2,000,000 dollars.

Bedford.—The Electric Light Committee reported at the Town Council meeting that the engineer had submitted to them estimates of extensions of the electric lighting scheme. The committee recommended that application be made to the Local Government Board for their sanction to the borrowing by the authority of the further sum of £20,000 for the purpose of making additions to the existing buildings and machinery, and providing and laying the mains for supplying the electrical energy within the borough for all public and private purposes, as defined by the Electric Lighting Acts, in accordance with the foregoing estimates, prepared by the engineer. The report was adopted.

Rochdale.—At the Town Council meeting, the chairman (Alderman Cheetham) made a short statement with reference to the application of the tramway company for permission to substitute electric traction for the present method on the Littleborough section of their lines, and for a renewal of the lease for another 21 years. He said the committee had considered it wise not to accede to the request of the company, for several reasons. After the five years of the unexpired term were up, improvements might and probably would be made in electric traction, and the committee did not wish to fetter the action of the Council which would then be in existence. At the end of the five years the Council might desire to purchase the tramways.

Dublin.—At the meeting of the Judicial Committee of the Priory Council an application was made by the Dundalk Electric Tramways Company, Limited, for permission to construct an electric tramway from the town of Dundalk to the village of Blackrock, a watering-place on the coast, distant about five miles from the town. Mr. Drummond, Q.C. (instructed by Messrs. V. B. Dillon and Co.), appeared for the promoters. The only objection was made by Mr. O'Shaughnessy, Q.C., who (instructed by Mr. Dickie) appeared for certain residents in Clanbrassil-street, who opposed the running of the tramway through that thoroughfare. The committee overruled the objection, and decided to report in favour of the whole scheme subject to agreements with certain objections by the railway company and others.

Tunbridge Wells.—A long discussion took place at the Town Council meeting, chiefly in regard to the position of lamps on Mount Ephraim and London-road. Councillor Wood defended the arc lamp system of lighting parts of the borough. It was explained that Tunbridge Wells trade establishments and private households now used the new lamp—about 235 places altogether. Councillor Putland said it seemed as if some of the gas shareholders on the Council did not like the fine light produced by the electric arc lamps. Councillor Strange, as one of the gas company shareholders, strongly opposed this reflection, and Alderman Delves, also of the gas company, further protested against the words of Councillor Putland. After remarks by Councillors Robinson, Finch, and Brindle on the rival merits of gas and electricity, the report of the Lighting Committee was adopted.

The "Premier" Code.—We have received a copy of the "Premier Cypher Telegraphic Code," compiled by Mr. W. H. Hawke. It is claimed for this code that not only is it the most complete, but that its use will, in general, admit of a saving of 50 per cent. in words over most other codes. The plan upon which the code is arranged is, first, a set of phrases in alphabetical order (185 pages), and then 300 pages of tables incorporating as much of the English language as is required for business and social purposes. In this part the left-hand pages consist of code words in columns. These words indicate a figure, and a letter read at the top and side of the column and reference to the opposite page shows these to mean a combination of a phrase and a word or two phrases. The code is published by Effingham Wilson, 11, Royal Exchange, and also in the provincial, most of the colonial, and some foreign capitals.

Worcester.—The Town Council have adopted all the recommendations made in the recent report of Mr. E. T. Ruthven-Murray, city electrical engineer, with the exception of the one relating to a reduction in the charge for the supply to the waterworks motors. The Council have adopted the alteration in tariff from 5d. per unit to 6d. per unit for the first hour's daily average use, and 2½d. per unit for all extra. All discounts have been abolished, and free lamps are to be given in lieu thereof for prompt payment. The charge for current to motors and cooking apparatus has been amended. Meter rents have been reduced 50 per cent. all round, and the Council are now entering into the agreement for free wiring of consumers' premises with the Free Wiring Syndicate. Lastly, and not least, the whole of the extensions recommended in the report, at an estimated cost of nearly £9,000, are to be carried out.

Liverpool.—The Liverpool Gas and Electric Fittings Company, Limited, have the following work in hand: (1) Upton Asylum, Chester, consisting of three 50-horse vertical engines by Messrs. Browett and Lindley, and three 35-unit Jackson dynamos direct coupled, 1,800 16-c.p. lamps distributed over a very large area, necessitating overhead mains; (2) Prince of Wales Hotel, Harrogate, consisting of one 40-horse Premier gas-engine, one 25-unit Taunton dynamo, two sets of Epstein accumulators, 600 16 c.p. lamps; (3) Ashworth's buildings, Manchester, consisting of two Stockport engines and two Jackson dynamos, belt-driven, heavy flywheeled, countershaft between, 400 16-c.p. lamps; (4) Spring-gardens, Manchester, consisting of two Stockport engines and two Jackson dynamos, belt-driven, heavy flywheeled countershaft between, about 400 16-c.p. lamps; (5) Messrs. Ayrton and Saunders, Liverpool, 200 16-c.p. lamps; Corporation main; beside many other installations in Liverpool.

Water Power in the United States.—The St. Lawrence Power Company has been incorporated under an Act of the Legislature

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of the State of New York, dated May 9, 1896, to construct a canal about three miles and a half long—from the St. Lawrence River to a point on the Grass River, close to the town of Massena, which is situated in St. Lawrence County, State of New York, about 60 miles above Montreal, and about 20 miles below Ogdensburg. The canal will, it is said, be capable of delivering 150,000 h.p. in water, and the requisite electrical machinery will be set up for delivering 75,000 of this by electricity. The remaining power will either be sold as water power, or as electrical power in the event of additional electrical machinery being erected in the future for its development As the demand for the power warrants, the capacity of the canal, it is stated, can be easily increased to produce as much as 400,000 h.p. to 500,000 h.p. The works of the canal will be situated in the town of Massena.

Walsall.—The Electric Lighting Committee recommended at the Town Council meeting that, with a view of increasing the demand for electric lighting, the charge for the excess above a maximum consumption for a period of 1½ hours daily throughout the year be from July 1 2d. per unit, the charge of 6d. per unit to be continued for all below the maximum, and that the instruments be affixed to the meters at an estimated cost of £200. Mr. Brownhill explained that this was not a resolution in favour of the larger consumers, but of those who used the light the longest period. The Town Clerk added that, notwithstanding the competition of the electric light, the make of gas last month was 12½ per cent. above the make in the corresponding month of last year. Mr. Brownhill proposed the adoption of the recommendation, and Mr. Noake seconded the proposition. Mr. J. H. Roberts proposed and Mr. Siddons seconded an amendment that the matter should be adjourned for a month, and a copy of the electrician's report be supplied to each member. The motion was carried by 21 votes to 8.

The Cork Tramways.—At the meeting of the Judicial Committee of the Privy Council at Dublin, Mr. T. M. Healy, M.P., applied on behalf of the Cork Electric Tramway Company for an order changing their title to the Cork Electric Tramway and Lighting Company. The company had, since obtaining their previous order, obtained a lighting order from the Corporation, and hence the necessity for the present application. Mr. M'Carthy Mahony, on behalf of the Cork Corporation, offered no opposition. Mr. Dunbar Barton, Q.C., M.P. (instructed by Messrs. V. B. Dillon and Co.), for the National Telephone Company, applied that the clause protecting the interests of the Postmaster-General should be extended and applied in this case so as to include his licensees, the Telephone Company being licensees of the Postmaster-General. Mr. Connor, on behalf of the grand jury, did not oppose, and the committee intimated that they would report in favour of the application, with the extension of the clause asked for by Mr. Barton.

Stockton.—The Finance Committee reported at the Town Council meeting that the following letter had been approved by them and forwarded to Messrs. Durnford, the parliamentary agents: "Dear Sirs,—I am in receipt of your letter of the 28th inst., forwarding print of provisional order. I consider the purchase clause, as altered by the promoters, most objectionable. It was intended that one or two of the municipal authorities, with the consent of the other, should have the power of purchasing the tramways at the expiration of 7 or 14 years. The new clause provides that the power of purchase shall only apply on the joint requisition of the three corporations and two parish councils. It seems inconceivable that all the five combined authorities should ever unite, so that practically the clause is useless. I think the clause should be altered so as to harmonise with that agreed between us and the promoters, and that such should be laid before the Board of Trade. If the Department then declines to accept the agreed clause, it may be necessary to oppose the confirmation Bill. I gather from your letter that the town clerk of Middlesbrough also objects to the alterations, presumably on the same grounds I have mentioned. I also think that the words omitted in sub-section 4 of the agreed clause, requiring the promoters to keep separate accounts, should be insisted upon."

Mexican Electric Works, Limited.—This Company has been registered, with a capital of £320,000 in £5 shares, to carry on the business of generators and distributors of electric energy for the purposes of light, heat, and motive power, or otherwise, in the United States of Mexico and elsewhere in America, and with a view thereto to adopt and carry into effect two separate agreements expressed to be made between Messrs. Siemens and Halske, of Berlin, of the one part, and this Company of the other part; generally, to carry on in all or any of their respective branches the businesses of electricians, mechanical engineers, manufacturers of and dealers in all apparatus and things required for or capable of being used in connection with the generation, distribution, supply, accumulation, and employment of electricity, and in particular to construct, lay down, establish, fix, and carry out all necessary cables, wires, lines, generators, dynamos, accumulators, transformers, lamps, plant, and machinery; to apply for, purchase, or otherwise acquire, any patents, brevets d'invention, licenses, concessions, and the like, conferring an exclusive or non-exclusive or limited right of use or manufacture or sale, or any secret or other information as to any invention which may seem to the Company capable of being profitably dealt in; to construct and maintain rail and tram roads, wharves, factories, warehouses, shops, stores, and other works and conveniences. Registered office: 65, Old Broad-street, E.C.

Keswick.—At the Urban District Council meeting Mr. Philipson moved that a sub-committee be appointed, as recommended, because the electric lighting company did not seem as though they were going to take over the order quickly or do it in a reasonable time even. If a sub-committee were formed they would be able to consider how they should deal with it themselves, or perhaps they could dispose of it elsewhere. Mr. Bromley thought it was a pity that a little electric fluid could not be inserted into the workings of the directorate of the company. They had been negotiating for the order for six or seven months, and they didn't seem to be anxious to take it. He would advertise the order right away. Mr. Mumberson thought it was distinctly understood, March 31 having expired, and there having been no reply from the electric lighting company, although the Council's legal adviser had written one letter after another, that their hands were now free, and if they chose to take up the lighting of the town themselves, they were perfectly at liberty to do so. It could not be said that the Council had acted with any undue haste. They did not want the electric light company to turn round and say that they had acted shabbily towards them; he thought they had waited very patiently indeed. The recommendations of the Finance Committee were adopted, and Messrs. Mumberson, Philipson, Lowther, Pape, Wood, and Hope were appointed the sub-committee in regard to the electric lighting order.

New Swindon.—Two letters from Mr. J. G. W. Aldridge, electrical engineer, of London, respecting his charges for professional services, were read at the Urban District Council meeting. Mr. Aldridge offered to prepare a plan of an electric light station, mains, lamps, etc, for the whole of New Swindon for £50. Mr. Mills proposed that the letters be referred to the Electric Light Committee. This motion fell through for the want of a seconder. Mr. Protheroe then proposed that, in accordance with the terms of the letter, Mr. Aldridge be asked to prepare a plan of the station, etc., for £50. He said they all desired the fullest information before taking any further step. This was seconded by Mr. Pryce, and supported by Mr. Brain. The proposition was lost. Mr. Williams proposed that the Council ask Mr. Aldridge to come to Swindon and meet the Electric Light Committee, and discuss the question with them at his earliest convenience. Mr. James seconded this, and said there was one attitude which this Council must not take up, and that was an attitude of non-enquiry. If they did that they would be condemned generally in the town, and rightly so, too. The members would get the information they required by seeing Mr. Aldridge. The resolution was carried, and it was resolved that the fee to be paid Mr. Aldridge for attending should not exceed £5. On the motion by Mr. Brain, seconded by Mr. Carpenter, every member of the Council was invited to attend the interview and obtain what information they required.

Hull.—A Local Government Board enquiry has been held by Colonel Hasted respecting the proposed borrowing by the Corporation of £52,000 under the Electric Lighting Act, 1882, for electric lighting extension. Mr. Barnard said the Corporation built their present works four years ago. In January, 1893, they had 33 attached to the mains, and that had grown steadily ever since, and now they had 556 customers. In the first area the supply was kept within the docks with 2½ miles of mains, but early in 1893 there was an additional three miles laid down outside the docks. The capacity of the plant at first laid down was sufficient for a maximum of 10,000 lamps. This was increased in 1894, and again in 1895, whilst now the capacity was 22,000 lamps. They had since received notices for 1,700 of the same lamps to be fitted up. At present the plant was therefore clearly inadequate to meet the demands that would be made upon it next winter, unless it was supplemented by permanent or temporary plant. The present mains served an area which was almost exclusively composed of shops and business premises. It was felt that they would also have to serve residential districts, and they would require a greater variety of lamps. Numerous requests were continually being made for a supply of current in residential districts. They required a new station in Sculcoates-lane, with sub stations at Albion-street, Argyle-street, and Holderness-road. Councillor Skinner stated that since the first year of the works they had been a profit to the town. The profits had increased from year to year.

Sheffield.—The following is the letter which the electric light and power company sent to the Parliamentary Committee declaring that the Corporation's notice to purchase the undertaking was invalid: "The Sheffield Electric Light and Power Company, Limited, April 22, 1897. Dear Sir,—In reference to your letter to this company of the 15th inst., and the notice of the same date from the Corporation of the city of Sheffield to this company, a copy of which is hereto annexed, I am instructed by the directors of this company to inform you that the company is advised that: (*a*) The Corporation have not any power to issue in the terms of Section 60, Sub-section 1, of the provisional order granted by the Board of Trade to this company, under the Electric Lighting Acts, 1882 and 1888, 'such an amount of Corporation stock as will produce by the interest or dividends thereon an annuity of 5 per cent. per annum upon the amount properly expended by this company upon the undertaking, and chargeable to capital account.' (*b*) The Corporation are, by reason of the fact stated in paragraph (*a*), unable to comply with the terms for purchase of the undertaking of this company contained in Section 60, Sub-section 1, of this company's provisional order, for such sub-section provides for the issue or transfer by the Corporation to this company, by way of purchase-money, of Corporation stock, of the description referred to in paragraph (*a*) of this letter, except as to a comparatively small amount which is payable in cash. (*c*) In the circumstances stated above, the Corporation are not, as the local authority for the city of Sheffield, as defined by the Electric Lighting Acts, 1882 and 1888, or in any other capacity, entitled at present to require this company to sell its undertaking to the Corporation upon the terms of Section 60, Sub-

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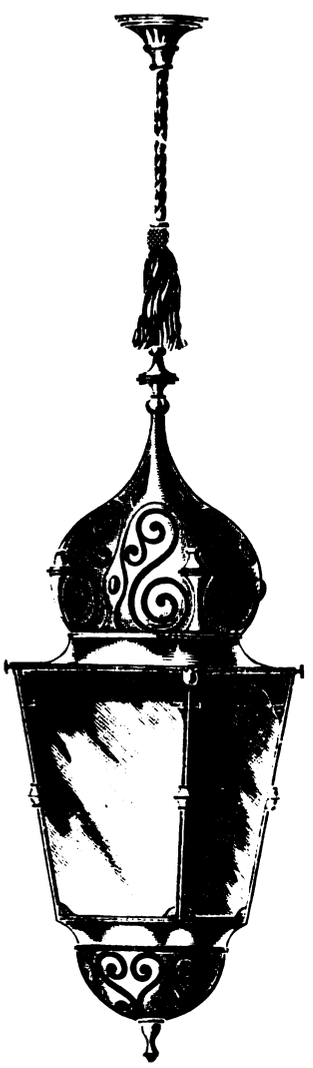
section 1, of the company's provisional order, or otherwise. (*d*) The notice by the Corporation to this company requiring this company to sell its undertaking to the Corporation is for the foregoing reasons invalid and of non-effect. I am also instructed to inform you that this company will treat the notice from the Corporation as a nullity and invalid, and will act accordingly.—Yours obediently, WM. JOHNSON, secretary."

Electric Light Fittings.—We give below two illustrations of what may be described as "up-te-date" electric light fittings,



which will be of some interest. They are facsimiles of articles turned out by the Ediswan Company.

Business in Japan.—Some of the American technical papers are advising electrical engineers to keep a close eye on electrical developments in Japan. During the last session of the Japanese Imperial Diet it was agreed to appropriate a sum of above 12,800,000 yen, or something like £3,000,000, spread over seven years, for the extension of the telephone service, and the work of construction is being actively carried on at various important places. Notwithstanding the activity of the Japanese in these matters, many of the applications which are now being granted this year were sent in so far back as 1893. The *Journal of Electricity* says the way is being made much easier for American manufacturers by the marked preference which the Japanese have shown for American methods. This is strikingly instanced in the fact that three electrical experts, Messrs. Mine, Nakayami, and Wadachi, engineers of the Department of Communication, have lately been sent to the States for the purpose of studying the latest developments. That Japan is open to adopt the best electrical appliances of any country is seen in a recent large purchase of camp telegraph apparatus in Berlin for service in Japanese military operations, and it is stated that in future the Berlin material will be imported for the use of the Japanese army. It is to be hoped that those persons in this country who are specially interested in the matter will take careful note of these facts.

Cardiff.—In the minutes of a special committee *re* electric tramways, read at the Town Council meeting, it was recommended that a deputation, consisting of the Mayor, the Deputy-Mayor (Councillor Morgan Morgan), the chairman (Alderman Carey), Alderman D. Jones, Councillors Hallett and Andrews, the borough engineer, and the electrical engineer, be appointed a deputation to visit places where such tramways were in use for the purpose of getting information as to the best measures for providing the energy and working the proposed tramways, and also as to the best system of traction. Alderman Trounce asked if it was intended that those gentlemen should travel on the Continent. If so, the expense would be very great, and he thought the number should be reduced. Alderman Carey said Leeds, Birmingham, Manchester, and other corporations sent their deputations round several Continental towns. This was a most important matter, which would involve many thousands of pounds, and he thought the committee should be allowed to go where they thought necessary in order to get proper information. Alderman Trounce considered the proposed deputation too large, and moved that it be reduced to four. Councillor Robinson seconded, and named the chairman of the committee, Councillor Hallett, the borough engineer, and the electrical engineer. A desultory discussion ensued, several members advocating the larger and others the smaller number, while Councillors Hallett, Morgan Morgan, and Andrews urged that each member of the deputation should pay his own expenses, an idea which Councillor Brain (chairman of the Finance Committee) and others thought unwise. Councillor Morgan Morgan said the guinea a day of "snuff money" was not sufficient to pay expenses, and he would rather pay his own way. He was not so fond of going on the "razzle-dazzle" as to take it at that rate. A proposal was made to include Aldermen D. Jones and Jacobs and others, but on a division Alderman Trounce's and Councillor Robinson's proposition was carried by 26 votes to 6, Councillor Hallett, who was one of two neutrals, remarking that he would pay his own expenses. A paragraph which related to the extent of the scheme was referred back to the committee for reconsideration.

Bristol.—At the meeting of the Corporation, Councillor Pearson moved the adoption of the second clause of the report referring to the extension of public lighting by means of electricity. He pointed out that the Sanitary Committee, in arranging for the extension of electric lighting, considered that all parts of the city should get a part at least of the benefit of the improved method of lighting. The general lines the committee had gone on were that each main thoroughfare into the city from the boundaries should be lighted by electricity. The list of streets set out in the report would show that the committee had practically worked this out with a fair amount of success. One point had been omitted. The occupiers of premises in Redcliffe-street were apprehensive lest the extension to Bedminster might pass along another thoroughfare from Bristol Bridge. He desired to allay any doubts in regard to that matter by saying that they would go direct from Bristol Bridge through Redcliffe-street and East-street to the London Inn. The price recommended to be paid was lower than that now being charged. As a matter of fact, the Electric Lighting Committee found that the Sanitary Committee were their best customers, hence they felt they would be best consulting the interests of the public by taking the earliest opportunity of giving back to the public some of the money they were contributing in aid of the electrical undertaking. The Electrical Committee had ascertained that they might reasonably hope to make a moderate profit by charging £23 per lamp against £35 now paid. In the present case, as in all cases, the cost was governed by output. He thought the Council would be satisfied (he was, as chairman of the Electrical Committee) that they were able to reduce the price to £23 per lamp, which price would cover every expense in connection with the lighting, and would also bear one-tenth of the cost of the building. As a matter of fact the electrical works would be enlarged if the electric extension took place or not. Although the cost of the expansion of the works would be about 10 per cent., the increased output would be about 50 per cent. The result would be that the proposed 200 lamps would mean an expenditure of less than £900 a year more than was now paid for gas. Councillor Lloyd seconded the adoption of the clause. In reply to the discussion which ensued, Councillor Pearson said the objection to going to Totterdown beyond the three lamps was that they would then be in the county of Somerset. Certainly, the size of the lamps might be reduced. Replying to Mr. Alderman Dix, he said the total cost of gas and electricity over the whole area to be lit by electricity was £6,090, and the future cost would be £6,969, and the difference which the ratepayers would be called upon to pay would be £879. In addition, the gas lamp posts displaced would be at the disposal of the Sanitary Committee for erection elsewhere, and the Electrical Committee would provide the lamp-posts for the electric light. If Mr. Alderman Dix would look at the accounts for last year of the Electrical Committee he would see that they had repaid £4,000 in respect of loans, bringing up the total repayments to £11,240. They had kept their machinery up to date, and the station was better equipped to-day than when it was opened. The question of renewals scarcely arose when a machine was kept up to its original

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capacity, and, in addition, they provided during the life of a machine for its replacement at its death. At the end of 25 years the station would be handed to the city free, and the price of electricity would not, he ventured to say, then be 6d. per unit. The recommendation was adopted.

PROVISIONAL PATENTS, 1897.

MAY 3.

10994. Improvements in electric arc lamps. Frederic Stanhope Worsley, 47, Lincoln's-inn-fields, London.

10995. Improvements in carbon-holders for electric arc lamps. Frederic Stanhope Worsley, 47, Lincoln's-inn-fields, London.

11009. Improvements in the manufacture of incandescent electric lamps. William Edward Barras, 46, Lincoln's-inn-fields, London.

11017. Improvements in telegraph cables or the like. John James Hall, 31, Southampton-buildings, Chancery-lane, London.

MAY 4.

11022. Improvements in telegraph keys. Alfred Christopher Robinson, 115, Cannon-street, London.

11045. Improved apparatus for supplying or measuring a current of electricity. William Dobson Watson and Thomas Humphreys, 4, St. Ann's-square, Manchester.

11051. Improvements in ceiling roses for electrical purposes. William Paul Theermann, 12, Corporation-street, Manchester.

11058. Improvements in electric meters applicable also to instruments for testing the magnetic properties of iron. James Finlayson, 62, St. Vincent-street, Glasgow.

11086. Improvements in electro-pneumatic steering-gear for vessels. Alfred Julius Boult, 111, Hatton-garden, London. (Charles Eaton Creecy, United States.) (Complete specification.)

11119. Improvements in telegraphic apparatus. Charles Frederick Eaton. jun., 6, Bream's-buildings, Chancery-lane, London. (Complete specification.)

11124. Improvements in electric lampholders. Edward Lionel Joseph, 65, Chancery-lane, London. (Complete specification.)

11148. Improvements in alternating-current motors. Reginald Belfield, 322, High Holborn, London. (Benjamin Garver Lamme, United States.)

11149. Improved methods of and means for controlling electric motors. Reginald Belfield, 322, High Holborn, London. (The Westinghouse Electric and Manufacturing Company, United States.)

11155. Improvements in or relating to electric arc lamps. Alfred Julius Boult, 111, Hatton-garden, London. (Ernest Albert Pellet and Jules Déjardin, France.)

MAY 5.

11190. Improvements in the electrolysis of fused zinc chloride. Farnham Maxwell Lyte, 60, Finborough-road, South Kensington, London.

11199. A combination automatic action cut-out and trigger switch for governing the speed of vehicles worked by electricity or other power. John Felix O'Neill, Mary Mount, Dalkey, co. Dublin.

11224. Improvements in electricity meters. Chamberlain and Hookham, Limited, and Sydney Holmwood Holden, 18, Southampton-buildings, Chancery-lane, London.

11226. Improvements in telephones. Edward Priddle, 40, Chancery-lane, London.

11231. Improvements in dry batteries. Edgar Giglio, 322, High Holborn, London.

11236. An improved process and means for electrically purifying liquids. Dexter Reynolds, Norfolk House, Norfolk-street, Strand, London.

MAY 6.

11270. Improvement in electrical connections for theatrical stage purposes. William Howell Williams, 154, Wheatland-lane, Seacombe, Cheshire.

11317. Improvements in electrical signal systems for railways. Louis Charles Werner, 45, Southampton-buildings, Chancery-lane, London.

11320. An improvement in electric fuse heads for blasting and for other purposes. George Pettinger, *Invention* Office, Mitre-court, Fleet-street, London.

11334. Improvements in electric ignition devices for gas-engines and other gaseous explosive mixture engines. John Vaughan-Sherrin, 77, Chancery-lane, London.

11337. Improvements in or relating to sockets or holders for incandescent electric lamps and the attachment of lamps thereto. Alfred Julius Boult, 111, Hatton-garden, London. (Eduard Worringen, Holland.) (Complete specification.)

MAY 7.

11355. Improved means for attaching shades to electric incandescent lampholders. Herbert Hampton Hall and Thomas Clarke, 6, Clayton-square, Liverpool.

11383. Improvements in electric heel plates and like articles. John Wilson Gibbs, 119, West Forty-second-street, New York, U.S.A.

11402. A process of and apparatus for electrically decomposing solid substances. William Swart Romme, 65, Chancery-lane, London.

11413. Improved electrical signalling apparatus for transmitting commands and the like. Charles Denton Abel, 28, Southampton-buildings, Chancery-lane, London. Allgemeine Elektricitäts-Gesellschaft, Germany.) (Complete specification.)

MAY 8.

11480. A new method of making and breaking an electric circuit. Charles Newman, 13, Pembridge-crescent, London.

11497. Electrical advertising apparatus. John Sydney Collett, 17, Farringdon-avenue, London.

SPECIFICATIONS PUBLISHED.

1896.

7621. Electric switches and apparatus for connecting electric circuits. Andrews.

8398. Electrical resistances. Edmunds.

10284. Reflector in connection with glass bulbs or glow lamps for electric lighting. Pridmore, Sturgeon, and Yorke.

12070. Transmission dynamometers. Dally.

12329. Electrical switches. Binswanger.

13145. Construction of ammeters and voltmeters. Baker.

23195. Machines for weaving insulating coverings on electrical conductors. Lake. (Clark.)

27391. Electric furnaces. Price.

1897.

1158. Dynamo-electric generators and motors. Scott and New.

4138. Electric furnaces. Patten.

4212 Alternating-current meters. Raab.

6778. Electric current conducting apparatus for electric railways with underground feed. Stendebach and Linker.

6818. Storage battery. Entwisle. (Barret.)

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	9¼-9¾
Brush Company, Ordinary	3	¼ 1¼
—— Non. Cum., 6 per cent. Pref.	2	1⅛-1½
—— 4½ per cent. Debenture Stock	100	104-108
—— 4½ per cent. 2nd Debenture Stock	100	95-99
Callender's Cable Company, Debentures	100	109-114
Central London Railway, Ordinary	10	9⅞-10¼
——	6	5¾-6¼
Charing Cross and Strand	5	10¼-11¼
Chelsea Electricity Company	5	8¾-9¼
—— 4½ per cent. Debentures	100	112-116
City of London, Ordinary	10	22-23
—— 6 per cent. Cumulative Pref.	10	16½-17½
—— 5 per cent. Debenture Stock	100	130-135
City and South London Railway, Consolidated Ordinary	100	58-60
—— 4 per cent. Debenture Stock	100	137-139
—— 5 per cent. Pref. Shares	10	15½-16
County of London and Brush Provincial Co., Ordinary	10	12¼-12¾
—— 6 per cent. Cum. Pref.	10	14¾-15¼
—— 4½ per cent. 2nd Debenture Stock	10	14½-15
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	1¾-2¼
—— 5 per cent. Debentures	—	90-95
Edison and Swan United Ordinary	3	1¾-2¼
—— 5 per cent. Debentures	5	3-4
—— 4½ per cent. Debentures	100	105-110
Electric Construction, Limited	2	1½-1¾
—— 7 per cent. Cumulative Pref.	2	2⅞-3¼
Elmore's Copper Depositing	1	¾-1
Elmore's Wire Company	2	1-1¼
W. T. Henley's Telegraph Works, Ordinary	10	18½-19½
—— 7 per cent. Preference	10	18½-19½
—— 4½ per cent. Debentures	100	108-113
House-to-House Company, Ordinary	5	7½-8
—— 7 per cent. Preference	5	9½-10
India Rubber and Gutta Percha Works	10	20½-21½
—— 4½ per cent. Debentures	100	104-107
Kensington and Knightsbridge Ordinary	5	11¾-12¼
—— 6 per cent. Pref.	5	8-8½
London Electric Supply	5	1½-1¾
Metropolitan Electric Supply	10	16½-17½
—— 4½ per cent. First Mortgage Debenture Stock	100	120-124
National Telephone, Ordinary	5	6⅞-6⅝
—— 6 per cent. Cum. First Pref.	10	15-17
—— 6 per cent. Cum. Second Pref.	10	15-17
—— 5 per cent. Non. Cum. Third Pref.	5	6-6½
—— 3½ per cent. Deb. Stock	100	105-109
Notting Hill Company	10	13-14
Oriental, Limited, £1 shares	1	1½-2
—— £5 Shares	5	8¼-9
—— £4½ shares	4½	7½-8
Oriental Telephone and Electric Company	1	⅝-¾
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	102-104
St. James's and Pall Mall, Ordinary	5	15-16
—— 7 per cent. Pref.	5	10-11
Telegraph Construction and Maintenance	12	34-37
—— 5 per cent. Bonds	100	103-106
Waterloo and City Railway, Ordinary	8	10¾-11¼
Westminster Electric Supply, Ordinary	5	13¾-14½
Yorkshire House-to-House	5	8⅛-8¼

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NOTES.

The King's College Dinner.—The annual dinner of old students of King's College, London, is to be held at the Holborn Restaurant on Monday, June 28. Lord Kelvin will take the chair, and the Duke of Cambridge intends to be present.

Fire.—There was a fire at Messrs. Siemens Bros. and Co.'s works, at New Charlton, early on Tuesday morning. The site of the fire was a pile of timber in the yard. The cause is unknown, and some of the workmen very quickly put the fire out with the help of a hydrant.

The Institution Students.—The next students' meeting in connection with the Institution of Electrical Engineers will be held at 28, Victoria-street, S.W., on Wednesday, May 26, at 7.30 p.m., when a paper will be read on "The Working of Long Submarine Cables" by Messrs. R. M. Sayers and S. S. Grant.

Faraday House.—Mr. James Swinburne will commence a course of lectures to the senior students of the Electrical Standardising, Testing, and Training Institution on the subject of "Dynamo and Transformer Construction" on Tuesday, June 1. We have received from Faraday House a souvenir of the old students' dinner in the beginning of the year. It has a report of the speeches, and portraits of all the speakers.

Received.—Part 5 of vol. xiii. of the *Transactions* of the North-East Coast Institution of Engineers and Shipbuilders deals with their annual dinner. There is also a discussion on the strength of girders and Mr. Wallis's paper on liquid fuel. A notion that came up on the discussion of this was to prevent the possibility of an explosion of oil gas in bunkers by running water in as fast as the oil ran out and so having no air-space.

The Pender Medal.—The International Submarine Telegraph Memorial Committee, of which the Marquis of Tweeddale is the chairman, has granted "The Sir John Pender Gold Medal," value £5. 5s., to the Glasgow and West of Scotland Technical College. It is given annually to the best student who at the same time obtains the college diploma in electrical engineering, and at the end of this session, which terminated last week, was awarded to Mr. David Robertson, Glendale, Uddingston.

Another "Closed Conduit."—Messrs. Megroz and Stork are reported to have brought out before the Hungarian Society of Engineers and Architects at Budapest a new "closed conduit" system for electric tramways. According to the *Schweizerische Bauzeitung*, the arrangement is that as the car runs along the rails, metallic tongues rise up and make the contacts with the car. As to what new precautions have been devised to obviate the effect of dust and mud upon contact-making arrangements of this sort, no details are available.

Electrolytic Sugar.—Mr. E. Urbain, in a note in the *Revue Générale des Sciences*, speaks highly of an electrolytic method of sugar purification worked out by Messrs. Javaux, Gillois, and Dupont. There are three compartments in the trough. The lead anode is in the centre one, and is separated from the cathodes, which are of iron or carbon, by porous diaphragms. It is supposed that the salts formed at the anode will be insoluble, but the presence of lead at all is objectionable; and it does not appear that the process is at present a particularly cheap one.

Chemical Society.—It is announced that a meeting of the Research Fund Committee will be held in June, and applications for grants, accompanied by full particulars, should be sent to the secretaries of the Chemical Society before June 8. A new list of officers and Fellows of the society being in course of preparation, it is requested that Fellows will send any alteration of address, without delay, to the assistant secretary, Burlington House, London, W. Among the papers for reading at yesterday's (Thursday) meeting were two, on "The Theory of Osmotic Pressure and the Hypothesis of Electrolytic Dissociation," and on "The Molecular Rotations of Optically Active Salts," by Mr. Holland Crompton.

The Telephones and the Post Office.—It has been announced that arrangements have been concluded between the Telephone Company and the Postmaster-General by which subscribers connected to the exchanges of the company in London will, after June 1, be enabled to telephone a message for transmission over the postal telegraphs as a telegram, delivery as an express letter, or as an ordinary letter, or to call for the services of a Post Office express messenger. There are a number of rules (*a*, *b*, *c*, and *d*) to be complied with, which at first reading are a little bewildering.

Discharge in a Gas.—According to a communication of Prof. Villari to the Naples Academy, a gas that has been subjected to the action of a prolonged electrical discharge, although apparently unaltered in composition, has suffered some change which causes a heated substance, such as a red-hot platinum, wire immersed in it to cool quicker than it would do before discharge. This seems a roundabout way of putting it, but it is not clear that the phenomenon would be correctly described as one of increased conductivity of heat. The difference is stated to amount to as much as 10 per cent., but apparently is dependent upon the atomic weight.

Auto-Lux.—That gas and electricity have in so many cases decided to be foes is to be regretted, because there are many ways in which they could work together. One would not, however, lay too much stress on the use of electrical arrangements for the simultaneous extinction and lighting of gas lamps. Mr. Chateau, in conjunction with Mr. Engraz, who is the director of the local gasworks, and Dr. Guyenot, have devised a system for effecting this at Aix-le-Bains which is said to be both reliable in operation and economical in practice. It is fully described and illustrated in the *Revue Industrielle*. The gas is turned on by the action of an electromagnet and lighted by the incandescence of a platinum wire. The inventors have given a name to the system; it is "auto-lux." An overhead wire from lamp to lamp would be objectionable, and to put it underground costs money.

The Mechanical Engineers.—The summer meeting of the Institution of Mechanical Engineers will be held in Birmingham, and will begin on Tuesday, July 27. This is the jubilee year of the establishment of the institution, which took place at Birmingham in 1847. The programme has been settled in outline. On Tuesday, July 27, there will be a reception of the president, Mr. E. Windsor Richards, and the council and members of the institution in Mason College by the Lord Mayor of Birmingham and the Local Committee. Discussions of papers follow, with luncheon at the Grand Hotel; in the afternoon, visits to works in Birmingham; and in the evening the institution dinner. On Wednesday, more papers and visits to works in Birmingham, or Oldbury, or Tipton, or Wolverhampton. In the evening a conversazione in the Botanical Gardens, Edgbaston. On Thursday, July 29, there is an excursion to Coventry, to visit cycle and motor works, and to Warwick; and on Friday an excursion to Stratford-on-Avon. Members may take ladies with them to see the cycles and the Shakespearean relics.

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Boiler Legislation.—In the House of Commons on Monday, Sir W. Houldsworth asked the Secretary for the Home Department whether the Government would appoint a Select Committee to consider the working of the Boiler Explosions Acts with a view of ascertaining whether any further legislation was desirable; but Sir M. W. Ridley said the session was too far advanced to hope that a committee could do much with an enquiry before its close. If he saw any indications that an enquiry would be generally welcomed in regard both to the subject and also to that of the Bill relating to the persons in charge of engines and boilers, he would be prepared to favourably consider the proposal. Precisely. But the only hope of the latter Bill is that it should be got through by an appeal to the feelings of members who know next to nothing about boilers, and are incapable of appreciating how the measure would work. It will be found that nobody wants an enquiry, nor that the general public should be made aware of the fact that the results of what are classed as "explosions" are very different in different types of boiler, and that ignorance on the part of the boiler tender has seldom anything to do with them.

Current Convection.—Mr. Appleyard's investigations into liquid coherers and the experiments which he exhibited at the Physical Society were exceedingly interesting. The prompt way in which a high-tension discharge brings down one of the constituents of an emulsion, is a discovery which seems certain to be turned to practical use before very long. Mr. Appleyard's further experiments also appear in a communication to the Physical Society. If mercury is divided by a diaphragm of some permeable substance (such as damp leather), and a current passed across, a film of metal is formed on the anode side of the leather, which sticks there when it is removed from the mercury. Mercury is unfortunately the only metal which is liquid at ordinary temperatures, so comparison experiments are not easy. Tinfoil between filter paper gets perforated with tiny holes. Slight deposits of gold on wet filter paper follow the course of the current. With commendable caution, Mr. Appleyard presents no theory of the action pending further investigation. It is probably enough somewhat complicated, and not by any means to be explained off-hand. A complete understanding of it might lead not only to interesting theoretical deductions, but to the application of electricity to a field which is at present almost unworked.

The Marconi Telegraph.—News comes to hand of the progress of the experiments which are being carried on by the Post Office in the way of wireless telegraphy between Flat Holm and the Welsh mainland. Mr. Marconi was at work for several days last week at Lavernock Point, near Cardiff, in testing the system, the communication being from the Point to Flat Holm. The trials were witnessed by Mr. Preece, Mr. Gavey, Mr. Fardo (the Cardiff postmaster), and other officials of the Department. On the Tuesday the experiments were not so successful as might have been desired, but on Wednesday and Thursday the results were satisfactory. On Friday a number of local engineers and others were invited to inspect the apparatus, and signals were sent, not from Flat Holm, but over a distance of about 20 yards. The Marconi apparatus, finally, gives a Morse record, but that is, of course, a question of relays. Up to the present nothing is published as to the details of the receiver. It is not possible to transmit induction signals of this character for any great distance through earth or water, and this may have something to do with the high pole with a large cylinder at the top which was erected on Lavernock Point. This would be one way of getting over the curvature of the earth and the effects of proximity to the sea. Meanwhile, there has been talk about balloons on Salisbury Plain. But balloons are unmanageable things to work with at any time.

Royal Institution.—The courses of afternoon lectures at the Royal Institution have run out almost simultaneously, so that there is now a new set commenced. They do not, however, touch our domain. Last week's discourse was by Prof. Harold Dixon on explosion flames. By experiments in long tubes he demonstrated the fact that there is a critical point in the pressure which determines whether an explosive mixture of gases will go off violently, or whether the process will be one of little more than rapid combustion. To use Prof. Dixon's words, the gas wants "something to kick against"—for instance, the closed end of the tube—in order to get up anything like a detonation. To-night (Friday) Lord Kelvin lectures on the contact electricity of metals, and the succeeding discourses are of more than usual interest. In the first (May 28) Prof. Moissan will exhibit the element fluorine, which for so long successfully resisted all the efforts of the chemist to drag it out of combination with something else. The method which finally succeeded is a good example of electrolysis under difficulties. Then, on June 4, will come Mr. Preece on wireless telegraphy. Mr. Preece should be able to tell us what he and Mr. Marconi have done at Penarth. Lastly, on June 11, there is Mr. Crookes on diamonds. One may expect that Mr. Crookes will show diamonds in unusual settings and peculiar circumstances, and he may say something about the possibility of making and breaking them.

The Gasworks View.—The *Journal of Gas Lighting* keeps a constant eye on electricity. It has observed that in towns where electric lighting is undertaken by companies, there is a strong movement favouring the transfer of the business to the local authorities. Our contemporary has considered the matter, and has come to the conclusion that the movement is wrong, apparently mainly because an electric lighting order does not last for ever. "If the company should be prosperous, let them enjoy their prosperity for the short time that is allotted to them by law." This is kind. Moreover, it implies a recognition that in the competition for the supply of light between gas and electricity the handicap is in favour of the former. One would hardly suggest that a company as it approaches the end of its term would be less likely to lower rates and push extensions than a municipality, for that is looking very far ahead. *Fas est et ab hoste doceri*, though the thing learned may usually be just what the other side is not trying to teach. From a purely selfish point of view, electrical people will be glad to hear from our contemporary that the gas industry is not going to do anything much in the future that it has not already done. It is a business with "a future not likely to bring many or great surprises." There were some of us who thought that there were one or two things that the gas people might think worth trying, if they were pressed too hard.

New Cable Proposals.—The Berlin correspondent of the *Standard* says that the Mozambique Company and the Compagnie Industrielle d'Orient have opened negotiations for the conclusion of a contract for laying a cable from Beira, in Portuguese East Africa, to Europe, and it is also reported that the Compagnie Industrielle intends to erect a telegraph line from Beira to the frontier of the South African Republic. It is supposed in Lisbon that the Transvaal will be willing to share a large portion of the cost and provide a good deal of the capital (it is certain that Portugal cannot). The correspondent further throws upon Portugal the suggestion of laying a cable from Swakopmund to Mossamedes, in Portuguese West Africa, instead of a land line connecting to the Cape telegraphs.

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This proposal, says the correspondent, will be accepted by Germany, as she can thereby obtain a land telegraph station in South-West Africa without coming in contact with the English. This cable and its prospects have already been referred to in these notes. That communication with the Cape would give in every way greater facilities is of no importance, because a cable ending at Swakopmund, which is the Germanesque way of saying the boundary of the British settlement at Walfisch Bay, would carry as nearly as may be no business at all. It is, of course, impossible to get to the Transvaal that way, because there is first of all the Kalahari "desert" to be crossed, and then either South Rhodesia or Bechuanaland.

Illuminations.—The *Daily Telegraph*, which has managed to put together rather more than a column on the subject, informs the world that electricity will play a more important part in the illuminations that are to mark the celebration of the Diamond Jubilee than was possible in 1887, and also that in 1837 the incandescent lamp had not been heard of. It is confidently believed that both statements are strictly accurate. Our contemporary has got hold of one thing, however, and that is that a great demand for current for a very short time is just the thing that the central-station engineer is not anxious for. "There can be no doubt that it (electric lighting) would make a still more imposing show than it will be permitted to do had the generating stations of the Metropolis been prepared with a greater reserve than that which they can call into requisition upon an emergency. It is precisely because some companies have already been compelled to refuse applications, and because of the uncertainty on the part of others as to their being able to fulfil their ordinary obligations, that the extent of electrical illumination will be limited. But it will, of course, be on a much larger scale than was feasible 10 years ago." As many of the illuminations will run for three nights, and will thus overlap the full business load, one can see that there might easily be some anxiety as to where all the current was to come from. And the incandescent lamp is such a handy and convenient thing to work up into devices, that it can hardly fail to be tried pretty extensively.

University of London.—At the presentation of the successful candidates for matriculation and degrees at the University of London last week, Lord Herschell presided, and, after distributing the certificates and medals, delivered an address in which he expressed a hope that the long-discussed changes by which it was proposed to make the university a teaching as well as an examining body would before long be effected. A committee of the senate, and subsequently the senate itself, had been carefully revising the studies which formed the curriculum of the university, with the view of bringing the examinations to the level of present knowledge and present needs. At a meeting of Convocation Dr. J. R. Bradford presented the report of the annual committee and moved its reception, which was carried. The report dealt with a variety of subjects, the first of which was the syllabus for the Intermediate B.Sc. Examination. A sub-committee was appointed to report on this question, and was unanimous that the number of subjects for the examination might be increased with advantage, and that a certain choice of subjects should be allowed to candidates, so as to relieve some students from necessity of taking so much general biology; also that the subjects of mathematics, physics, and general chemistry should still be compulsory on all candidates. The committee reported that the new regulations for the intermediate examination in science, as generally approved by the senate, carried out its views by allowing a candidate to take three only of the four subjects.

A Rontgen Ray Experiment.—According to *Nature*, Mr. R. W. Wood, working in the physical laboratory of the Massachusetts Institute of Technology, has got diffraction phenomena with Röntgen rays. The radiations operated with were produced by an arc-like discharge between two very small beads of platinum in a high vacuum. The bulb was only about 1in. diameter. A tube was used with a platinum slit 0·1mm. wide, mounted within the bulb at a distance of 2mm. from the radiating bead. A second slit of variable width was placed at a distance of 10cm. from the first, and the photographic plate at distances varying from 10cm. to 30cm. from this. "The images of the slit on the plate showed a distinct dark line on each edge, which could only be explained on the supposition that interference occurred." One may reasonably doubt the "only" in the latter sentence. The wave-length corresponding to the diffraction observed does not appear. From accounts in the American papers, it seems that at a meeting of the Washington National Academy of Sciences, Prof. A. W. Wright, of Yale, presented some experiments on refraction and diffraction of Röntgen rays. The results are such as might be expected, on the assumption that the radiations are of very short wave-length. Little or no refraction was obtained, but something was observed which was assumed to be due to diffraction. There is, however, no record of further experiments confirming it. Prof. Wright is not confident himself, and what details are available make it seem improbable. The difficulty is not so much that the waves are probably very small, though that is bad enough, but that it is pretty certain that they are of very different lengths.

Liquid Air.—At the Royal Institution last week Prof. Dewar finished his course of lectures on "Liquid Air as an Agent of Research." He began by discussing the limiting volume of substances at absolute zero. He said that it was impossible that substances at that temperature could have no mass, and the extension of the curves expressing variations of density at attainable temperatures might give wrong results, because at very low temperatures many properties of bodies fell, as it were, over a precipice. Experiments were then shown, illustrating the changes produced in the elastic properties of bodies by being being brought to the temperature of liquid air. A rubber ball, which at ordinary temperature rebounded when thrown against the wall, broke like glass when at this low temperature. A coil of wire, which when frozen held a heavy weight on the end without stretching, became quite straight as it grew warm. All chemical reactions ceased at very low temperature, because the bodies all became solid, a state in which it was difficult for chemical action to take place. Photographic action, however, was still present to a certain extent, particularly with gelatine plates. Prof. Dewar also showed how the intense cold produced by liquid air increased the magnetic moment of a magnet 20 or 30 per cent. He also demonstrated at the same time the weak magnetic properties of liquid air and oxygen. If a sheet of aluminium was used as an electromagnetic induction screen, its power was much increased at the low temperature owing to its great increase of conductivity. Various phosphorescent effects of low-temperature air on feathers, cotton wool, an egg, and glycerine were shown. Perhaps one of the most striking experiments was the curious behaviour of liquid air and oxygen in a V-tube in the immediate neighbourhood of the electric arc.

A New Telephone Trouble.—The following is from the *Western Electrician* (Chicago). Were it not from an American source it would not be reproduced here. For even with every allowance for what is meant by "farmer" in the more out-of-the-way parts of the States, it seems

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impossible not to imagine that erecting lines without first obtaining and possibly paying for permission to do so may have something to do with it. The townsman all over the world is too apt to assume that the country is simply a place maintained for his convenience and has no rights of its own. "Until within a few months telephone lines have been unknown in Alabama outside of cities, but recently many towns have established telephonic connection. Some of the ignorant farmers had heard of this, but they could not understand how it was that a man in one place could speak to another 100 miles away. It so happened that about the time the long-distance telephone was run out of Huntsville, Ala., the price of cotton depreciated several points. The farmer is jealous of quotations of his cotton, and being unable to account for the slump in any other way, laid it to the telephone. At first it was but a mere suggestion, but later it became the actual belief along the line built by the Georgia and Alabama Company. So thoroughly imbued were they with this idea that they took the law into their own hands, and the courts have been appealed to by the corporation to protect its lines. On more than one occasion poles have been chopped down and wires cut into by farmers in their belief that they were responsible for the low price of cotton. One line in particular, extending from Gadsden to Walnut Grove, has been the victim of this belief at least half a dozen times. One farmer, after breaking the wire in two, tied one end to his wagon and pulled down seven miles of it."

Rapid Telegraphy.—The Americans are great at doing things quick and telling you about it afterwards. It was therefore pretty certain that Dr. Crehore and Mr. Squier's paper on the synchronograph before the American Institution of Electrical Engineers would bring out some tales of record transmissions. The *Western Electrician*, commenting on the paper, says: "In 1876 news of the Centennial was transmitted between Philadelphia and New York at a rate of speed at the time unheard of in telegraphic exploits. By the Edison automatic method the number of words sent in a minute varied from 500 to 5,000, a speed of from 1,500 to 2,000 being easy. A message of 1,000 words was sent from Philadelphia to Sir William Thomson in New York in 56 seconds, every word of it being received clearly and accurately. At other times, when the need of absolute accuracy was not so great, 2,000 and 3,000 words per minute were frequently transmitted for several minutes in succession. In the same year dispatches were sent daily between New York and Bridgeport at a rate of fully 3,000 words in one minute. Between Pittsburg and Buffalo, also, a speed of from 1,000 to 2,000 words were regularly maintained. After the close of the Centennial there seemed to be less demand for extraordinary telegraphic communication, and the Edison method fell into disuse. A great objection to it was that a grounding of the wire would clip out great portions of the message." If circumstances are such that the line produces no difficulty of its own, rapid automatic transmission would obviously be a mere matter of quick-running mechanism. Apart from telegraph tales, it may be said that Dr. Crehore and Mr. Squier's paper, though read at the last meeting, will not be discussed until this week, so we must wait a little while before we know what they think of it in America.

Education in Elementary Science.—The report of the committee appointed by the Duke of Devonshire, President of the Council, to enquire into the distribution of science and art grants, has been issued. The committee consisted of Sir J. Gorst (chairman), Lord Balfour, Mrs. Sidgwick, Major-General Sir J. Donnelly, Sir H. Roscoe, Mr. G. L. Ryder, Prof. Jebb, Mr. W. Armstrong, and Captain W. de W. Abney (who acted as secretary); and the reference included grants which now exceed £500,000, and are increasing. The committee recommend that in counties and "county boroughs," which are willing to undertake the responsibility, while the rights of the managers of existing schools and classes should be preserved, no managers of a new school or class, except under special circumstances, should be recognised unless they are responsible to the county authority. As to "literary instruction," the Royal Commission, in dealing with the grants made by the Science and Art Department, stated that in order to meet the new conditions the department needed to be more liberal in its recognition of literary subjects, and to feel that they were essential to education and not alien to science. The committee have inclined to this view, and in order to give a stimulus to students in evening science and art classes in England to improve their general education and to encourage the study of languages and literary and economic subjects, they recommend that where any *bonâ fide* student of these classes desires such instruction a grant should, under somewhat stringent conditions, be made on his behalf to classes held by university extension authorities. "This, it is thought, will meet the objection that the science and art grants tend to encourage a one-sided education, while it is improbable that it will ever absorb more than an infinitesimal portion of the grants." All the members of the committee sign the report, but Mr. G. L. Ryder (of the Treasury) adds the reservation that he is obliged to withhold his assent from the part relating to literary instruction, as he considers it outside the terms of the order of reference.

The Conduit in America.—Various more or less contradictory statements have been made as to the success of the Lenox-avenue tramway in New York (one was referred to here last week). It appears, however, that the Metropolitan Street Railway Company are satisfied with it, and, having obtained the consent of the State authorities, are about to put down 40 miles more of conduit line in New York, and the *Street Railway Journal* says the decision to instal the conduit system was based upon the generally satisfactory service secured on the Lenox-avenue division of the company, $6\frac{3}{4}$ miles in length, which has been in operation for about two years. As regards electrical leakage, the electrical engineer of the company states that the average leakage on the Lenox-avenue line has not been more than might be expected upon a similar length of track equipped with the overhead system. The current required during the two or three months which have just passed averaged, with the heaters, about 30 amperes per car. "It should be stated, however, that the conditions for maintaining good insulation are exceptionally favourable. In no other city in the United States, except possibly in Washington, where the only other successful conduit lines are in operation, are the streets kept so clean by the municipal authorities as in New York. Again, the snow and rainfalls in New York are never excessive, while the drainage is good. The method of caring for the snow last winter was to put the snow-ploughs in operation as soon as the snow commenced to fall, and thus keep the track clear. Salt was sparingly used on the switches and in the conduit during very cold weather and during snowstorms to keep the conduit from clogging up. The use of salt in this way had no appreciable effect in reducing the insulation resistance between the conductors. In addition to this, the conduit was cleaned about once a month. The method employed was the same as that on the New York cable railways—that is, by hand. Long scrapers so designed that they could be slipped through the slot were used, the mud and *débris* being pulled to the

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nearest manhole. The policy of the company in regard to the equipment of its other lines, now operated by animal power, has not yet been determined."

Answers.—The "examination answer" is now usually regarded with suspicion. Unlike the atom (all apologies to the ghost of a very great physicist), it too often "bears the stamp of the manufactured article." But the following are genuine, as time and place are given. They occur, in fact, in the report of the results of the annual scholarship examinations in connection with the Brighton and Preston School Board. Two are quoted as a sample. One candidate in magnetism and electricity, in answer to the question, "What is frictional electricity? Show that that there are two kinds of electricity," says, "Friction was a man who evented *(sic)* electricity. Volta also evented it, so they divided it into two sorts." This muddle up of half-remembered book knowledge is very terrible. Anyone, however, who has not forgotten his school-days, and really understands the mental processes of half-taught students, can see exactly how it came about. What is really terrible is to think of the proper way to answer the question. No doubt the boy was wanted to say in a roundabout and disguised way that frictional electricity was the "electricity" produced by friction—a way of explaining and describing things which is fatal to progress in science. And then he is to show that "there are two kinds of electricity." Now, Mr. Examiner, on your reputation as a member of a learned profession, are there? Answer number two, which is held up for scorn, is merely a case of a boy being stuffed with an illustration which he does not understand, but reproduces to the best of his ability. It is his misfortune that though he wrote it all by rote he did not write it right. The inspector complains "the few papers in mechanics were of very uneven merit. While there was one of peculiar excellence there was another equally distinguished in the opposite direction. The latter informs us that 'When a dog pursues a hare the dog's superior weight causes it to swing aside more. This is called inertia.' Then follows a diagram of inertia!" It does not by any means follow that the boys who gave these answers are dolts, though as a matter of fact there are grown-up people in the world who seem incapable of forming definite physical conceptions. But what does seem to follow is that a certain amount of what passes as science teaching has very little value.

Induced Draught.—In the course of a series of articles on the design and construction of electric power plants contributed to the *Western Electrician*, Mr. B. J. Arnold makes the following remarks on the use of an induced draught instead of a chimney shaft: "It is fair to say that (in America) this method represents most modern practice. In this method a stack is erected just high enough to rise far enough above the roof of the power-house, so that the gases will not be objectionable, and the draught is produced by means of fans or blowers placed at the bottom of the stack or in the leading flues. This method overcomes a great many of the disadvantages of the chimney: (1) The cost is less. (2) The flue gases can be reduced to a very low temperature, as the heat is not required to produce the draught. The heat loss due to a chimney is shown to be usually between 15 and 20 per cent. With a mechanical draught this loss can be reduced two-thirds. (3) This method is safer, as there is no stack to blow over. (4) The draught can be controlled more easily and quickly, which is a very important advantage for many electric power stations. (5) The boilers can be forced far beyond their rated capacity, and they can also be worked below their rating without seriously reducing their economy. (6) The induced-draught method removes the necessity of providing an expensive foundation, as required with a chimney. The disadvantages are that any accident to the fans or driving engine will cripple the plant, and the device needs more or less attention. The fact that the blower engines will take power is not a real objection, for the amount of power required is found to be a very small percentage of the total capacity of the boilers supplied with draught, and is very much less than the usual loss due to a chimney." If he can convince engineers of all this, there was obviously no need for Mr. Arnold to spend much space over the description of the approved form of chimney shaft. It is curious that in this country, where there are local authorities which have a fixed and unreasoning prejudice against tall chimneys, the expedient of forced draught has not been more often tried. There is much to be said for it, though, of course, as between Shaft *v.* Draught the case is not quite so clear as it would appear in Mr. Arnold's pleadings. The other side would ask for proof of some of them.

The Institution. — The electrical engineers have discussed the most economic way of governing a steam-engine—with digressions. If the steam engineers got together to discuss dynamo design, it is just possible they might digress on the means of driving. There were some suggestions. Mr. Geipel proposed to run lights off a traction circuit by sending the current through a motor-generator. It would have to be a special machine to do what Mr. Geipel evidently wants it to do. Mr. Tremlett Carter's and Mr. Raworth's dispute was not as to the results, but the way to get at them. Mr. Carter, however, had a suggestion which was to alter the speed of the engine. Prof. Perry expressed his opinion in the form of a question. The main issue discussed (there were several subsidiary ones) was put into plain words by Mr. Crompton. Every now and then people discovered that cut-off governing was theoretically correct, a great fuss was made, the thing was tried, and then dropped because of mechanical difficulties. Then after everyone had had time to forget, the cycle started afresh. Mr. Gadsby thought poorly of running a lighting circuit off the traction plant, and of the engineer who advised it. The debate was about to die when Mr. Garcke revived it by a vigorous onslaught on the municipal electrical engineer for wanting to charge 3d. or even 4d. for his current. (How is the poor man to make his committee understand that it is not mere favouritism to let a company have a thing at a quarter the price of a ratepayer.) Mr. Wordingham repudiated asking for 3d. on the part of the municipal engineers in general, and Manchester in particular. In Manchester they will send you out energy in small parcels of 4 h.p. at 1½d. per unit. Mr. Clirehugh is a novelty as a speaker to us southerners. One could do with more of him. He disagreed with Mr. Gadsby. Mr. Raworth replied, and there were just a few words from Sir Henry Mance. In the old times one would then have gone home after a full evening's work. What was done was to read Mr. Trotter's paper. Various disparaging things have been said about the working of the West Coast cable to the Cape, but it was a new notion to some of us to find that its southernmost section abandoned its proper duties in order to pay close attention to the doings of the Cape Town tramcar drivers. That almost every remedy except the right one was tried first was due to the fact that the right one required a telegraph ship. An extra meeting was announced, but it will be over before this can be read. Whatever may be thought of the new plan of discussion first and paper afterwards, it is certainly making the Institution keep shockingly late hours to what it used to do. But then so many people do not stay to hear the paper.

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THE MECHANICAL CONSTRUCTION OF ELECTRICAL MACHINERY.

BY F. M. WEYMOUTH.

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THE DYNAMO.

(Continued from page 623.)

Bearings (continued).—Figs. 192 to 195 herewith represent what may be best described as a modified form of spherical bearing, and the design here shown is such as is specially adapted for use at the commutator end of a dynamo or motor shaft. It will be observed to be of the general type which we have denominated in connection with Fig. 188 as a "solid" bearing, and consists essentially of a main casting, A A, including within it a sleeve, B B; and this latter more immediately carries the shaft, as depicted. As illustrated at *c c*, the sleeve may also be lined with white metal.

FIG. 192.

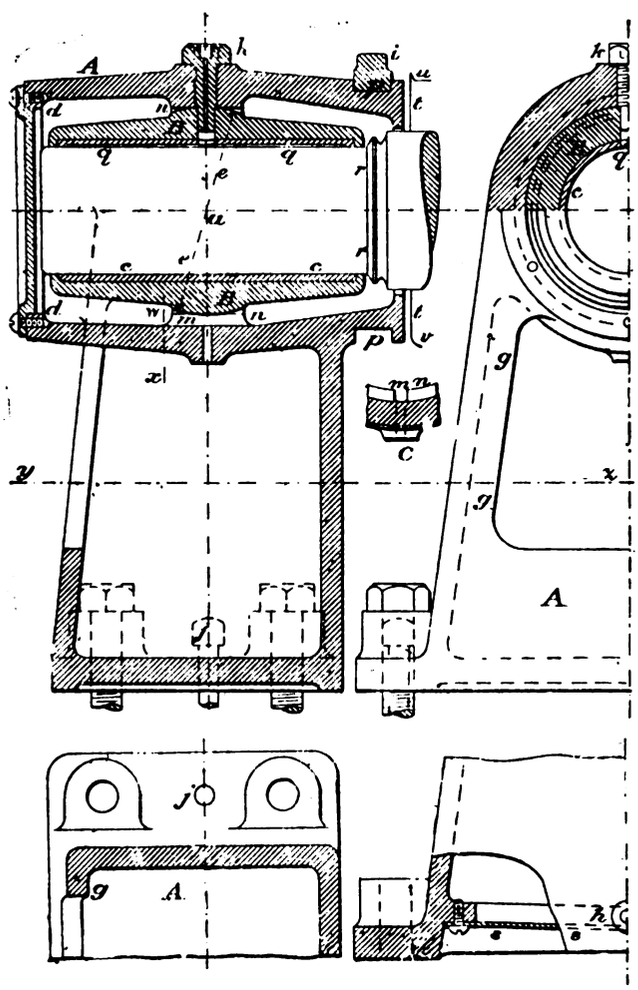

FIG. 193.

FIG. 194.

FIG. 195.

The *raison d'être* of this form of bearing is the fact that it permits of self-alignment of the sleeve on the shaft. For it will be noted that the central portion of the sleeve is part of a sphere of which the line *e e* is a diameter. Within the limits, therefore, of its enclosure by the main casting, and supposing the shaft to be absent, the sleeve is free to rotate in all directions about the centre, *a*. It is, of course, usual in line shafting to fit such a spherical bush into a seating likewise spherical, affording a plenitude of wearing surface combined with ease and freedom of movement; and perhaps in cases where there is a long length of shafting carried on a series of bearings one after another, and wherewith the shaft has some flexibility due to its length, there may be a certain amount of "wobble" in the bush with each rotation of the shaft, which may justify precautions against wear on the outer spherical surface of the bush and its seating. But it is obvious that the necessity for any such precautions in a well-made dynamo or motor is entirely inadmissible. An essential quality of an armature shaft is that it must under all normal circumstances run perfectly true without the slightest deflection, such as might cause a rotatory movement of the sleeve in any direction about its centre at *a*. The convenience in the present case is that, the sleeve being bored or made to an exact working fit on the shaft, when the bearing is put in place, the sleeve will slip over the journal end, and automatically align itself, and there is no trouble such as that of having to scrape the bearing to make it afford a true support to the shaft along the whole length of the journal. The "journal" is that portion of the shaft which is actually included within the bush or bearing, and is always finished off in the lathe to a high polish; whereas the remainder of the shaft may be only rough turned, or perhaps not be turned at all. A dynamo shaft however, having to fit other parts, such as the armature and commutator, is usually smooth turned all over. But this is somewhat of a digression.

With the above considerations it will thus be noted that the expense of a spherical seating in such a bearing as that we illustrate would not be warranted. Reverting to the sketch (Fig. 192) it will be seen that the spherical portion of the brush is made just a fit within a *cylindrical* seating, *n n*. The bush itself will be either of gunmetal or cast iron, the latter more especially when lined with white metal. It is plain that no pressure of the shaft on the bush will be able to effect the slightest perceptible crushing of the metal of either the spherical bush or its seating where they meet; and as there is (or should be) no motion whatever at this junction of the parts, there is no reason left for supposing that the cylindrical bearing will be otherwise than sufficient. Its use is at least, however, amply justified by experience.

Spherical bearings as usually made (having spherical seats) are of necessity of some split type, with a removable cover or cap. We thus now find that an additional quality of the cylindrical seating for the bush or sleeve is that it enables the latter to be put in from the end, which would, of course, be impossible with the spherical seat. A very inexpensive form of bearing is thus arrived at: all the required advantages of the spherical bearing are retained, while the expense of fitting a cover is obviated. Among the former it is, of course, to be noted that the arrangement conduces to equality of wear along the whole length of the bush. When over-worn it is a simple matter to supply a new sleeve, or to re-line one with white metal.

We may now glance at some further points in this design. It will be noted that the entrance to the bearing at one end, *d d*, must be sufficiently large to admit the passage through it of the bush. It is optional to close this end with a polished gunmetal cover as shown, or to leave it open. If left open, it would be advisable to have that end longer, so that it may project farther beyond the shaft end than here shown. The reason of this affects the next point, which has reference to the collection of the waste oil from out of the bush. We have already, in our opening remarks on this branch of our subject, called attention to the absolute necessity with a dynamo or motor of allowing no oil or lubricant whatever to escape from the bearings. It is obvious that the oil exuding from both ends of the bush, and creeping along the shaft rotating at a high speed, will be thrown off the latter by the centrifugal force. At the one end this is easily prevented from escaping further by the cover screwed on as shown, and made an oil-tight fit, or else as above intimated, by this end of the bearing being made to project well beyond the shaft. The waste oil is then kept in by the inward turned lip, also indicated by the letters *d d*. But the other end cannot be closed in any case. We find here that an annular ridge, *r r*, is left on the shaft in turning it, which has the effect of causing all waste oil at that end to be thrown off from it by the centrifugal force; and this takes place, it will be noted, well within the bearing. The end of the commutator is shown at *t t*, and it is optional, in case by any bad chance whatever any oil should yet get beyond the bearing, to add an oil-throwing edge thereon, as shown at *u*: otherwise the back of the commutator may finish with a small radius, as at *v*. Excepting, therefore, any occurrence of this latter eventuality, we find that all the waste oil is caught within the head of

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the main casting, A A. A small groove, *m*, cut through the cylindrical seating, *n n*, and a drip-hole therefrom, as shown, will now enable the waste oil to flow out where it may be caught by a suitable can placed in the recess beneath for the purpose. It is to be noted that this hole can be drilled by letting the tool pass down through the lubricator hole above. The small view, C, is a section on *w x*, showing more clearly the oil way, *m*. This thus shows that the groove, *m*, is too narrow to impair the efficiency of the seating of the bush, as might otherwise, perhaps, seem to be the case.

It will be observed that in Figs. 192 to 194 the lower part of the bearing, A A, is shown of box form, open on one side. To strengthen the unsupported edge of the sides, flanges may be added as represented at *g g*, and illustrated clearly in Fig. 194, which is a section on *y z*. In Fig. 195, however, another method is shown, wherein the bottom is cast open, instead of the side. To catch the waste oil, a false bottom, *s s*, of sheet metal, brass, steel, or iron, is screwed on with an oil-tight joint, and the oil is drawn off at intervals by a tap inserted at the small boss, *h*. To facilitate the collection of the oil, the plate is dished so as to have a dip toward *h* from all sides, as indicated in the drawing. It is to be noted that for any given degree of strength and rigidity, the form shown Fig. 195 may be cast thinner in the sides than that shown Figs. 192 to 194. Thus, for a journal about 2½in. diameter, the sides as in Fig. 192 may be about $\frac{7}{16}$in. or ⅜in. thick, but ⅜in. or $\frac{5}{16}$in. if boxed all round as in Fig. 195. These dimensions, however, apply to the small castings shown. If, with the same journal, the castings were two or three times the height, thicknesses from ½in. to ⅝in. would probably be advisable to obviate spring or vibration.

Though we have dealt first with the retention and collection of the waste oil, inasmuch as this is a feature more particularly special in an electrical generator or motor, the original lubrication is far from being an unimportant matter. In the design now before us, it may be said that in this connection two ends are attained with the one means: for it is necessary to prevent the sleeve from moving or from rotating with the shaft. Thus, to prevent any such movement, a steel stop screw is inserted, as shown at *k*, which may be an ordinary Whitworth tap-bolt, with the lower end turned down in the lathe to a diameter less than that at the bottom of the threads. A hole is drilled down the centre line of this bolt, the upper end of which in the head is enlarged and tapped suitably to enable a lubricator to be screwed in. The oil or other lubricant can then descend through this small hole to the shaft. To facilitate the spreading of the oil on the journal a longitudinal oil way is cut in the white metal, as shown at *q q*; though it is not uncommon in practice to let such oil ways proceed somewhat spirally from the central hole, descending a few degrees on either side below the top of the journal. The subject of lubrication, however, is not one that can be treated parenthetically, and must be left for the time being.

Inasmuch as this design is for the commutator end of the shaft, an annular recess, *p p*, is turned on one end to receive the brush rocker. This latter thus requires to be put on in two halves; and a section of the ring which forms the basis of its construction, and fits the annular recess, is shown above at *i*. It will be noted that for the sake of symmetry the slope of the bearing at the top towards the ends is the same on either side, though this is of course not of much import; while on the other hand, the straighter the top, or, in other words, the more the outer barrel of the bearing keeps to one diameter outside, the easier it becomes in the pattern-making to unite thereto the upper ends of the flat sides, which rise from below for its support. The bearing is here shown held down by two tap-bolts on each side, with a taper steady pin, *j*, between them. These bolts will preferably be smooth turned, with bright heads if a good appearance is desired. Two forms of steady pin are shown at A and B, Fig. 196. Both have square heads, though in the one case the head projects all round, but in the other the flat sides are merely filed out of the round bar. A very slight taper only is necessary, such as an ⅛in. or a $\frac{1}{16}$in. decrease of diameter in a foot of length. The top should be rounded so that the blow of a hammer may fall quite central; and it may be loosened if required by a spanner applied to the square head. Clearance holes for the bolts will enable an adjustment of the bearing to be made with the shaft in place: the bolts being then screwed down tight, the taper steady, pinholes will be rimmered out, and thus the position secured finally.

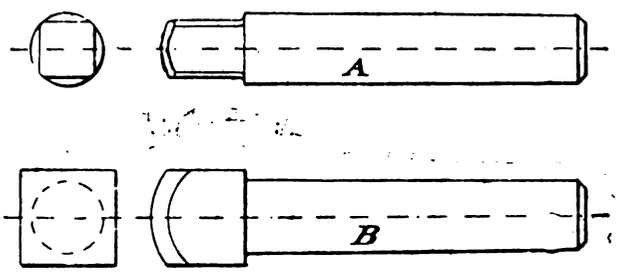

FIG. 196.

The machining is sufficiently obvious. In the barrel portion, the seatings for the sleeve and the cover need turning and boring; also the entrance at the other end for the shaft so as to form an even clearance between it and the shaft of, say, an ⅛in. all round. The flat end adjacent to the commutator at *t t* must be faced, and of course the annular groove for the brush rocker needs turning. Other parts can be left rough, and are usually painted. The sleeve, beyond being bored, must have the ends turned, and the spherical portion, which latter is left as an annular raised facing for that purpose. On this latter point, however, it may be mentioned that instead of the spherical portion being turned to a radius equal to half the diameter, as shown, it may be turned to a radius equal to the whole diameter, or even more, as at *r r*, Fig. 197, which gives a

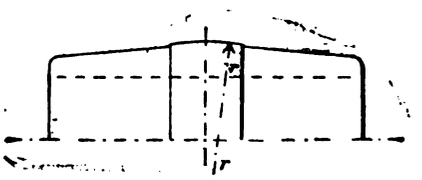

FIG. 197.

half outside view of such a sleeve. This will thus flatten the curve, and so enable the total diameter of the sleeve to be somewhat reduced, and with it the diameter of the outer barrel: more support is also afforded to the metal in the sleeve at the periphery of contact with the cylindrical seating. It would, perhaps, seem as though this would

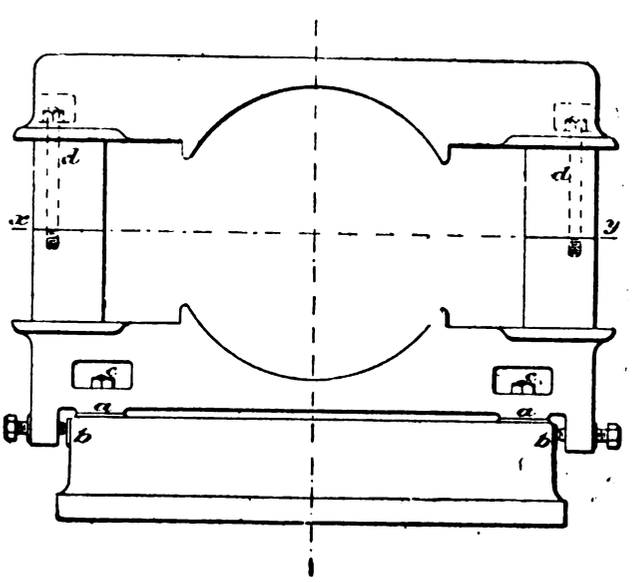

FIG. 198.

stultify the use of the spherical method altogether; but in practice the axis of the sleeve will deviate so slightly, if at all, from coincidence with the axis of the cylindrical seating, that the loss of freedom of motion of the sleeve within the seating due to the flattening of the curve has little consequence.

On a recent page we intimated that we should introduce

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one more bed-plate, a design by Messrs. P. R. Jackson and Co., Manchester. We have to thank this firm very much for drawings of which Figs. 198 and 199 herewith are reproductions. As will be seen, this design affects more particularly the magnets and their attachment to the bed-plate. Top facings, *a a*, and side facings, *b b*, are cast on the bed-plate. Into the former studs, *c c*, are fixed. The magnets are cast in two halves, divided as shown, on the horizontal central line, *x y*, and these are held together by long studs, *d d*, let into the lower halves. As will be

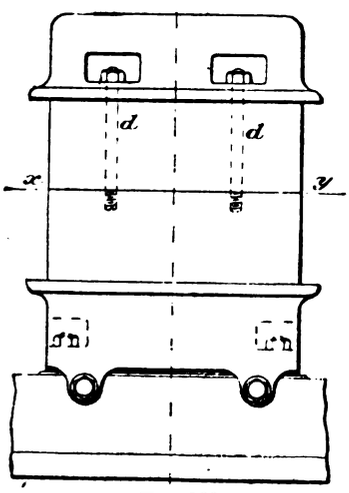

FIG. 199.

perceived, either the lower halve singly, or the two parts bolted together complete, can be dropped over the studs in the bed-plate. The pinching screws at the sides will permit accurate side adjustment before tightening the nuts on the studs. It will be noted that the principle of having pockets for bolt heads and nuts cast in the magnets is adhered to in this case as in the design shown Fig. 172; and this appears to be a feature incident to all or most of the designs by this firm.

(To be continued.)

THE LOCAL DISTRIBUTION OF ELECTRIC POWER IN WORKSHOPS, ETC.

BY ERNEST KILBURN SCOTT.

(Continued from page 588.)

PART II.

Thus far any details which may have been mentioned have, for the most part, been only applicable to continuous currents. The remainder of the article will now be taken up with a brief consideration of the advantages and disadvantages of *alternate currents* from the point of view of power distribution in factories. The limit of pressure within which continuous currents can be successfully used is about 4,000 volts, and when the length of line is so great as to require, for economy, a higher tension than this, it becomes necessary to resort to alternate currents, with which there is no difficulty in transmitting at a tension of 15,000 volts. It will be noticed from Table X. that on the Continent and in the United States there are a number of factories which receive their power at high pressures from waterfalls considerable distances away. The actual distribution of power inside the factories is, however, uniformly carried out at the lower pressures of 100 to 300 volts. Thus far, in England, with one exception, the maximum pressure has not been more than about 3,000 volts, and this has been for public supply stations only. Until the schemes which have been mooted from time to time of distributing power from our coalfields are carried into effect we shall continue to convey the coal to the factory, and it is, therefore, for the present unnecessary in this country to exceed the Board of Trade limit of 500 volts.

The question of the *relative weights of copper* which are required by different systems of transmission is, perhaps, not so important inside a factory as it is in transmitting power from a distance outside. Thus, the Lauffen-Frankfort (100 miles) transmission of power plant cost about £60 per horse-power, and of this about £50—or over 80 per cent.—was required for the transmitting cables and their fittings. For a factory the cost of cables will probably not be more than 35 per cent. of the total cost; but as the interest and depreciation on these cables must go into the annual charges, it is advisable to give the matter consideration.

That there is a considerable saving in copper by using continuous currents, assuming the same difference of potential and taking into account the maximum stress on the insulation, is shown by Table XI. There has been a good deal of discussion as to how this subject should be approached, but obviously the fairest way is to take into account not only the amount of ohmic resistance or drop for certain power, but also the relative stresses tending to break down the insulation. The question has been gone into by Messrs. Georges, Kapp, Kennelly, Steinmetz, and others; and the table may be taken as about representing their opinions. The writer arrived at the third column by averaging the first two columns.

TABLE XI.—Relative Weights of Copper for Equal Power, Voltage Drop, and taking into account the Stress on the Insulation.

Style of current.	Number of wires.	System of transmission.	Remarks.	Weights of Copper.		
				On basis of equal effective E.M.F. at end of cable.	On basis of the stress on insulation or maximum E.M.F.	Average of the two preceding values.
Alternating	2	Single-phase	—	100	200	150
,,	3	Single-phase, three wire.	The third wire ·6 the section of outers	32	64	48
,,	3	Two-phase...	With common return	72	290	181
,,	4	Two-phase...	Two separate circuits	100	200	150
,,	3	Three-phase, star or Y connections	—	25	150	87
,,	3	Three-phase, mesh or Δ connections	—	75	150	112
Continuous.	2	Simple two-wire	—	100	100	100
,,	3	Three-wire	The third wire ·6 the section of outers	32	32	32
,,	5	Five-wire	The inside wires ·6 the section of outers	12	12	12

The above figures for alternate currents were got out assuming that the curve of E.M.F. follows an *exact sine curve*. As a matter of fact, in practice it very seldom does, a sawtooth form being generally preferred, in order to keep down the iron losses in transformers, etc. It will be easily understood that the stress on the insulation is much greater with a sawtooth curve than it is with a sine curve, and that the above figures, if anything, favour the alternating-current systems too much. We therefore see that for factory driving, so far as copper in the wires is concerned, the three-wire system with continuous currents scores most distinctly.

It should be noted that the ratios given in Table XI. do not necessarily mean relative costs, as this latter depends on a number of secondary considerations. For example, the cost of insulation on a cable is almost as much as the copper; so that although a saving in copper may be made by increasing the number of wires and distributing on the three-phase or three-wire system, the amount to be spent on insulation increases. The general cost of an installation also goes up, because, naturally, there is an increase in the cost of erecting and maintaining two or more circuits instead of one, or three wires instead of two.

The *frequency, or periodicity*, also affects the question, according to whether the distance of transmission is long, the voltage high, and the cables laid on the concentric system. Under all or any of these conditions, a high frequency causes the line to absorb current by virtue of its electrostatic capacity. As a rule, this capacity effect only causes trouble

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in long-distance transmission; but there is another reason why the periodicity should be kept low—namely, the speed of small motors. All motors, whether single or multi-phase, run at speeds directly proportional to the frequency, and inversely proportional to the number of poles in the field. To get a moderate speed, therefore, we must either have a low frequency or build the motors with many poles, and this latter is not so easy in small machines. This question also comes up in the design of alternators, but is not quite so important; thus, for the same speeds, a machine for high frequency having a large number of poles must be of large linear dimensions, and will therefore be costly to build on account of the multiplicity of parts, though its weight need not be heavy. On the other hand, a machine built for low frequency will have a small number of field poles, and be more compact although heavier. They are not, however, so easy to regulate, the characteristic having a large drop. One other important consideration must be taken into account, and that is the fact that below a frequency of 40 cycles per second the alternating-current arc lamp works badly, the low-period current waves producing a decidedly fluctuating light, to say nothing of the noise.

The *frequencies commonly used* vary from 20 to 140 per second. Lower frequencies reduce the speed and increase the weight of motors and transformers beyond a commercial economy; whilst a higher frequency than 140 mechanically prevents getting the necessary number of pole-pieces within an efficient radius or compass. About 83 per second is the highest limit when motors are employed, and taking all the various requirements into consideration, 50 periods per second seems to be about the best compromise. A periodicity of 25 per second is used at the Westinghouse Company's works, Brenton, Pittsburgh, where upwards of 1,250 machine tools are operated by Tesla 200-volt two-phase motors. This frequency is the same as that employed by the company at the Niagara Falls central power station. Some of the incandescent lamps are run with it, but most of the lighting is done by continuous currents. It is an interesting fact that although the motors are placed as near as practical to the machines they are to drive, there is necessitated, nevertheless, almost a mile of shafting in the machine-shop alone. From this we can see what a tremendous amount of shafting and its accessories would have been required if the transmission of power had been mechanical throughout.

When the Westinghouse Company supply plant which is only intended for lighting and not for driving motors, they employ a frequency of 60 cycles per second, and, generally speaking, wherever a lower frequency than this is employed, a separate continuous-current lighting plant has been laid down. The lowest frequency of 20 per second is employed at Messrs. Bally and Sons' boot and shoe factory, Schoenenwerd. In this installation the alternator is attached to the vertical shaft of a Jonval low-pressure turbine, running at 30 revolutions per minute, so that even with so low a periodicity as 20, no less than 80 poles are required, and it was found necessary to put exciting coils on one set of poles only.

The single-phase *synchronous alternate-current motor*, being simply an alternator reversed, requires only two conductors to transmit the power, and is called synchronous because it must run at one constant speed in synchronism with the generator. The use of such motors is limited, because (1) they require to be separately excited by continuous currents; (2) they will not start themselves, having practically no initial torque; and (3) they are extremely liable to sudden stoppage by a temporary overload throwing them out of phase. Their one good quality of running at *constant speed*, no matter what the load may be (so long as it is within the capacity of the motor), is useful in textile factories—spinning mills especially — where very steady running is necessary. Such an example is the electric transmission at the Ponemah Cotton Mills, Taftville, Conn., U.S.A., only in this instance the synchronous motors work with three-phase currents instead of single-phase. Two motors are supplied with current by two similar generators (see Table X.), and the motors are brought up to the correct speed by a special starting winding, which is cut out as soon as the machines are in synchronism. This method is rather cheaper than having a small separate continuous-current or three-phase motor for starting up, but, of course, it takes up space on the armature of the machine which would otherwise be usefully filled by the main winding. It must be noted that no attempt is made to get rid of shafting and belting in the mill itself, as each of the motors replaces a Corliss engine which had previously been employed. It is, therefore, more interesting as an example of long-distance transmission utilising water power hitherto running to waste, and also as an application of synchronous motors in order to ensure steady running of the spinning machines. One point in favour of alternate-current motors is that they can never race—their speed can never exceed that of synchronism.

(*To be continued.*)

THE ELECTRIC WORK AT THE BERKELEY HOTEL.

This well-known and high-class hotel has been lately in the hands of the builders and decorators, and is now just finished. Several extensive structural alterations have been made under the supervision of Mr. Griggs (architect), amongst which may be specially mentioned the construction of a new restaurant on the ground floor. Considering that the whole of the hotel has been redecorated as well, it is a credit to all concerned that all the work has been done since Christmas. Messrs. Strode and Co., of 18, Osnaburgh-street, have had no small amount of the work through their hands. In the first place, about a thousand electric lamps have been wired for and the fittings manufactured and fixed. Besides these lamps, two Blackman motor fans have been installed to ventilate the kitchen, as well as one fan for the bakehouse and two for the restaurant. An electrical turnspit has also been devised and erected in the kitchens. The same firm have also supplied and fixed two vertical steam-boilers, which are not only the means of supplying steam for all the cooking apparatus, and for heating purposes, but, by an ingenious automatic arrangement, provide a hot-water supply for the hotel of over 1,000 gallons per hour if required. Messrs. Strode and Co. have also fitted up the whole of the apparatus for steam cooking, gas stoves, hot-plates, roasting range, kitchen fittings, etc., and the hot-water supplies throughout. They have also rearranged the cold-water supply, and have fitted the various fire-hydrant mains and fittings.

The electrical arrangements are well designed throughout, and the fittings harmonise with the architecture. In those places where structural alterations have been made, the wiring has been carried in Messrs. Strode and Co. patent conduit system. In this system strong iron barrel is used, and is coated inside with a fibrous insulating compound. The pipes are screwed into draw-boxes, which are so placed that any section of the wire can be withdrawn and replaced if necessary. These boxes are placed in the floors or skirtings as required, and the covers harmonise with their surroundings. In other places, where the wall had not to be disturbed, wood casing is used. The current is taken from the Westminster Company at 200 volts, and the circuits are well sub-divided by fuse-boxes; not more than 10 lamps are connected to any one circuit. The fuses are of the spring-clip bridge type, and these, as well as all the main switches and fuses, are of Messrs. Strode and Co.'s new design and manufacture.

The fittings in the restaurant and entrance hall are Jacobean in style, and are made in polished ironwork. The iron is brightened and then covered with some special lacquer to protect it. These fittings *in situ* can be seen in Fig. 1, which is a general view of about one half of the restaurant. From it a good idea of this picturesque room can be obtained.

Electrical three-light standard lamps are provided for each table. The connections are made to these by flexible cords and plugs passing through the table to contacts under the carpet. For the general lighting of the room there are seven five-light electroliers and seven three-light wall brackets of similar type. The whole appearance is most effective, and excites considerable attention from passers-by of an evening. Fig. 2 shows a view in a drawing-room, also on the ground floor. In this case the electrolier is of polished brass. The standard lamp can be moved about the room

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to suit the convenience of the occupiers, as a number of plugs round the skirting enable current to be taken anywhere. The other rooms in the hotel are too numerous for individual mention, but the usual type and number of bedroom fittings are as follows: two pendant lights, controlled both from the door and bed; one reading lamp and plug near the bed-head and one power plug, which can be used for heating electrical curling-irons or any other electric toilet appliance.

FIG. 1.—The New Restaurant at the Berkeley Hotel.

The electrical turnspit referred to above is illustrated in Fig. 3, and the drawing is self-explanatory. As will be seen, there is a double-reduction gear between the motor shaft and the vertical spit axles, and drives by bevel wheels. The work has been superintended by Mr. A. Higgins, the energetic manager of the electrical department of Messrs. Strode and Co., who, with the firm, deserve great credit for the completeness of the installation.

FIG. 2.—A Drawing-room at the Berkeley Hotel.

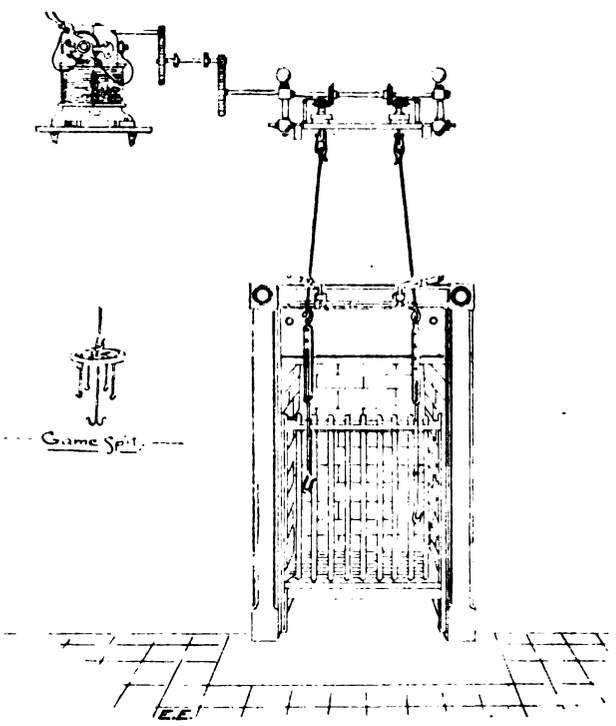

FIG. 3.—The Electrical Turnspit at the Berkeley Hotel.

The Royal Society.—This society gave its first conversazione for the season at its rooms in Burlington House on Wednesday. There was a large attendance of guests as usual. Among the exhibits was one, by Prof. O. J. Lodge, of the Zeemann discovery. Prof. Lodge has just made the remarkable discovery that the spectrum lines not only broaden under the action of the magnetic field, but break up into groups. The theoretical importance of this is very great. At first sight it would seem almost to imply some orientation of the atoms analogous to what, upon one theory, is supposed to take place in iron when magnetised. It is, however, exceedingly difficult to imagine anything of the sort taking place in a gas.

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THE ST. LAWRENCE POWER TRANSMISSION SCHEME.

The existence of large waterfalls which can be economically developed may in certain conditions prove as valuable as coalfields. These conditions are either that a waterfall shall exist within reasonable distance of large centres of industry, to which the power can be transmitted with economy electrically, or, in the present advancing state of the electro-chemical industry, be located in a district to which the raw materials can easily be transported for the manufacture electrically of chemical reagents to be used on a large scale commercially. In this country very few water powers exist that can be described as large powers compared with those found in other parts of the world; and even in Switzerland, where perhaps larger water powers exist than in any other parts of Europe, the water powers are small compared to those to be found on various parts of the American Continent.

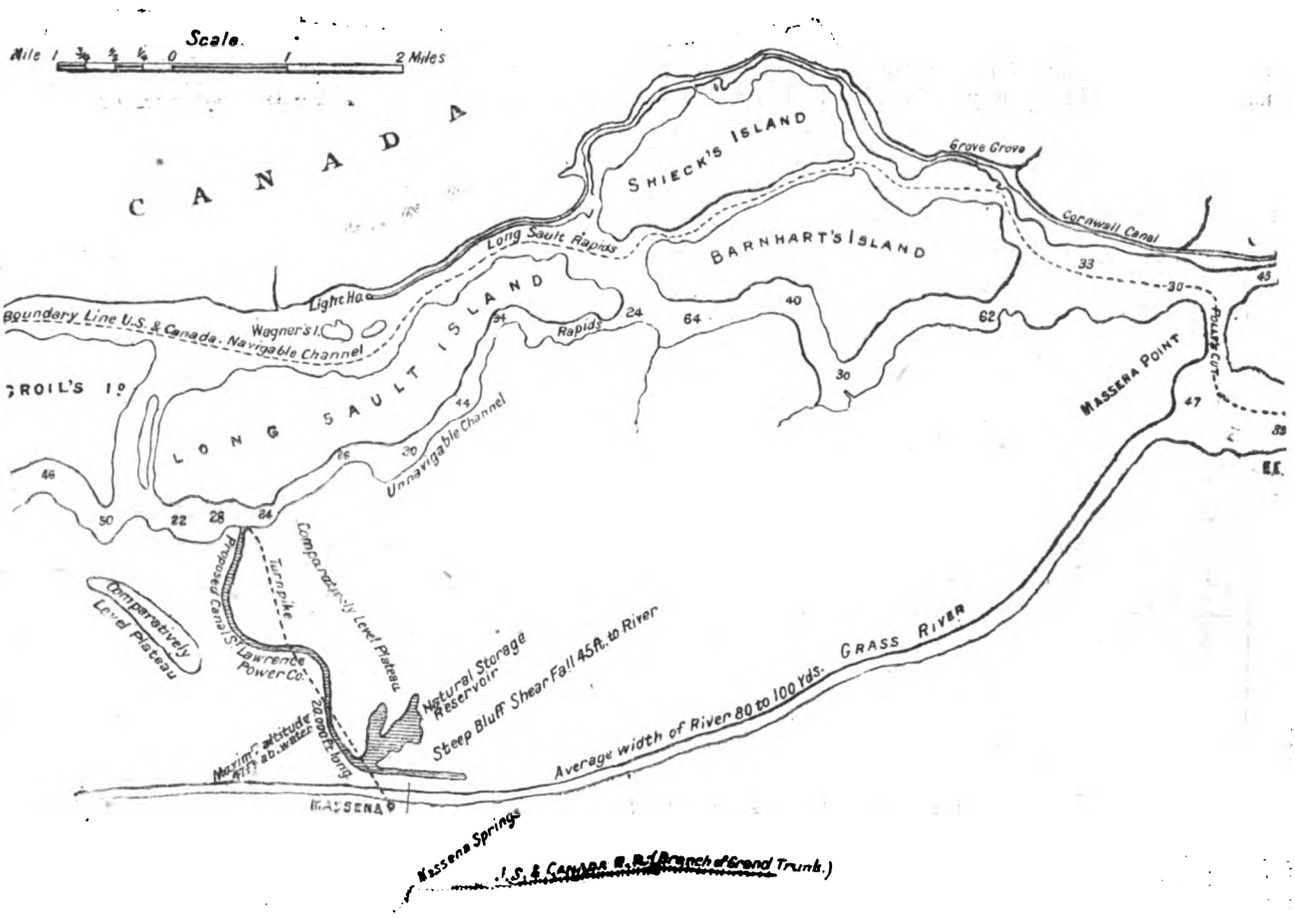

FIG. 1.—Map of the St. Lawrence, showing the Proposed Canal for the Massena Transmission Scheme.

Of late the value of cheaply-developed water powers has been realised in the United States, and from month to month we hear of these powers being developed and put to useful purposes. The developments at Niagara represent, of course, the largest instance of a single water-power development, but there are many others also in the States of not inconsiderable size that have been put to useful work—for instance, taking those only above 5,000 h.p.—there are the following: Potomac River, 5,000 h.p.; Macon, 5,000 h.p.; Weldon River, North Carolina, 10,000 h.p.; Knoxville, 5,000 h.p.; Mechaniceville, 5,000 h.p.; Corral, Hollow Mines, California, 9,000 h.p.; Sacramento, 11,000 h.p.; the Pelzer Manufacturing Company, 7,610 h.p.; Big Cotton Wood Power Company, 6,800 h.p.; Columbia Water Power Company, 5,000 h.p.; Lachine Rapids Hydraulic Company, 12,000 h.p.; Pioneer Electric Power Company, 11,000 h.p.

At the time that the Niagara works were contemplated and executed it was thought hardly possible that any power on such a considerable scale could be developed more economically in the United States, and at present this company have, as is well known, a tunnel of sufficient capacity to carry off the tail water from 120,000 water horse-power with an inlet canal of the same dimensions. Whilst some portions of this power is delivered as water to the Wood Pulp Paper Company, 15,000 h.p. have been delivered electrically, and are being used for the purposes of the electro-chemical industries of various sorts who have established works in the neighbourhood, and a portion is transmitted to the city of Buffalo, 26 miles distant, for working electric tramways in that city, and a further amount will ultimately be used for providing a supply for lighting purposes there also. The demand for power has been sufficient to warrant the directors of that company lately to place orders for the extension of their power-house and wheel pit and the purchase of five more generators with their turbines, each of 5,000 h.p., making in all a total of 40,000 e.h.p. development. The capital spent by the company in reaching this point is in the neighbourhood of £1,800,000.

Rather more than a year ago it was discovered that extraordinarily favourable conditions existed to utilise the waters of the St. Lawrence River in the neighbourhood of the township of Massena. The St. Lawrence River flows past the township of Massena at a distance of about 2½ miles from it, and from this point falls rapidly, upwards of 56ft. in a distance of seven miles. A smaller river, which takes its rise in the Adirondack Forest, flows through the township of Massena, and joins the St. Lawrence about seven miles below this township. This river is called the Grass River. The Grass River falls less than 6ft. between the township of Massena and its junction with the St. Lawrence River. It therefore follows that the difference of level between the St. Lawrence River and the Grass River in the neighbourhood of the township of Massena is upwards of 50ft. The Grass River, although a very small river in comparison with the St. Lawrence, would be in our estimation a river of considerable dimensions, being at its narrowest part below Massena about 300ft. in breadth, and bounded by steep banks on each side, enabling an enormous volume of water to be put into it without in any way endangering the surrounding

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country. It has been found that a canal can be cut between the St. Lawrence and the Grass Rivers across country, having a length of about 3½ miles. The country between the St. Lawrence and the Grass Rivers is practically level at this point, and at this point is fortunately at the same height as the banks of the St. Lawrence until the Grass River is reached, where the country falls over steep bluffs, to the level of the St. Lawrence River.

These facts having been ascertained, a charter was obtained from the New York Legislature empowering a canal to be cut between the two rivers and the waters utilised for the purposes of power generation, the charter providing that water might be drawn from the St. Lawrence to any extent that would not interfere with the navigation of that river. The navigation is limited by the depth of the Cornwall Canal, up which all vessels have to pass in order to avoid the rapids of the St. Lawrence; and the extreme depth of the Cornwall Canal being 14ft., the draught of all vessels navigating the St. Lawrence above the canal is limited to something less than that. The minimum depth of the St. Lawrance in the navigable channel at this point is 24ft., and its maximum depth about 64ft.; it therefore follows that the waters of the St. Lawrence might be tapped to the extent of nearly 10ft. in depth before the navigation could in any way be interfered with, and if the best of foundations for the construction of the proposed electrical power-house.

The company are proposing, whilst making the canal of sufficient dimensions to develop 150,000 h.p., to put down electrical machinery for the production of 75,000 e.h.p. from this. This power will be developed by the installation of 15 sets of turbines and electrical generators, each having an output of 5,000 e.h.p. The reasonable height of the fall allows of the turbines and generators being placed on horizontal shafts in place of on vertical ones, as at Niagara, with a consequent simplification of the whole of the engineering problems. The plan shows the manner in which it is proposed to dispose of the turbines and generators, from which it will be seen that the turbine flumes will be separated from the head race by a strong masonry wall with arched entrances into each flume, which entrances will be closed by sluice gates and suitable racks. The shafts on which each of the two pairs of turbines will be mounted will be continued through the wall of the power-house and be there connected to the 5,000-h.p. electric generators. It has been decided to use four turbine wheels on each shaft, arranged in two pairs, in order to obtain a speed of 150 revolutions per minute under the working head of 40ft., enabling the generators to be made at a reasonable cost, whilst if one

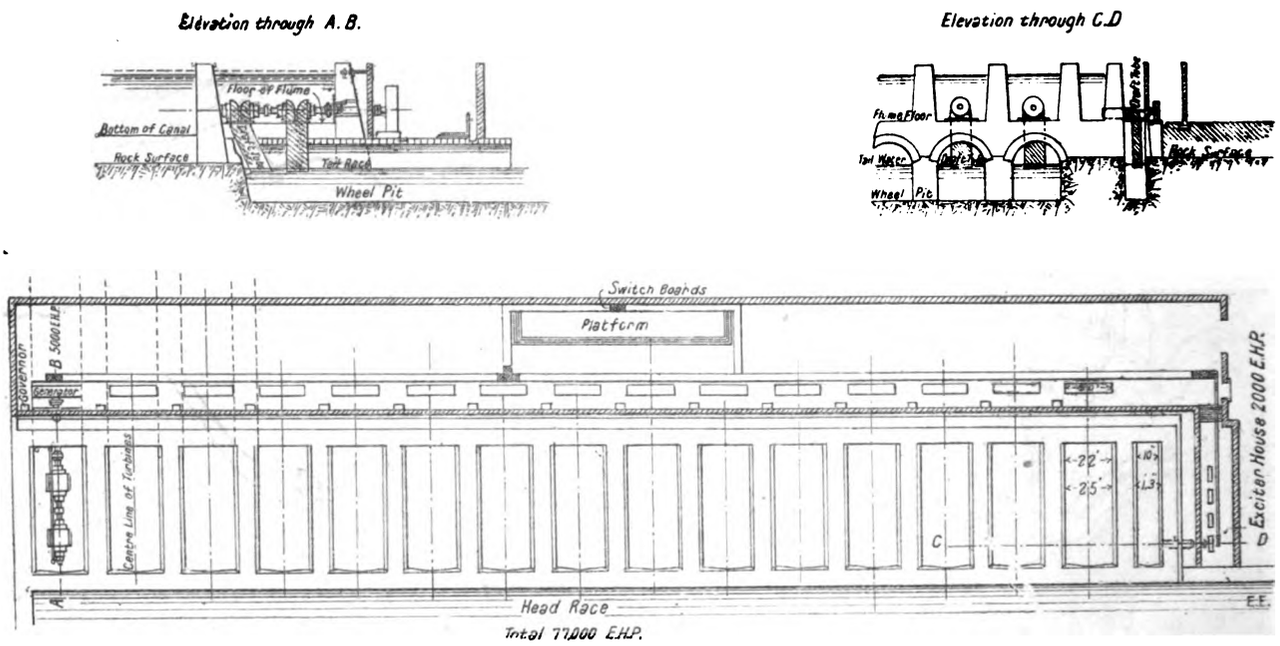

FIG 2.—Proposed Arrangement of Plant for the Massena Power Transmission Scheme.

waters so abstracted were diverted to the Grass River, they would be returned to the St. Lawrence further down, thus having no effect on the river in its lower reaches. The company has been formed for the construction of a canal between the St. Lawrence and the Grass Rivers, and for the utilisation of a large quantity of the power so produced electrically. This canal will be about 220ft. in width along the water surface, and about 26ft. in depth, and will have a water-bearing section of something over 6,000 square feet. Running at a reasonably slow speed, it will enable a sufficient quantity of water to be put into the Grass River to develop 150,000 h.p. with a working head of 40ft. The country between the St. Lawrence and Grass Rivers is almost wholly alluvial soil, comparable to our blue clay, though somewhat looser in its nature. It is therefore extremely easily excavated, whilst, on the other hand, it will form an exceedingly reliable bed for the canal. Borings having been made all along the route of the canal, it has been ascertained that no rock exists along the line of the cutting, but nevertheless a ledge of limestone of an excellent quality outcrops on the banks of the Grass River, and underlies the whole of the country towards the St. Lawrence at a lower depth than the bottom of the canal. These conditions are quite phenomenal, for whilst ease of excavating the canal with the absence of all rock cutting is ensured, the existence of the level plateau of limestone on the banks of the Grass River and just above its waters provides the pair of turbines of larger diameter were used the speed would be so low that the generators would be of excessive cost. These turbines are supported in draught boxes resting on the floor of the turbine flume, and a draught tube will continue the fall to the forebay of the tail race underneath. The head in the turbine flumes will be about 19ft., whilst the length of the draught tubes to the level of the water in the tail race will be about 21ft. The excavation of rock that will be made for the formation of the forebays into the Grass River will provide most of the material required for the masonry walls and arches and superstructure forming the turbine and power house. As will be seen from the sketch-plan of the power-house, the whole of the machinery employed will be of exceptionally large dimensions; the outside diameters of the generators will approximate to 20ft., whilst the shafts connecting them with the turbines will be about 22in. in diameter. The total length of the power-house to accommodate the 15 main generators will be 525ft. in length, whilst the electrical horse-power provided in the exciter annexe for the excitation only of fields of these generators will be 2,000 h.p., not an inconsiderable power station in itself.

The phenomenally favourable conditions of the country referred to above will enable, on the estimates made, the canal for 150,000 h.p., the power-house and generator for developing 75,000 e.h.p., to be put down at a cost not exceeding £500,000, and the electrical horse-power

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developed for this capital sum will be, therefore, just twice as much at Niagara, whilst the water horse-power carried by the canal will also be in excess of that developed so far at Niagara. It is proposed to charge from £2. 8s. to £3 per electrical horse-power per annum for 24 hours a day, which is also, probably, the cheapest price at which electrical horse-power has yet been sold. The engineers for the company are Messrs. Kincaid, Waller, and Manville, 29, Great George-street, Westminster, S.W., and Mr. John Bogart, of 50, Wall-street, New York, U.S.A., who was one of the consulting engineers most concerned in the Niagara Falls development.

EXPERIMENTS UPON PROPELLER VENTILATING FANS, AND UPON THE ELECTRIC MOTOR DRIVING THEM.*

BY WILLIAM GEORGE WALKER.

(Continued from page 629.)

Mutual Relations of Revolutions, Brake Horse-Power, and Air Discharge.—Fans 1 to 6 were tried at progressive speeds ranging from 300 to 1,000 revolutions per minute, and the following relations were verified for constant angle of blades and position of fan: (1) air discharge varies as speed of revolution; (2) horse-power varies as (air discharge)^3. Whence

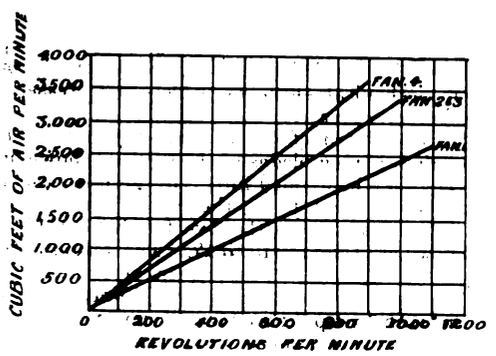

FIG. 30.—Revolutions and Air-Discharge of Fans Nos. 1 to 4.

follow—(3) horse-power varies as (speed of revolution)^3; (4) torque varies as (speed of revolution)^2; and also (5) torque varies as electric current. Therefore (6) electric current varies as (air discharge)^2. This last relation (6) applies to the particular motor used and to the limits of the experiments; it does not mean that all electric motors will invariably agree with it. Hence for all speeds of the same fan the ratio of air discharge to speed of revolution, and that of (air discharge)^3 to brake horse-power, are both of them constant; and putting relation (6) into a different form, the ratio of (air discharge)^2 to ampere current is also constant. The mechanical efficiency of the fan is therefore constant at all speeds within the limits of the range tried, because it varies as the cube of the air discharge and inversely as the brake horse-power. The experimental results of several of the fans at different speeds have been plotted, the revolutions and air discharge in Fig. 30, and the brake horse-power and air discharge in Fig. 31. The results for each fan have been given in the tables for one speed only, but can be found for any other speed by the above relations.

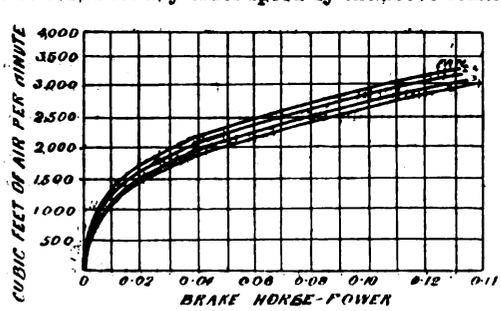

FIG. 31.—Brake Horse-power and Air-Discharge for Fans Nos. 1 to 4.

Calculation of Horse-Power in Air Discharged and of Efficiencies.—Weight of one cubic foot of air at temperature $t$deg. F. $= \frac{1{\cdot}3304 \times B}{T}$ lb., where B = barometer height in inches of mercury, and T = absolute temperature = $t$deg. + 461deg. F. Taking into account the moisture in the air weight of one cubic foot of air $= \frac{1{\cdot}3304}{T}\left(B - b + \frac{5}{8}b\right)$ where b is the pressure due to the moisture in inch of mercury. If W = weight of air discharged per second in pounds, and V = velocity of air in feet per second, then kinetic energy of air discharged $= \frac{W V}{2g}$; and horse-power of air discharged $= \frac{W V^2}{2g \times 550} = V^3 \times$ constant, for same fan under same conditions, which follows from relation (2). Therefore if Q be the quantity of air discharged in cubic feet per second,

$$\text{horse-power of air discharged} = \frac{V^2 Q}{550 \times 64{\cdot}4} \times \frac{1{\cdot}3304 \times B}{T} = \frac{V^2 Q B}{T} \times 0{\cdot}00003756 \quad . \quad (1)$$

$$\text{Mechanical efficiency} = \frac{\text{horse-power in air discharged}}{\text{brake horse-power}}.$$

Suppose the air to be flowing against the mouth of a Pitot tube connected with a water-gauge, and let H = height of column of air in feet, and h = equivalent column of water in inches.

Then
$$H = \frac{V^2}{2g} \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (2)$$

Taking the weight of a cubic foot of water at 62deg. F. to be 62·35lb., $12\ H \div h = 62{\cdot}35 \div \frac{1{\cdot}3304\ B}{T}$; whence $H = \frac{62{\cdot}35\ T\ h}{1{\cdot}3304\ B\ 12} = \frac{3{\cdot}9\ T\ h}{B}$. The substitution of this value for H in (2) gives $h = \frac{V^2 B}{251\ T}$. Whence substituting in (1), horse-power in air discharged $= h \times 251 \times Q \times 0{\cdot}00003756 = h\,Q \times 0{\cdot}00943$, from which the mechanical efficiency can then be determined. Volumetric efficiency $= \frac{Q}{U r^2}$, where U = velocity of tips of blades in feet per second, and r = radius of fan in feet. Pressure efficiency $= \frac{V^2}{2U^2}$, the pressure varying as the square of the velocity. These three efficiencies are each of them constant at all speeds with the same fan; this follows from the fact that the air discharge varies as the speed of revolution. There is great want of a recognised standard for comparing fans. Not being acquainted with any reliable experiments on the class of fans here tested, the author felt some hesitation in deciding upon the best method to employ. It may appear paradoxical that the volumetric efficiency can be greater than unity, but that the formula is based on correct principles is shown by the fact that it gives a constant efficiency for the same fan at all speeds. It was first employed, the author understands, by Prof. Rateau, of St. Etienne. The dynamic pressure varies as the velocity squared. The pressure efficiency varies as the square of the volumetric efficiency, both being a maximum at the same time. The pressure efficiency is not of essential importance in the fans here tested, because it is calculated only from pressure due to velocity of air, and not from compression, as it would generally have to be calculated in a centrifugal fan.

Experiments with Fan Blades at Different Angles.—The angles are those which the plane of the blade makes with the plane of rotation. The experimental results of fan 17 for different angles varying from 15deg. to 60deg. are given in Table 2, and

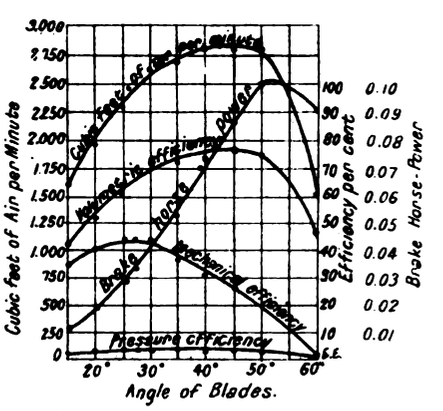

FIG. 32.—Characteristics of Fan No. 17.

are plotted in Fig. 32. These may be termed the characteristic curves of the fan for varying angles, showing at a glance its general performance. The angles are plotted as abscissæ; the air discharge, brake horse-power, and efficiencies as ordinates. In this example it will be noticed that the air discharge increases nearly with the angle from 15deg. to 30deg.; after which the curve bends down moderately until 45deg. is reached, and then with further increase of the angle the air discharge rapidly falls off. The brake horse-power increases with fair uniformity until an angle of 50deg. is reached, after which it commences to fall

* Paper read before the Institution of Mechanical Engineers.

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TABLE 3.—Comparison of Propeller Ventilating Fans Nos. 16 and 17 with Blades Set at Different Angles to Plane of Revolution. Both Fans 23¾in. Diameter, Revolving Inside Delivery Air-Tube of 24in. Bore; Speed, 600 Revolutions per Minute. Friction of Motor Included.

Angle of blades.	Fan No. 16.						Fan No. 17.					
	Air discharged per min.	Horse-power		Efficiency			Air discharged per min.	Horse-power		Efficiency		
		Gross.*	Air.	Mechanical.†	Volumetric.	Pressure.		Gross.*	Air.	Mechanical.†	Volumetric.	Pressure.
Deg.	Cubic feet.	H.P.	H.P.	P.c.	P.c.	P.c.	Cubic feet.	H.P.	H.P.	P.c.	P.c.	P.c.
15	1,079	0·0377	0·0012	3·1	28 6	0·41	1,562	0·0453	0·0038	8·3	41·4	0·87
20	1,622	0·0429	0·0042	9·7	43·0	0·94	1,916	0·0519	0·0070	13·4	50·8	1·31
25	2,030	0·0521	0 0084	16·1	53·8	1·48	2,291	0 0620	0·0120	19 3	60·8	1·88
27	2,185	0·0588	0·0106	18 0	58·0	1·73	2,423	0·0672	0·0143	21·2	64·3	2·10
30	2,439	0·0698	0·0145	20·7	64·7	2·13	2,598	0·0761	0·0176	23·1	68·9	2·42
35	2,580	0·0848	0·0172	20·2	68·4	2·39	2,705	0·0876	0·0199	22·7	71·7	2·62
40	2,627	0·0958	0·0182	18·9	69·7	2 47	2,805	0·1045	0·0222	21·2	74·4	2·82

* Gross horse-power = brake horse-power + horse-power due to friction of motor.
† Mechanical efficiency = ratio of horse-power in air discharged to gross horse-power.

off, showing that the resistance of the fan is not increased by increasing the angle beyond about this inclination. The mechanical efficiency increases with the angle, and reaches the maximum of 42·8 per cent. at an angle of 27deg., after which it falls off with further increase of the angle. The volumetric and pressure efficiencies increase with the angle, until they reach the maximum of 76·7 and 2·87 per cent. respectively at an angle of 45deg., after which they fall off with further increase in the angle. A difficulty arises from the mechanical and volumetric efficiencies not being the maximum at the same angle.

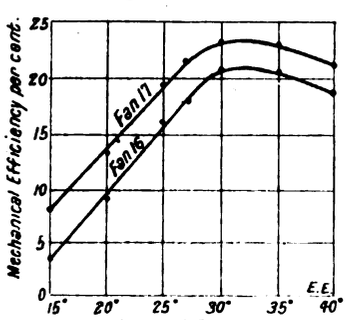

Fig. 33.—Mechanical Efficiency of Fans Nos. 16 and 17.

If the blades were fixed at 27deg., so as to give the maximum mechanical efficiency, the volumetric and pressure efficiencies would fall to 64·3 and 2·10 per cent. respectively; if placed at 45deg., so as to give the maximum volumetric and pressure efficiencies, the mechanical efficiency falls to 26·4 per cent., falling somewhat rapidly after 27deg. is reached. The angle of the fan blades must therefore be governed to a certain extent by the nature of the work which the fan is required to perform, and also by the kind of motor employed, whether electric, steam, or gas. In electrically-driven fans, supplied with current through a meter, the mechanical efficiency may be of more importance than the volumetric, the latter varying directly as the air discharge and inversely as the revolutions and the cube of the diameter. Taking into account the combined efficiency of

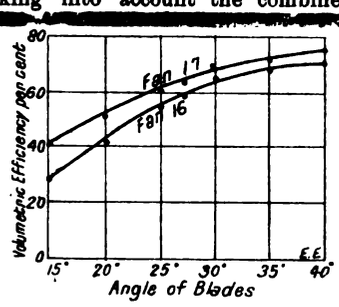

Fig. 34.—Volumetric Efficiency of Fans Nos. 16 and 17.

motor and fan, it may be advisable to modify the application of the formula for the volumetric efficiency, for the reason that it may be more economical to run the motor at a comparatively high speed, and that the required amount of air discharge would then be obtained with blades set so as to give the maximum mechanical efficiency, but not the highest volumetric efficiency. In calculating the mechanical efficiency, the power due to the friction of the motor has been excluded, so that the actual performance of the fans could be better compared, and that the results should not be affected by a factor which depends only on the state of the bearings. In Table 3 the initial friction of the motor has been included with the brake horse-power, so that the mechanical efficiency of fans 16 and 17 may also be calculated including the friction. The mechanical, volumetric, and pressure efficiencies of fans 16 and 17 have been plotted with the friction of the motor included, in Figs. 33, 34, and 35. By including the friction of the motor, not only is the mechanical efficiency reduced, but also the angle of maximum mechanical efficiency is altered; for instance, the angle which gives the maximum mechanical efficiency is 30deg. in Fig. 33 when the friction is included, instead of 27deg. in Fig. 32 when no friction was included. At very small angles of the blades the horse-power of the air discharged is small, but the comparatively large friction of motor being included in the gross horse-power gives a low mechanical efficiency, which is increased as the air discharge becomes greater.

Effect of Cross-Section of Fan Blades.—Seventeen three-bladed fans were tried, having blades of the sections shown in Figs. 1 to 17. They may be divided into four groups: the first comprises the four fans 1 to 4; the second group the six fans 5 to 10; the third group the five fans 11 to 15; and the remaining two are the fans 16 to 17. The blades are of sheet iron 1-16in. thick, with the exception of fan 10, their cross-sectional lines are all composed of straight lines or arcs of circles. The fans in each group differed from one another only in the cross-section of their blades, which were flat, plano-convex, concavo-convex, of different degrees of curvature. Fan 1 had flat blades. Fan 2 was formed by fixing a circular face upon the non-propelling surface or back of the blades of fan 1, giving a plano-convex section to the blades. Fan 3 was

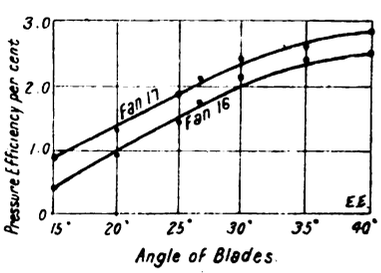

Fig. 35.—Pressure Efficiency of Fans Nos. 16 and 17.

formed by curving the blades of fan 1, so that the cross-section became concavo-convex, the propelling face being concave. Fan 4 was formed by fixing upon the back or non-propelling face of the blades of fan 3 a still more convex surface, so that the cross-section remained concavo-convex with the propelling face concave, but the section was not of uniform thickness. The blades of the other groups were similar in form, but of different area and thickness. In Figs. 22 and 24 is shown a fan of the second group in position on the spindle. The same boss and spokes were used throughout the experiments. From Table 1 it will be seen that variation in the cross-section of the blades of the fan, while retaining the same shape and area and the same conditions of trial, produced a considerable effect on the results. The first group, fans 1 to 4, were all tried with their blades at an angle of 17deg. to the plane of rotation, and under identical conditions. The mechanical, volumetric, and pressure efficiences of fan 1 were 21·2 and 38·2 and 0·7 per cent. respectively. The effect of putting the curved surface upon the back of the blades in fan 2 was to increase the efficiencies to 28·0 and 54·0 and 1·4 per cent. respectively. In fan 3 with the curved blades of uniform thickness the efficiencies were all greater than those of fan 1, being 23·9 and 53·0 and 1·4 per cent. respectively; the volumetric and pressure efficiencies were about the same as for fan 2, but the mechanical efficiency was 4·1 per cent. less. Fan 4 was the most efficient of the group, the section of its blades being concavo-convex with a hollow space between the faces; the thickness of the blades on the centre line was 7-16in., and the three efficiencies

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were respectively 28·0 and 65·0 and 2·1 per cent. The efficiencies of these fans were thus increased by making the blades thicker in the middle of their breadth.

(To be continued.)

INSTITUTION OF CIVIL ENGINEERS.

ENGINEERING CONFERENCE.

As has been previously announced in our columns, the Institution of Civil Engineers has this year organised an engineering conference for the 25th, 26th, and 27th of this month. The conference will be opened at 10.30 a.m. on Tuesday next in the Westminster Town Hall by a short address from the president, Mr. J. Wolfe Barry. The sections will then meet, as indicated by the accompanying time-table and programme, in the large hall and Council-chamber of the Westminster Town Hall, and in the Council-chamber and committee-room of the Guildhall, Westminster. Proofs of the notes introducing the various subjects may be obtained at the hon. secretaries' office on or after the 24th inst. The office will be open at the Town Hall from 10 a.m. to 4 p.m. on the 24th, 25th, 26th, and 27th inst. A reading and writing room will also be open there on those days for the use of members. For the convenience of those attending the conference and taking part in the visits to works, arrangements have been made for luncheon to be served, at a charge of 3s. each, between 12.30 and 3 p.m. on the 25th, 26th, and 27th inst., in a room reserved for the members at the Westminster Palace Hotel. Arrangements have been made for visits to a number of engineering works of interest, as below. The numbers that can be received being in many cases limited, it will be essential that those who wish to attend should make early application, as priority will be given to the earlier applications. When the limiting number for any visit is reached, applications to take part in other visits will be considered in order of the choice indicated for each day.

The works to be visited on Tuesday, at 3.30 p.m., are the Bankside station of the City of London Electric Lighting Company; the Central London Railway works, Oxford-circus; the General Hydraulic Power Company's works, Wapping pumping station, and the Linde British Refrigeration Company's works at Shadwell; the South Metropolitan Gas Company's works at Deptford, and the New River Company's works at Finsbury Park.

On Wednesday, the 26th inst., visits can be paid to the Dover Harbour works, leaving at 10 a.m.; or at 2 p.m. to the metropolitan sewage disposal works at Barking, the Blackwall Tunnel, and the Woolwich Arsenal; or at 3 p.m., the Waterloo and City Railway works at Upper Ground-street.

On Thursday, the 27th, a party will start at 10.30 a.m. to view the London water companies' riverside works between Hammersmith and Sunbury; at 1 p.m. a visit will be arranged to the London Dock and Thames Iron-works; at 3 p.m. to Messrs. Siemens and Co.'s works at Charlton, to the Tower Bridge, or the Royal Mint.

TUESDAY, MAY 25.

10.30 a.m., in the Large Hall, Westminster Town Hall. All the sections. Address by the President.

10.45 a.m., in the Large Hall, Westminster Town Hall. Sections III. and VII.—Machinery, etc., and Applications of Electricity. (1) "The Transmission of Power by Electricity," introduced by Mr. W. H. Preece, C.B., F.R.S.; (2) "The Transmission of Power by Water," introduced by Mr. E. B. Ellington; (3) "The Transmission of Power by other Agents," introduced by Dr. John Hopkinson, F.R.S.

10.45 a.m., in the Council-chamber, Westminster Town Hall. Section I.—Railways. (1) "Rails and Permanent Way," introduced by Mr. H. Copperthwaite; (2) "Permanent Way," introduced by Mr. F. W. Webb.

11 a.m., in the Council-chamber, Guildhall. Section VI.—Waterworks, Sewerage, and Gasworks. (1) "The Law and Allocation of Underground Water," introduced by Mr. James Mansergh.

11 a.m., in the Committee-room, Guildhall. Section IV.—Mining and Metallurgy. (1) "Dealing with Water in Pits During Sinking and in Permanent Work," introduced by Mr. J. B. Simpson; (2) "Water in Deep Shafts," introduced by Mr. Henry Davey; "Deep Levels in Mining Practice in the United Kingdom," introduced by Mr. Bennett H. Brough; (4) "Prospects of Deep Mining in Cornwall," introduced by Mr. William Thomas.

12.15 p.m., in the Council-chamber, Westminster Town Hall. Section V.—Shipbuilding. (1) "Practical Application of Model Experiments to Merchant-Ship Design," introduced by Mr. Archibald Denny.

12.30 p.m., in the Council-chamber, Guildhall. Section II.—Harbours, Docks, and Canals. (1) "Concrete in Relation to Marine Works," introduced by Mr. John Kyle and Mr. A. E. Carey; (2) "The Arrangement of Docks in Relation to Approaches, etc.," introduced by Mr. H. F. Donaldson.

WEDNESDAY, MAY 26.

10.30 a.m., in the Large Hall, Westminster Town Hall. Section III.—Machinery and Transmission of Power. (1) "Important Questions in the Economic Working of Steam Engines and Boilers," introduced by Mr. Bryan Donkin; (2) "Separate Condensing Plants," introduced by Mr. Henry Davey; (3) "Petroleum as Steam-Engine Fuel," introduced by Mr. John A. F. Aspinall.

10.30 a.m., in the Council-chamber, Westminster Town Hall. Section VII.—Application of Electricity. (1) "Should Generating Plant be Mounted on Springs?" introduced by Mr. James Swinburne; (2) "Turbines Applied to Dynamos," introduced by the Hon. C. A. Parsons.

10.30 a.m., in the Council-chamber, Guildhall. Section VI.—Waterworks, Sewerage, and Gasworks. (1) "Water Gas," introduced by Mr. Corbet Woodall: (2) "Gas for Power Purposes," introduced by Mr. J. Emerson Dowson; (3) "House Sanitation," introduced by Mr. Rogers Field; (4) "Refuse Destructors," introduced by Mr. H. P. Boulnois; (5) "The Bacteriology of Water Supply," introduced by Dr. Edward Frankland, F.R.S.; (6) "Relation between Rainfall, Flow off the Ground, and Actual Yield of Reservoirs, introduced by Mr. W. Fox.

10.30 a.m., in the Committee-room, Guildhall. Section IV.—Mining and Metallurgy. (1) "Some Points relating to the Appliances used by Metallurgists," introduced by Prof. W. C. Roberts-Austen, F.R.S.

12 noon, in the Large Hall, Westminster Town Hall. Section I.—Railways. (1) "The Location and Cost of Working of Pioneer Railways," introduced by Mr. R. Elliott Cooper; (2) "What is True or False Economy in Light Railway Construction?" introduced by Mr. A. C. Pain.

12 noon, in the Council-chamber, Westminster Town Hall. Section V.—Shipbuilding. (1) "The Relative Advantages and Disadvantages of Rotary and Reciprocating Engines as applied to Ship Propulsion," introduced by the Hon. C. A. Parsons; (2) "Use of Water-Tube Boilers in the Mercantile Marine," introduced by Mr. A. E. Seaton.

THURSDAY, MAY 27.

10.30 a.m., in the Large Hall, Westminster Town Hall. Section III.—Machinery and Transmission of Power. (1) "Piston-Valves in Locomotives," introduced by Mr. S. W. Johnson; (2) "Ball and Roller Bearings," introduced by Mr. W. Bayley Marshall; (3) "Pneumatic Grain Elevators," introduced by Mr. C. R. Parkes.

10.30 a.m., in the Council-chamber, Westminster Town Hall. Section V.—Shipbuilding. (1) "Improved Materials of Construction and their Influence on Design," introduced by Prof. J. H. Biles; (2) "Influence of Choice of Materials and Workmanship on the Structural Strength and Durability of Merchant Shipping," introduced by Mr. H. H. West.

10.30 a.m, in the Council-chamber, Guildhall. Section II.—Harbours, Docks, and Canals. (1) "The Value and Scope of Inland Navigation," introduced by Mr. E. D. Marten, Mr. Lionel B. Wells, and Mr. J. A. Saner; (2) "Comparison of Dredging and Training Works as Means for the Improvement of Rivers," introduced by Mr. A. F. Fowler and Mr. I. C. Barling; (3) "On Automatic Dredging of Rivers and River Bars," introduced by the Hon. R. C. Parsons.

10.30 a.m., in the Committee-room, Guildhall. Section IV.—Mining and Metallurgy. (1) "The Kent Coalfield," introduced by Mr. Robert Etheridge, F.R.S.; (2) "West Australian Gold Mining," introduced by Mr. C. A. Moreing.

12 noon, in the Large Hall, Westminster Town Hall. Section VII.—Applications of Electricity. (1) "The Decimal System in Engineering Measurement," introduced by Captain H. Riall Sankey, late R.E.; (2) "The Equilibrium System of Feeding Electric Railways," introduced by Mr. C. E. P. D. Spagnoletti.

12 noon, in the Council-chamber, Westminster Town Hall. Section I.—Railways. (1) "The Standardising of Working Loads and Working Stresses for Railway Bridges," introduced by Mr. J. M. Moncrieff; (2) "The Use of Small Scale Experiments in some Engineering Problems," introduced by Mr. A. Mallock.

Meteorological Society.—The monthly meeting of the Royal Meteorological Society was held last Wednesday afternoon, at the rooms of the Royal Astronomical Society, Burlington House, Mr. E. Mawley, F.R.H.S., president, in the chair. Mr. F. Gaster, of the Meteorological Office, read a paper by himself and Mr. R. H. Scott, F.R.S., on "The Mean Monthly Temperatures of the British Isles." The authors dealt with the means of the daily minimum, average, and maximum temperatures for the various months of the year in the 25 years 1871-95. They pointed out that the range between January and July amounts to about 16deg. at coast stations but to more than 23deg. at the inland stations. A paper by Mr. C. V. Bellamy, on "The Rainfall of Dominica, West Indies," was also read.

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THE

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ENGINEERING CONFERENCE.

The forthcoming engineering conference under the auspices of the Institution of Civil Engineers, is a new departure for that institution. There is no gainsaying the fact that this institution is generally accorded throughout the world the premier position of all such institutions. In the course of its growth it has seen the rapid development of all branches of civil engineering; it has witnessed the formation of kindred institutions, each intended to deal with a special branch of engineering. Now, as ever, the fundamental principles underlying all engineering work are as they always were, but the details of practice can no longer be contained within the covers of a single book, or, for the matter of that, of a score of books. Practical men in all directions have to specialise, that is, if they wish to create a name or fame. Hence one of the necessities of this new departure. The various sections at the conference, after the manner of the sections at the British Association meetings, will read specialistic papers and discuss specialistic subjects. Each section will be attended by specialists, and the exchange of experienced opinions by such men should be particularly valuable. It will be seen from the detailed programme given in another column that the subject of electricity will receive considerable attention, and good ought to come out of the discussion on the transmission of power. Curiously enough, at this juncture preliminary accounts are being given of a Canadian scheme of power transmission which is to outrival that of Niagara. While, however, these huge schemes are of interest, it is far more important to thoroughly discuss the smaller schemes which may come into operation nearer home, such as those relating to traction on roads, tramways, or railways. A vast amount of information of one kind and another has been collected about electric and other transmission of power, but little generalisation has been done, and the time ought to have come when that might satisfactorily be done. Many years ago, in the early days of electric light stations, troubles arose on account of vibrations. These troubles are not altogether of the past, and Mr. Swinburne, we presume, on their account will discuss the heroic remedy of mounting generating plant on springs. We do not know, of course, the details of his scheme, but it may be mentioned that almost as soon as complaints were made as to vibration the suggestion was made, first in America and afterwards in England, that the generating plant might be hung upon a platform. That plan presents but comparatively few engineering difficulties. It gets rid of the vibratory troubles, as has more recently been shown by Mr. Beaumont in his vibromotor. Of course, there are scores and hundreds of central stations wherein vibration is of little importance to anyone outside the station. It is only when the central station is in the midst of a thickly-populated district and the inhabitants commence legal proceedings that anyone cares. There seems to be no valid reason against the suspension of platforms, and such suspension would, we imagine, prove more effective against external vibrations

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and present fewer structural troubles than the mounting on springs. We are, however, falling into the error of criticising a paper of which we know nothing, when our intention is only to direct attention to the importance of the subjects to be brought forward at the conference which commences next Tuesday.

Another departure will be found in the visits to works. No matter how able, how experienced, a man may be, he surely gains knowledge in visiting other works than his own. Frequently to the less experienced, a visit to a well-organised works is an education in itself. Still further, we hail with satisfaction the fact that this conference is open to the Press for report. The ordinary reporter at a meeting of experts is like a fish out of water, but since the birth of the institution the technical Press has grown, although its items are not yet recognised as belonging to the literary fraternity, and not a few of its members are quite capable of understanding and correctly reproducing technical terms and explanations. Their criticisms are not immature imaginings, but those of men who have had a wide experience in engineering work. Thus the instant information properly given to the whole of the technical world, must assist in the dissemination of the latest views as expressed at such a conference.

FORTHCOMING EVENTS.

The following are some of the announcements for the forthcoming week:

TO-DAY (FRIDAY).—Royal Institution (Lord Kelvin on "Contact Electricity of Metals"), 9 p.m.—Also at Paris, the Ingenieurs Civils de France fortnightly meeting.

TO-MORROW (SATURDAY).—Royal Institution (Mr. J. A. Fuller Maitland on "Music in England During the Reign of Queen Victoria"), 3 p.m.—The Prince of Wales opens the Blackwall Tunnel, 3.30.

MONDAY, MAY 24.—Society of Arts, John-street, Adelphi (Mr. L. F. Day's Cantor lecture on "Lettering"), 8 p.m.

TUESDAY, MAY 25.—Royal Institution (Dr. E. H. Starling on "The Heart and its Work"), 3 p.m.—Institution of Civil Engineers' Summer Conference.

WEDNESDAY, MAY 26.—Institution of Electrical Engineers (at 28, Victoria-street, students' meeting, Messrs. Sayers and Grant on Long Submarine Cable Working), 7.30 p.m.—Civil Engineers' Conference.—Society of Arts (Mr. Moreton Frewen on Bimetallism), 8 p.m.

THURSDAY, MAY 27.—Royal Institution (Mr. Churton Collins, M.A., on "Burke and the Revolution"). 3 p.m.—Institution of Electrical Engineers, at the Society of Arts (Discussion of Mr. Mordey's paper on "Dynamos"). 8 p.m.—City and Guilds Institute Technical Education (Practical Work, Exhibition opened by Lord Cross, Imperial Institute), 4 p.m.—Civil Engineers' Conference

FRIDAY, MAY 28.—Royal Institution (Prof. H. Moissan, directeur, Laboratoire de Chimie Minérale à l'Ecole Supérieure de Pharmacie, Membre de l'Académie des Sciences, Paris, who will lecture in French on "The Isolation of Fluorine," with experiments), 9 p.m.

SATURDAY, MAY 29.—Royal Institution (Mr. Fuller Maitland on Music), 3 p.m.

OBITUARY.

We regret to announce the death of Mr. G. H. Thornton, A.I.E.E., who, until lately, was a member of the staff of Messrs. Siemens Bros. and Co. Mr. Thornton, after a distinguished career at the Wakefield Grammar School, obtained the Clothworkers' Scholarship at the Central Institution in 1888, heading the list of matriculated students that year. After taking the diploma of the institution in 1891, he joined the firm mentioned above, and in their employ gained steady promotion by his thorough treatment of the work allotted to his care. Mr. Thornton's name was attached to a patent for a block system for the regulation of the traffic on railways such as the Central London, which system this firm are developing. In the autumn of 1896 ill-health necessitated a voyage to Africa, and we regret to hear that it had not the desired effect, as he passed away a few hours after landing at Plymouth on Monday last.

MOTOR TRAFFIC AND TECHNICAL CONSIDERATIONS.

BY SIR DAVID SALOMONS.

The following is an abstract of a paper read before the Society of Arts on Wednesday, May 12, 1897, by Sir David Salomons.

The author, after referring to recent literature and papers read on the above subject, said he proposed both to deal with the matter from a technical point of view, and to examine the Patent Law so far as it affected the question. The interest he had taken in the matter had led to the forming of a large collection of books, old and new, dealing with road traction, as well as prints and engravings illustrative of the same subject. The two chief lessons to be learned by their study were the following: (1) how few patents taken out recently in connection with the subject were original; (2) how the whole tendency of the construction of light vehicles gravitated to the better types of those in existence between the years 1820-30. We, of course, possessed an advantage over the constructors of that period, inasmuch as we had improved materials to deal with.

The author then proceeded to discuss the relative characteristics of horse traction as compared with self-propelled vehicles, and the effect of bad roads on each. He was inclined to favour wheels with solid rubber tyres on account of certain mechanical disadvantages of the pneumatic tyres. Although it had been asserted that the draught was greatly diminished by the use of pneumatic tyres, the author's experience did not bear that out except in given cases. On bad roads an advantage might be gained, but on good ones, the steel tyre carried the palm. After a careful study of steam-power self-propelled carriages, the author considered that Hancock's disposition of the working parts could not be improved upon. He had pointed that out to M. Serpollet, who, having examined the matter, built his new carriages on those lines. Of all motors for carriages at the present day, the author held that steam was the most suitable and advantageous for real work.

Sir David then proceeded to describe the best and latest examples of steam-driven carriages and their structural details. Passing on to carriages driven by electric energy, he said that the only known practical method now for storing electricity was by means of batteries, either primary or secondary. The primary batteries were too troublesome and expensive in the present state of knowledge to call for any remarks. The secondary battery was either too heavy, or, if light, too costly in repairs, to be regarded otherwise than as a luxury. It was claimed by some makers that the vibration to which they would be subjected, both in the case of the heavy and the light type, did no harm, and the maintenance was greatly reduced. He had no desire to let it be thought that all those statements were false, but would point out that there was absolutely no evidence to bear out such assertions. All the evidence of the past was against the probability of such statements being fulfilled, and no new discovery had come to light to reverse past experience. Moreover, the only proof which could be brought forward contained the factor of time, and this had been so far impossible on account of the supposed improvements being very recent. It was only fair to state that some of the accumulators which had appeared of late, were more suitable for traction than the earlier ones. The modifications consisted in using celluloid pots, which were lighter than glass, transparent, and not brittle. Those pots could be closed effectually. The plates in the sections were made thinner, and in some cases wrapped round with perforated celluloid, the intention being to prevent possible contact between plate and plate. The most promising separator was, perhaps, the material devised by Mr. Joseph Swan. It was like cotton wool in appearance, though in reality celluloid. The "wool" was packed between the plates and

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round the section, converting the cell into practically a dry one. Notwithstanding these improvements, there was yet an element of possibility that the maintenance would work out higher than was anticipated, but, at any rate, the mechanical advances referred to had greatly improved matters, although the electrical properties and efficiency remained much the same. But to leave the subject of maintenance out of the question, the light accumulator was very heavy, and the losses for any type could not be estimated at less than 20 per cent., and in practice 30 per cent. was much nearer the truth. Hence it was unfair, from a commercial point of view, to regard the cost of the energy otherwise than one-third more than that at which it could be produced. There would be few who would disagree with the statement that a very fair price for the electric energy per unit was 3d. Although the author did not contend that under exceptional conditions it could not be produced for less, yet the figure given was by no means an unreasonable one in the light of extensive knowledge of the cost of the production of electric energy at lighting-power stations throughout the kingdom. Consequently, if the electric energy was to be carried, about 4d. per unit was a fair estimate of the cost when used on a moving vehicle. Roughly speaking, three-fourths of a unit was a theoretical horse-power. In practice, unless the motor was very large—say exceeding 6 h.p.—one unit per horse-power was the approximate expenditure per hour. No doubt many would say that that was excessive for a carriage carrying a 6-h.p. motor, capable at times of giving off a larger power, but the author pointed out that when the roughness of the roads came to be considered, and the stops and starts necessary when approaching and running through towns, the estimate was an exceedingly fair one. To sum this up, he contended that as matters stood to-day, it was impossible to reckon the power delivered in an electric carriage at less than 4d. per horse-power per hour, which was enormous when it was further considered that maintenance had not been taken into consideration at all, and that only a short distance could be run before the accumulators must be recharged, and that unless charging stations were to be found throughout the locality where such carriages ran, a useless mileage must be added for getting the vehicles to the charging station and back to the points where they had to be used. He then compared the costs with that of other motors, and concluded that, practically, benzine and steam came out four times cheaper than electric energy.

The author did not wish it to be thought from the remarks he had made on the value of electrically-driven vehicles, that necessarily they had no future as matters stood. His remarks only applied to those instances where the carriages were to be used commercially to obtain a good money return. Omnibus horses had to earn a certain amount per day. But that was not the case with a pleasure horse, or with an animal kept by a professional man. In such instances the maximum commercial output of the horse was not sought for, and under those conditions electric energy might do very well, provided that the following conditions could be obtained: (1) a guarantee from a company to keep the accumulator in order; (2) that conveniences for recharging the accumulator exist; (3) that the distance to be travelled in one day shall not utilise more than the electric energy stored at one charging.

Turning to the question of the power of the engines to be placed upon motor vehicles, the author said that it could not be too strongly impressed upon those who intended to take advantage of that class of traffic that the following conditions were essential for success: (1) That whatever is the proposed speed decided upon, it should be calculated upon the assumption of being an average speed, whether the country be level or hilly and the roads good or bad. Climatic changes must also be taken into consideration. Thus, if for a light vehicle, weighing when laden, say, one ton, 12 miles per hour has been fixed upon for the speed, then the power carried should be sufficient to run at this rate in all weathers and over all highways, and to climb every hill with a maximum ascent of, say, 1 in 10 at the proposed rate. The vehicle should also be able to mount a hill of 1 in 5, but at a less speed. (2) That the mechanical construction shall be such that any intelligent man after a few hours' practice shall be able to manage it. (3) That there shall be nothing about the carriage likely to prove a danger to the occupants, or the general public. (4) That the vehicle shall be strongly made, and no part likely to wear out quickly. (5) That dangerous fluids and fuels be excluded as far as possible. (6) That the construction be such that, when repairs become necessary, they can be carried out, either temporarily or finally, by any intelligent village smith.

In respect to the above considerations, there was only one which needed special comment. It was evident that the power required to obtain a given speed on the level and down-hill needed no consideration, for if the engine was strong enough to mount hills of 1 in 10, ample power existed to do the rest. He had come to the conclusion from experiments and practice, that for every ton not less than 10 h.p. should be carried. That did not necessarily imply that a 10-h.p. engine was required. It meant that the engine should, for considerable periods, and without injury to itself, be able to give off 10 h.p. It must be remembered that when the carriage was started, a far larger amount of power was necessary than when it was running. It was, therefore, very important to have a good reserve.

The author then gave figures from practice as to the power required for certain lines on different grades, etc., and then proceeded to criticise unfavourably the English Patent Law and practice.

DISCUSSION.

Mr. J. I. Thornycroft, F.R.S., said they were much indebted to Sir David Salomons, not only for this paper, but for the efforts he had made to lessen the difficulties of those who were anxious to engage in this industry, and especially for the formation of the society which had done so much to lighten those difficulties. With regard to the most suitable power for driving motors, he said that where the work was light electricity had many advantages, but that steam was more suitable where much work had to be done, and in that he entirely agreed with him. They would all admit that steam still held its own, and electricity was only a means of making use of energy, principally of the steam-engine, and conveying it to where it had to be used.

Mr. Carl Oppermann thought that 4d. per unit was too high a figure to take, as central stations were glad to supply a day load at a much lower price.

Mr. Worby Beaumont considered it rather out of place to say that either steam, air, gas, oil, or electricity was the best. There were cases where each was suitable, though the application of some was more limited than that of others. The question of expense was not the only one. The difference between the work to be done in one place or another would affect the motive power to be adopted. It would be a great waste of fuel and money to take motorcars up hills of a gradient of 1 in 10 at anything like the rate which would give an average speed of 12 miles an hour. The questions raised with regard to the Patent Law he would prefer to leave for the chairman to deal with, but some of his suggestions were undoubtedly original He could hardly follow those who thought it was a dreadful thing that a man who worked out a provisional specification found he had been anticipated. That was one of the risks which an inventor must run, and it was a risk which he ran at a very cheap rate under the present law; and if this were altered they would have to go back to the old days of enormous fees.

Mr. A. R. Sennett was much surprised to hear Sir David Salomons say that he thought the tyre of the future would be a steel tyre. The speaker favoured the pneumatic tyre. He also differed from Sir David Salomons in saying that a motorcar should run at a constant speed up hill and down. That entailed putting an unnecessary weight of mechanism into the carriage. He thought it would be more reasonable to design the car to run up hill at half the speed of the maximum on the level.

The **Chairman** (Mr. J. Fletcher Moulton, Q.C.) said the discussion had been very interesting, and to him rather amusing where it treated on the question of the Patent Laws, about which he knew something from practical experience. If he had any doubt about his income from patent business being in danger, he should certainly encourage Sir David Salomons to go about the country and persuade manufacturers that if they wanted to free themselves from the tyranny of patents they should perpetrate an infringement and see what came of it. It was suggested that if a person infringed a patent £100 would see him through it; he certainly should not like to add his guarantee to that of Sir David Salomons. He earnestly sympathised with the desire to make the Patent Laws as perfect as possible, but that was mainly because of his sympathy with inventors. With regard to the difference between the American and German law and our own, those systems were very bad for poor people, because they involved long investigations, which were usually very expensive. In England it was well known that the bulk of patents were dropped, being found to be of no value, and the only fee paid was the first. In England it was thought better to grant the patent, and then leave the person to drop it afterwards, and generally, unless it was of some value, that was what happened. The suggestion that the fee should be returned, must come home to everyone; but the idea of getting any fee returned from the Government was one they were hardly accustomed to, and he feared that even Sir David Salomons's energy would fail to get it carried into effect.

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INSTITUTION OF ELECTRICAL ENGINEERS, May 13.

Sir HENRY MANCE (president) in the chair.

After formal business, the discussion on Mr. Raworth's paper on the generation of electric energy for tramways was begun by

Mr. Geipel, who considered that while Mr. Raworth's curves contained truths which should be inwardly digested by every electrical engineer, it would have been better to have spoken of increased consumption of steam per unit instead of loss of steam per unit. He entirely agreed with Mr. Raworth in his tirade against excessive sub-division of the plant into a number of small units. One station he knew, which was not yet actually at work, would contain 12 units installed. There was not only the loss on the capital, but the very serious matter of the extra radiation from the complex arrangement of steam-pipes involved. From the specifications he had read of late, he was glad to see there was a growing tendency among consulting engineers to specify larger units. In arranging the number of units to be put down it was well to remember that our population was an increasing one, and a tramway might as a rule look forward to increasing traffic and possible extensions. Mr. Raworth might perhaps, in speaking of a combined station, have found more points in which a saving could be effected. For instance, if a stoker was saved by combining, he (Mr. Geipel) thought a dynamo attendant would be saved also. There was an allowance for depreciation of the boiler saved, but there should also be an allowance for the radiation loss, as this was a considerable item at very low loads. A further saving might be possible by running the lighting circuit by a motor-generator driven off the tram circuit at light load, and so coming down to one engine and boiler. He agreed with Mr. Raworth as to the fallacy of the possibility of the crankshaft bending. This, when it occurred, was almost invariably due to heating of the crank-pins and the strain due to the cooling distorting the shaft.

Mr. Tremlett Carter gave a quantity of figures from the Liverpool Overhead Railway, the Metropolitan Railway of Washington, the Manchester electric supply station, and two stations of the Chicago City Railway, with a view of showing that Mr. Raworth's estimated figures might be cut down lower. He considered that Mr. Raworth's diagrams should have been drawn in a different way, and exhibited his modification of the Willans diagram on the wall. [Mr. Carter's modifications of the diagrams are given herewith for comparison with Mr. Raworth's, which were published in our issue of April 30. Figs. 1 and 2 show the altered positions of the lines in Mr. Carter's way of presenting the facts. But, briefly, his contention was that the fact brought out by Mr. Willans amounted to the equation $W = W_1 + W_2 = W_1 + \omega$ h.p., while what Mr. Raworth had shown corresponded to $W = W_2 + W_4 = \alpha$ h.p. $+ \beta(1 - P/100)$. Fig. 4 has nothing to do with the Willans line, but represents the load at the station of the Philadelphia

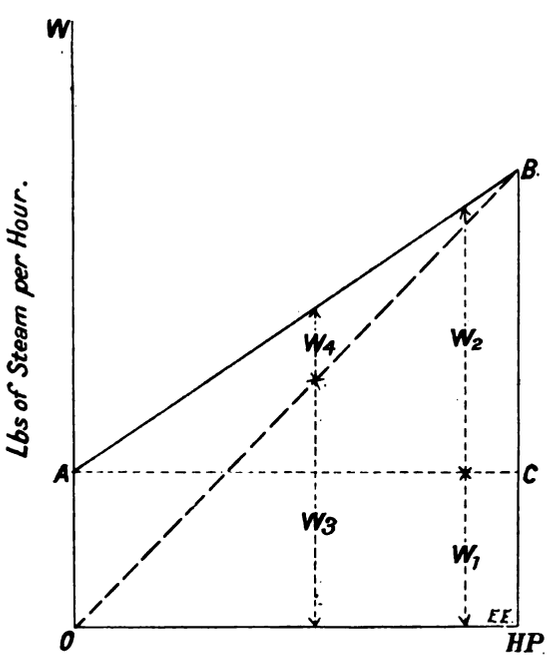

FIG. 1.

Traction Power Company, which was used by Mr. Carter in illustration of his argument.] Mr. Raworth's steam loss did not correspond to any physical fact. The throttle-governed engine was most economical at full load, and the cut-off governed engine at some fraction of the full load, generally about two-thirds. At high loads the efficiency fell off because there was insufficient expansion, and at low loads because of cylinder condensation. The sweet simplicity of Mr. Raworth's system would doubtless commend itself to them all, but he thought in a 5,000-h.p. station, instead of one 5,000-h.p. engine at work and another 5,000-h.p. engine as a stand by, it would be better to have three engines of 2,500 h.p. each. There were, he was well aware, small stations in America which worked with two engines, and some with only one engine, and no stand-by at all. Engine builders had hardly perhaps sufficiently realised that their load diagram was not a steady one. There might be some automatic arrangement

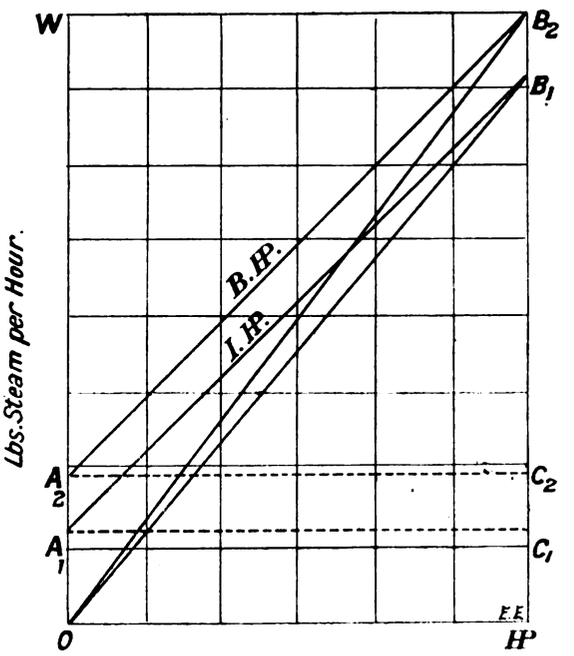

FIG. 2.

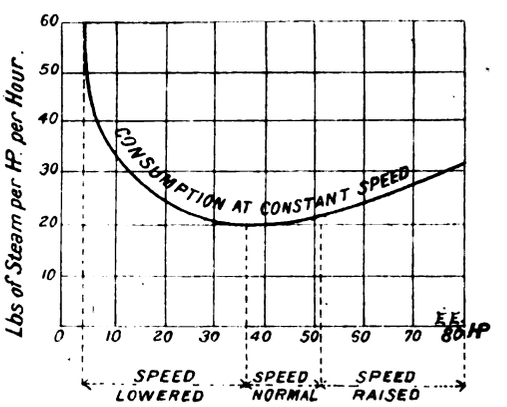

FIG. 3.—Speed Variation Efficiency.

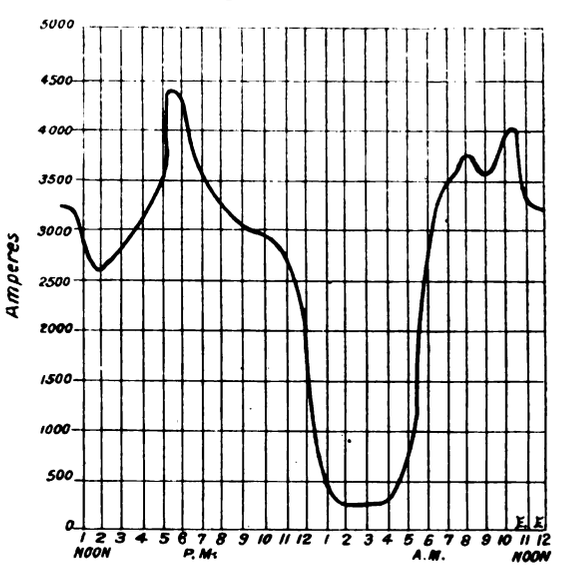

FIG. 4.—Load Diagram of the Philadelphia Traction Station.

by which the speed would be raised for heavy loads, and reduce the small loads, so as to bring the working within the limits of economic cut-off. It would of course be necessary to regulate the field magnets of the machine in correspondence.

Prof. Perry asked whether as a matter of fact anyone had tried governing by both the throttle and cut-off combined. In that way it would be possible to get a much greater range of load.

Mr. R. E. B. Crompton said this plan had been tried upon the City and South London Railway, and it was working very well there. Throughout his life he had found that there had been a regularly recurring fashion for automatic governing. It had been taken up at regularly repeated intervals and as regularly dropped again in favour of the throttle-valve. The subject had been

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discussed *ad nauseam* by societies of mechanical engineers and others. The advantages of cut-off governing were mainly apparent. It made the diagram look pretty, gave it square corners instead of round ones, and so on, but it had its disadvantages. In the old days of single-cylinder engines it was very apparent that the engine with the early cut-off was difficult to keep in repair, and engineers had to come back to doing a considerable amount of their adjustment with the throttle-valve. The wire drawing of the steam, to use the old word, by the throttle diminished the cylinder condensation, and this had to be set off against the advantage of the square-cornered diagram. No doubt Mr. Raworth's form of gear was a very perfect one, but in the types that they had to use in the older times he was speaking of, though the gear worked well at first, after a time the links wore, and there was back-lash, so that it was found that after some time of use the advantages of the expansion governing were mostly lost. It was considerations such as these which led the late Mr. Willans to go heart and soul for throttle governing. Cut-off governing had been tried from time to time at the Willans and Robinson works, but it had never come to much.

Mr. MacMahon said the engine spoken of in the City and South London Railway generating station had the most perfect governing of any engine he had seen in a traction station. Most traction engineers would not like to put down only one unit for an important plant. The load on the City and South London line varied much. For about two hours in the morning and two hours in the evening it was full load for two of their largest sets, and for the remaining 16 hours the large set would be only running at about half load. To remedy this, they had the smaller Willans set that was spoken of put in about two years ago. The saving paid the interest, etc., on its cost and left something over.

Mr. C. E. Grove said Prof. Perry might be interested in watching the course of events at the Shoreditch station, where the method of governing he spoke of had been adopted. They had a dust destructor and thermal storage on the Halpin principle, so that the engine started at 200lb. pressure, which fell to 120lb. during the evening load. To meet this great range the engineers had adopted the double governing.

Mr. Gadsby considered three units the proper number, if it could be determined what length of tramway would be ultimately laid down. It was not usual to have a dynamo attendant at a traction station, so there was no omission in Mr. Raworth's paper. No engineer who had been in traction stations where there were as many as 30 or 40 short-circuits in a day would advocate running a lighting circuit off the traction plant. One speaker proposed to vary the speed of the engine to get economy. It would be no use to save a loss of power in steam only to lose it in resistance later on. Doubling governing would be much too complicated. The cost of fuel was only a fraction of their cost, and therefore the saving was not so important as it seemed.

Mr. Geipel said he was aware that there was one man to work at both engine and dynamo, but if a stoker was saved surely that man would be saved also.

Mr. E. Garcke said he had found that municipalities and their electrical engineers had adopted extraordinary views as to the cost of supplying current (to a tramway company) for traction purposes. They regarded it from the same point of view as current for lighting. It was a matter which might seriously affect the adoption of electric in preference to steam traction on tramways in this country, and he was dissatisfied that the debate should terminate without some of the engineers defending or justifying their views. Threepence or even 4d. per unit was often asked as the price of supply. It was, of course, a commercial question, but it was worth attention.

Mr. Wordingham, as one of the class of municipal engineers, wished to say all of them were not as grasping as Mr. Garcke had suggested. At Manchester, instead of 4d., they asked 1½d. for current for power for any consumer who would take as much as 4 h.p. for a reasonable period. They had no doubt whatever that they could supply energy in that quantity at that rate and make a profit out of it.

Mr. Clirehugh spoke as one who was responsible for a station at Ashton-under-Lyne, which, he believed, was unique in its way, because they were putting down large units for combined traction and lighting. Local authorities, as a rule, would only look at the cost of current for lighting purposes, whereas in supplying it in addition for traction, the only thing that ought to be looked at was horse-power hours, whether the horse-power was electrical or brake was a detail. There might be a saving of labour by the judicious use of accumulators. In a town of 40,000 to 50,000 inhabitants it would be possible to run off the accumulators after 12 at night and shut down the engines altogether, and during the day to run off the traction plant through accumulators. He (Mr. Clirehugh) was in total disagreement with the speakers who said no one would run lighting off the traction engine. He had a certain amount of experience which led him to believe it could be done successfully. It was really a question of governing exceedingly well over a wide range. He thought the 30 or 40 short-circuits rather exaggerated. He thought, in this matter, English engineers had allowed themselves to be frightened by what the Americans had said. The reason why the combined system had not been a success there was that the factor of safety had been cut down too far. In this country, if a machine was not good enough for traction, it would not be good enough for lighting.

Mr. Sydney Morse said if some local authorities had been strangling electric tramway work by asking large prices for current, others had done much to draw attention to it by the excellent reports of their committees on what was done abroad. Mr. Morse gave statistics from the Sheffield report [it has been published at length in our columns] showing that in most towns in Germany the charge was from 1d. to 1½d. per unit.

Mr. Lawson drew attention to the importance of considering the minimum quantity to be taken in discussing the price, and

Mr. Raworth then replied. He was surprised to have got off so easily. It might be possible to effect further saving by a combination of lighting and traction work. Mr. Carter's diagrams did not reproduce the Willans idea. The Willans diagram began when the engine began to turn at full speed—that is, at the only point when any power was got and you could make an ordinate. When he spoke of a loss of steam he only meant a loss of something which might have been saved. The figures Mr. Carter quoted from America related to plants with an output of more than 12 times the cases he had calculated, which were what they might expect in the immediate future in this country. If, instead of calculating his figures, he had estimated them from the American basis, the difference in size would have been held to invalidate them at once. It had been known that it was better to have throttle governing for low loads. In one form of shaft governor, that result had been got without any trouble. It was the exact result Captain Sankey had wished for. He (Mr. Raworth) had always thought the late Mr. Willans had not seen his way to adopt expansion governing to the Willans engine. Otherwise they might have had the advantages of it enforced with the same acumen as those of throttle governing had been. The question of two or three units was one of the size of the installation. With large horse-powers, the question of labour saving became insignificant. Mr. Wordingham's success in supplying current at 1½d. per Board of Trade unit had probably been partly due to that a Manchester man would not give a higher price for the current than he thought he should get it for. Mr. Clirehugh had no doubt been told in the North that electrical engineers were perfect duffers. It was difficult for a cotton spinner, when he was producing horse-power at the rate of ½d. per unit, to understand that it might cost the electrical engineer five times as much to get it. He (Mr. Raworth) could wish that the question Mr. Garcke had suggested could be more fully taken up.

The **President** said there was a tendency to increase the size of the units. At Oxford he had put down one three times as large as they had before. If he had to supply the Oxford tramways he would not feel comfortable in relying upon this one unit, and there was a natural amount of hesitation in embarking on an expenditure of £5,000 or £10,000. As to the result of the variation of the load on the cost of the plant at Oxford, they could generate all the current used in a year in a single fortnight. With a tramway plant there would be something like a 14 or 16 hours' load.

Prof. Silvanus Thompson then read the paper on

DISTURBANCE OF SUBMARINE CABLE WORKING BY ELECTRIC TRAMWAYS.

BY A. P. TROTTER, MEMBER.

On August 6, 1896, the electric tramway service in Cape Town was opened, the cars running from the boundary of the suburb of Mowbray to the corner of Darling-street and Adderley-street (see Fig. 1). The rails are 81lb. to the yard, and are double bonded with "Chicago" bonds, except between Adderley-street and the tramway works, where the track is double and the rails are triply bonded. A test made on September 2 showed that the fall of volts on the rails was from half a volt to about one volt. From two to three tenths of an ampere passed between the earth-plates at the works and the dynamos. There are two earth-plates, but by a mistake only one wire was brought from them. A test made between the earth-plates and the feed service of the boilers showed that two volts caused 2⅓ amperes to pass. The works are about 1¼ miles from Adderley-street. The submarine cable is laid in a loop round Table Bay (Fig. 1), in order to avoid anchorages, and is landed at the foot of Adderley-street at a cable hut. From this hut a pair of cables are laid under the street to the Standard Bank, at the corner of Adderley-street and Darling-street, a distance of about 430 yards. The office of the Eastern and South African Telegraph Company is situated in the Standard Bank building, and looks out on to Darling-street. The first mile of the cable is at a mean distance of about half a mile from the tramway. As soon as the tramway service began, the working of the syphon recorder was found to be seriously disturbed. Numerous "kicks" occurred, and these being superimposed on the received signals made it difficult and almost impossible to decipher them. On August 14 I visited the office of the cable company with the Postmaster-General, and witnessed the disturbances. The then terminus of the tramways was almost immediately opposite the window of the cable company's office, and the movement of the driver's hand on the controller of the car could be watched while standing by the syphon recorder. We waited until a car started, and simultaneously with the movement of the handle of the controller, a "kick" was recorded on the slip. In a report to the Postmaster-General, dated August 16, 1896, I suggested that the disturbance might be due to the direct leakage of current, owing to the use of earth as a return by the tramway, or to induction owing to the proximity of the cable; and that the first might be removed by the use of an earth at a considerable distance, and the second by an equal and opposite induction. I proposed a series of systematic experiments.

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I am informed that, with the co-operation of the Post Office, a number of earths were tried. A telephone line to the top of Signal-hill, a telegraph wire run down to the sea at Sea Point and terminating in an earth-plate in the sea, an earth at Observatory (3½ miles from Cape Town), an earth-plate in the Alfred Docks, an earth at Durban-road (12 miles from Cape Town along the main line of the railway), an earth-plate near the cable hut, an earth in the garden of the Standard Bank, and the rails of the tramway, were all tried alone, and in

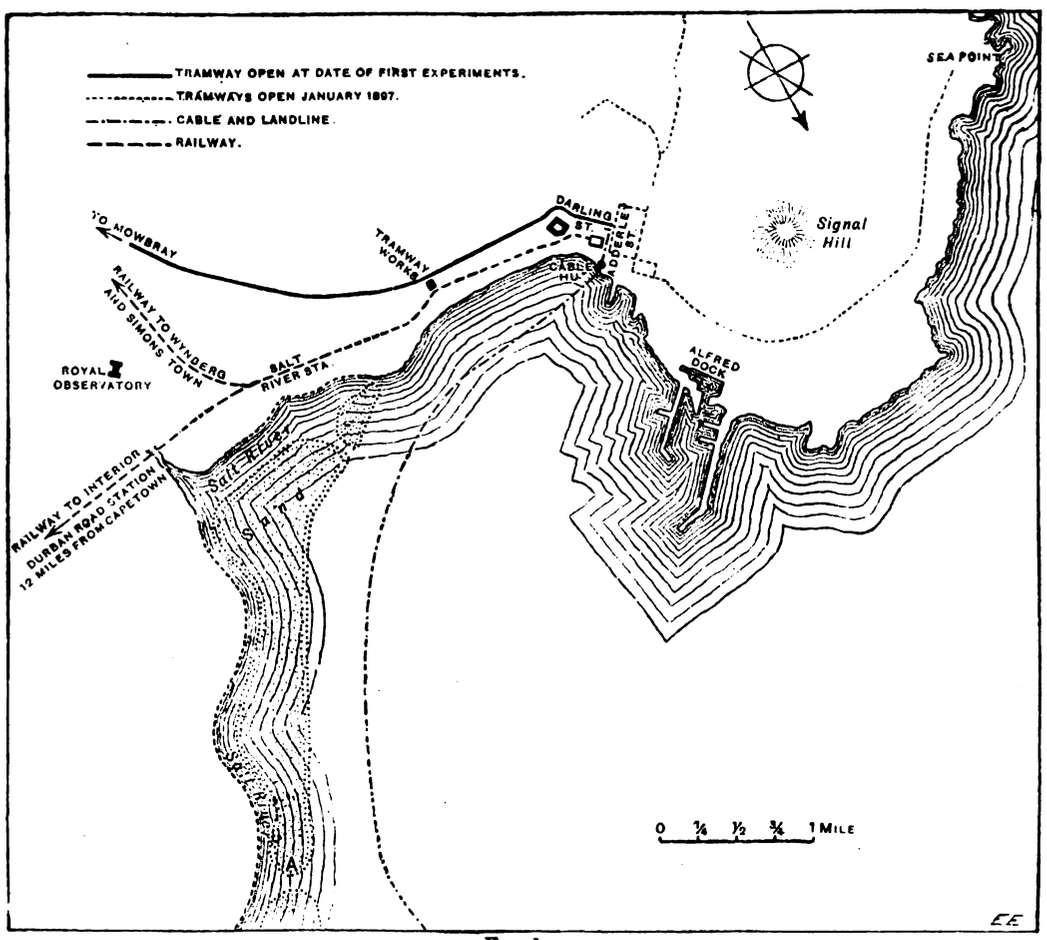

FIG. 1.

parallel with the sheath of the cable. No reduction of the disturbance was found, and, on the whole, the ordinary earth on the sheath gave the best results. On August 26 I was invited to take part in the experiments by Mr. T. Cassidy, superintendent of the cable company at Cape Town. Before dealing with the experiments I will briefly describe the nature of the disturbances. The cable was sometimes connected to Mossamedes. I am informed that the length is 1,383·526 knots, and the resistance 8,820 ohms. It was sometimes put through to Loanda, 530 knots up the coast. It is worked with 35 cells and a condenser of 60 microfarads. The resistance of the coil of the recorder is 500 ohms. In sending, it is shunted with 1 ohm. No disturbances are perceived during sending. In receiving it is sometimes shunted with 6,000 ohms.

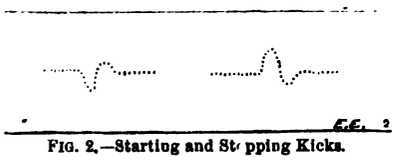

FIG. 2.—Starting and Stopping Kicks.

FIG. 3.—"Splash."

As this is a matter which concerns tramway engineers as much as cable men, and as the former have little opportunity of acquainting themselves with the work of the latter, it may be worth remarking that such a cable as this one is always worked through condensers, for the purpose of cutting off earth currents. A paper tape 16mm. wide is drawn at about 10mm. per second under a syphon which is kept in motion by an electric vibrator. It is worth noting, for examination of the details of the disturbances, that the vibrator in the present case gave about 32 dots per second. The "kicks" are of three kinds. The first—the starting and stopping kicks—are shown in Fig. 2. A starting kick for a car between the works and Cape Town resembles the signal for an N. The first swing is below the line, and falls to about 2·5mm. to 3mm. in about 0·2 of a second. This delay is due to the inertia of the working parts of the instrument. This swing is followed by a swing above the line. This is simply a mechanical overshoot of the instrument. It is generally about three-fourths of the amplitude of the swing. A third and even fourth swing is sometimes seen. Such a kick is due to the switching on of about 20 amperes by putting a controller on a car to the first notch. A stopping kick is reversed, and resembles the signal for an A. Its amplitude depends on the current which happened to be passing at the moment of breaking. A second kind of disturbance is shown in Fig. 3, and may be called a "splash." The syphon is often thrown right off the paper, but the instrument has never been damaged. A disturbance of this kind is comparatively rare. So far as I have observed, it always begins downwards. It is therefore probable that it is due to the sudden switching on of a considerable current. It is more or less sharp-pointed, and the rebound is sometimes greater than the first swing. Both of these features are, I believe, mechanical. The third kind of disturbance is a comparatively small and irregular quiver of the line, and is probably due to the jumping of the trolley at insulators and points, and perhaps to sand on the rails.

In order to form some idea of the magnitude of the disturbing currents in the cable, the syphon recorder was, at my request, disconnected entirely from the lines, condensers, and instruments. I then connected a Clark cell through 100,000 ohms and applied it direct to the instrument, under its ordinary conditions of shunt and control. Quickly snapping the contact gave a kick closely resembling a starting kick. The first swing was 2mm. Holding down the contact, the line settled down, after one or two small oscillations, with a permanent displacement of 1·7mm. (Fig. 4). As the various earths had failed to reduce the disturbances, and as there was no cable ship at Cape Town to lay an earth out to sea, I attempted to apply an equa and opposite induction. I arranged with the Post Office for the use of a private telephone line from Cape Town to Mowbray, running alongside the tramway for 2½ miles, and a distance of about 1¼ miles beyond the terminus. This line was almost useless to the subscriber, on account of the disturbances caused by the tramway. On August 27 this line was earthed at Mowbray, and was connected through the usual condenser of 60 microfarads with the syphon recorder at the cable office, and was earthed on the sheath of the cable. At the same time another recorder at the cable hut was connected, also through the usual condensers,

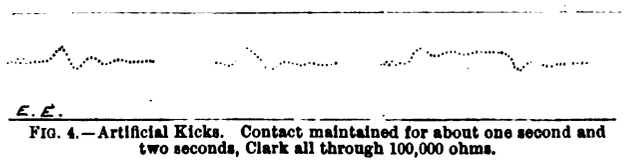

FIG. 4.—Artificial Kicks. Contact maintained for about one second and two seconds, Clark all through 100,000 ohms.

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to the core and sheath of the cable. The instruments were run simultaneously, and the time was marked at every 10 minutes on each slip, and these were afterwards compared. Every disturbance on the cable was clearly reproduced on the telephone line, with an amplitude about five times greater. Not a single kick on the cable failed to be represented also on the telephone line; but many of the smaller ones on the telephone line were not visible on the cable ship, on account of the small amplitude (Fig. 5). A marked difference between the kicks produced by the telephone line and those produced by the cable is worth

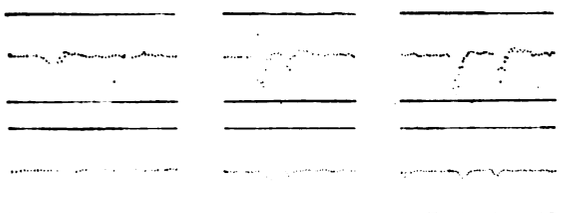

FIG. 5.—Upper Slip, Telephone Wire. Lower Slip (travelling rather slow), Cable.

notice. It may be seen in Fig. 5 that the telephone kicks are always sharp-pointed; a simple kick never has any sign of a rounded top, and there is seldom any trace of a rebound. I had no opportunity of examining this more fully. It did not strike me until later that the absence of any overshoot may be due to the relations of the inductance, capacity, and resistance of the line. At first I thought that the rounded top of the ordinary kick (Fig. 2) was due to the capacity of the cable; but Fig. 4, in which no condenser was employed, shows that this is not the case. The discharge was evidently instantaneous, but the fact that the line does not drop to zero until 0·2 to 0·3 second does not indicate that the current died away at the same rate. If the current died away twice as fast, or even three times as fast, it would probably check the swing in this manner. The metallic resistance of the telephone line, calculated from the gauge of the wire (No. 18 bronze), is 280 ohms, and I understand that the resistance of the whole circuit may be taken at about

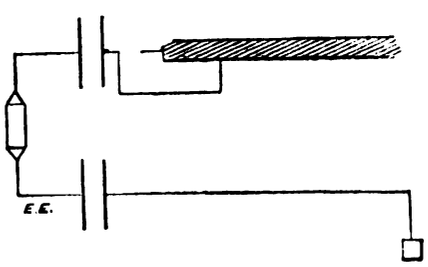

FIG. 6.

800 ohms. I fail to understand how the conditions of the telephone line could produce any appreciable prolongation of the discharge; but it is possible that the overshoot of the kicks on the cable may be due to the fact that the resistance of that part of the cable which is being affected is small, and that the length affected is short. There is no material difference between the recorders. The next day—August 28—was wet, but no difference was observed in the disturbances. An attempt was made to earth the cable through the telephone line, but, owing to some mistake about the connections of the condenser, the zero wandered. On August 29, the experiment was repeated, the connections being made as in Fig. 6. The syphon recorder, protected on each side by

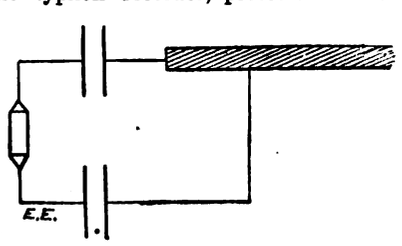

FIG. 7.

condensers of 60 microfarads, was connected to the sheath of the cable and to the telephone line, this line being earthed at the far end. The telephone line gave kicks as on the previous occasion. The instrument was then connected to the core of the cable through a condenser in the usual way, and earthed to the sheath. The cable was through to Mossamedes, and the usual kicks were observed. Fig. 7 shows the connections. An auxiliary and disturbed earth was then connected by putting the telephone wire to the sheath through a resistance. A rheostat was also placed in circuit with the cable, and these resistances were varied (Fig. 8). In order that the kicks might be comparable, signals were made from the window of the cable office to the driver of any car that happened to be standing at the terminus. The kicks were not materially reduced in amplitude until 100,000 ohms were introduced into the telephone line, or 8,000 into the cable circuit; the latter being, of course, an impracticable condition for working.

In order to study more closely the nature of the disturbances, the tramway companies arranged for a night test, and the programme which was suggested in my report to the Postmaster-

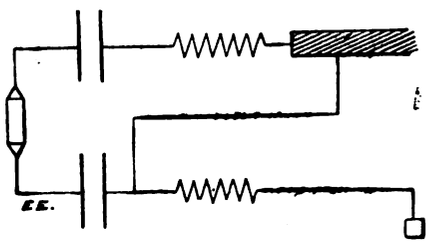

FIG. 8.

General of August 16 was carried out. On August 31, at 11.45 p.m., the cable being put through to receive from Loanda, and the tramway service being stopped for the night, a tramcar started from the works to Mowbray. According to a previous arrangement it stopped at Woodstock at 11.55, at Great Moore-street at midnight, and arrived at Mowbray-hill at 12.10. It then returned, and stopped at Salt River at 12.30, and Castle Bridge at 12.40, arriving at the end of Darling-street a few minutes later. The time was marked on the slip at every 10 minutes, and the stoppings and startings were clearly recognisable. Two points were clear—first, that the amplitude of the kicks was in proportion to the distance of the car from the works, but rather greater on the Cape Town side; and, second, that the direction was reversed when the car passed the works. An important experiment, suggested by Mr. W. B. Rommel, was carried out after this run. A feeder buried in the street was connected to the negative pole of the dynamo at the works, and a branch from this feeder was brought into the cable office. A rheostat was connected, and currents varying from 40 to 100 amperes (at 500 volts) were sent through the completely-insulated circuit formed by the feeder and the trolley wire. No kicks whatever were visible, and the line remained perfectly straight. The cable was through to receive from Loanda with the usual connections. A line was then run out to the rails in the street, and currents were sent by means of the rheostat. They pro-

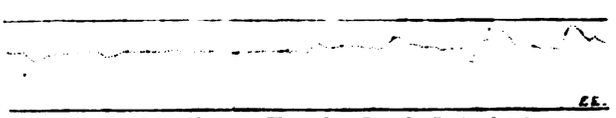

FIG. 9.—No Condenser. Through to Loanda, September 3.

duced violent kicks, a current of 40 amperes sending the syphon off the slip. On September 3, as a supplement to Mr. Rommel's experiment, the syphon recorder was, at my request, connected direct to the core and sheath of the cable, without condensers. The cable was through to Mossamedes. The character of the disturbances was somewhat altered; the return was, as might be expected, less prompt, and there was no mechanical rebound. Owing to the inertia of the instrument, the maximum deflection was reached in about 0·3 of a second, and the deflection of 3mm. died away in about 0·7 second and returned to the zero line (Fig. 9). The zero line without condensers was by no means straight, but it was sufficiently so to indicate that the disturbances were in all probability due to induction, and not to direct leakage. If time had permitted, experiments without condensers would probably have thrown some light upon the real nature of the disturbances.

To be continued.)

MEETING, MAY 20.

At last night's meeting of the Institution the following were the candidates balloted for:

Associates.—John S. Bowman, Oriental Telephone and Electric Company, Limited, Rangoon, Burma; William J Dale, St. Luke's Generating Station, City-road, E.C.; Harry Philip Gaze, Frenze Hall, Diss, Norfolk; George C. Laird, Scottish House-to-House Electricity Company, Coatbridge; Walter Rigge, Westminster Engineering Company, 67, Lord-street, Liverpool; Thomas M. F. Tamblyn-Watts, Goldisland, Settle, Yorkshire; Albert Edward Whitaker, Messrs. Muirhead and Co., 97A, Upper Parliament-street, Nottingham; Walter H. Whichello, 44, Trumpington-street, Cambridge.

Students.—Robert William Hodges, R.I.E. College, Cooper's Hill, Egham; John S. Martin, 7, Welbeck-street, London, W.; Henry Kirby Rodwell, Faraday House, Charing Cross-road.

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CITY AND GUILDS OF LONDON INSTITUTE.

ELECTRIC LIGHTING AND POWER TRANSMISSION.

The following are the questions set by the Examinations Department of the City and Guilds of London Institute, 1897 :

ORDINARY GRADE.

1. Why is a starting resistance used with a direct-current motor? Describe, with a sketch, the details of the starting resistance employed with a shunt motor. (20 marks.)

2. How should a dynamo be wound to give constant pressure with varying load at a distance from the machine? (25.)

3. In a water-power plant the dynamo which produces a fixed P.D. between its terminals of 120 volts is 300 yards away from the house. The usual load consists of 200 100-volt 35-watt glow lamps. What size leads should be employed if the resistance of a cubic inch of copper be 0·66 microhm? (15.)

4. A district is supplied with alternating current from a central station. What are the advantages and disadvantages of running the street arc lamps from the alternating-current mains or from an independent direct-current circuit provided specially for these street lamps? (25.)

5. Sketch a modern end-connection system for a drum armature with 32 commutator pieces. (25.)

6. Show by means of sketches the methods used for connecting compound-wound dynamos in parallel. (15.)

7. What kind of dynamo is the best to use for charging accumulators, and why? (10.)

8. A compound-wound dynamo producing a terminal P.D. of 150 volts is used to charge 60 storage cells, each having an E.M.F. of 2·2 volts and a resistance of 0·001 ohm. If the leads joining the dynamo and cells have a resistance of 0·2 ohm, what will be the current generated? (10.)

9. The key for a Wheatstone's bridge makes two contacts in succession. What are the circuits that are closed by each of these contacts, and is there any reason for closing one before the other? (15.)

10. What are the merits and demerits of the sub-station method of distribution? (20.)

11. What are the advantages and drawbacks of cast steel for dynamo magnets? What is the best cast steel that has been made up to the present time for this purpose. (20.)

12. Describe in detail how you would wind a motor-dynamo, fed at constant pressure, to give constant pressure between the secondary terminals. (25.)

13. What forms of ammeters and voltmeters are likely to be affected by neighbouring current circuits—for instance, those on a switchboard—and what are the forms that are practically unaffected? (15.)

14. Give a sketch of a tramway motor and the arrangements for altering its speed and the direction of rotation. (20.)

15. Explain fully why a shunt motor used on constant-pressure mains runs at a practically constant speed independent of the load. (20.)

17. Why should alternate-current mains be either concentric or laid close together in the same channel? Has any such precaution to be adopted with mains carrying a *rectified* alternate current? (25.)

18. What are the special advantages and disadvantages of electrostatic voltmeters as compared with current voltmeters? Describe in detail some form of electrostatic voltmeter that is suitable for use in a central station. (20.)

19. A 50-volt arc lamp is to be used on 100-volt alternate-current mains, while the cost of running the lamp is to be determined from the reading of a coulomb-meter. Will the cost be the same whether the pressure be reduced from 100 to 50 volts by using a non-inductive resistance or a choking coil or a step-down transformer; and if not, which arrangement will render the cost, as determined from the coulomb-meter, the least? (30.)

20. The declared pressure at which current is supplied to houses by mains coming from a central station is raised from 100 to 220 volts. If the percentage loss in the mains is to remain the same as before, by how much per cent. will their carrying capacity be increased when the heating limit has not to be regarded? (15.)

THE TRANSMISSION OF POWER IN FACTORIES BY ELECTRICITY.*

BY S. V. CLIREHUGH, MEMBER.

My intention to-night is to put before you some points in connection with power distribution by means of electricity, more particularly in factories, and especially in those factories devoted to the textile trades. I wish at once to state that I am not of opinion that electricity is the remedy for every extravagant coal bill, but I know it is a remedy for many. A few years ago there were people, even electrical engineers, who went about proclaiming that the days of shafting and rope driving were at an end, and that every new cotton mill would drive each line shaft, and even each machine, as some enthusiasts alleged, by means of electric motors. This was not only unreasonable, but it was harmful to the industry. Mechanical engineers who for years had had experience of equipping cotton mills, and who knew to a fraction what power each machine took, resented the fact that a body of men, who knew nothing at all about the intricacies of driving such machinery, should come in and teach them their business. They therefore looked closely into the claims of electricity, and found that the loss was so small that even if 50 per cent. of the losses could be saved by electricity, the additional capital outlay would more than outbalance the annual saving. Fifty per cent. sounds a lot, but when the losses in driving a cotton mill are not probably more than 20 per cent. of the brake horse-power developed, and you are dealing with engines which will develop an indicated horse-power hour for 2lb. of coal, 50 per cent. is not sufficient saving—in fact, there is not a big enough margin of loss to cut at. It should be remembered that even in Switzerland, where there are towns in which all the mills are driven by electricity from a central supply, they do not distribute the power inside the mill by means of electricity, but the millowner buys an electric motor in the same way as the millowner here buys a main steam-engine, and they both, as far as I am aware, distribute by means of ropes and shafting.

Fortunately, however, for the electrical industry, we have, especially in Lancashire, industries on which the margin of loss in the distribution of power is so enormous so as to enable us to effect a large money saving if we only reduce them by 20 per cent. The dyeing, bleaching, finishing, and printing trades, in my opinion, use more coal per brake horse-power hour than any other trades in the world. The reasons for these are not far to seek. Partly owing to tradition, and partly owing to necessity, partly also to convenience, nearly every machine in these trades has its own prime mover. One cannot, for instance, imagine a printing machine being driven off shafting, even were it provided with the most complicated system of speed cones, etc. The same applies to a calender, or mangle, and half a dozen other machines one could mention. In addition, even in machines where it might be possible, the attendant is so accustomed to have the stop valve of the engine ready to his hand that he could hardly work the machine without it or its equivalent. Here, then, is material ready for the electrical engineer. Even the worst-designed job will generally make the customer grateful, because you cannot by any stretch of the imagination waste more power, and the probabilities are you will save something. The difficulty is to induce the proprietor to spend the money. An electrical installation is not a cheap thing, as I shall presently show, and it is of little use to tell a man that by an expenditure of £5,000 he will save £1,250 per annum, or 25 per cent. on the outlay, if he has not £5,000 to spare. The general answer you will get is, "Trade is bad and the profits are too small. I can't afford it." A curious commentary on the methods employed by other nations is afforded by Germany. It is just when trade is bad and profits small that in that country there is an opportunity of introducing improvements. It is extraordinary how suspicious people are if you mention that you can effect any big saving, and how difficult it is to get them to go into the matter and to try and find out how you propose to do it. I suppose they have been so often bitten by the travellers who sell them oil which saves half their coal bill, the man with patent firebars, etc., that they have lost all faith in their fellow-men.

I have, however, recently been connected with some power installations of considerable size, and, while not wishing to weary you with a detailed description of each machine, I feel that some of the principal points in which difficulties presented themselves and the method of getting out of them may be of interest. The first question that occurs is, what is the best form of generating plant for the purpose? Let us assume that 200 h.p. will be required, and that steam will be used. I am of opinion that a direct-coupled plant of moderate speed is the best, having regard to running expenses, depreciation, and capital outlay; the difference in cost between a rope-driven plant in which the engine runs at 100 revolutions and the dynamo at 500, and a direct-coupled plant running at 200 revolutions, being practically negligible, the dynamo, of course, being a multipolar one. Special circumstances might lead one to a lower speed, say 120 revolutions, in order to be able to use a trip

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gear, but in this particular size it would, I think, be wasteful in capital outlay. The type of engine I have found most satisfactory is an inverted vertical compound (if the boiler pressure is anything over 90lb.), with piston valve on the high-pressure cylinder and balanced slide on the low-pressure, the governing being done by means of an automatic shaft governor. The engine should be of the enclosed type, and the lubrication should be under pressure. As a rule, with an engine of this speed an ejector condenser is the most convenient and will give a good vacuum, there being no moving parts. The dynamo direct connected through a flexible coupling would probably be of the six-pole type, the armature, of course, being slot-wound. It is absolutely essential that there should be very little movement of the neutral points with varying loads, and I have machines running now which only require an alteration of the brushes once between no load and 20 per cent. over-load. There is absolutely no sparking. The E.M.F. I have generally adopted is 200 volts. Of course, cases may arise in which higher pressures are advantageous. Such a combination will deliver a kilowatt-hour with 30lb. to 32lb. of water, or 1 i.h.p. with a consumption of 18lb. to 20lb. of water, or about 2½lb. of coal. I do not, of course, point this out as being anything special in the way of economy, but with the varying loads it is probably as economical as can be obtained, having regard to the capital expendture and wear and tear. I have had such a combination as this running 24 hours for six days on end, only stopping on Saturday night.

The first point on which difficulties arise is the question of the speeds and powers of the motors, and the best method of gearing them to the machines. It is with regard to the power taken by the various machines that the greatest difficulty arises. In order to economically carry out work of this character, it is essential that the motors should fit their work, for by the amount by which you have unnecessarily increased your capital outlay, by the interest on that amount have you reduced your saving. Although most of the machines you are asked to drive have not differed very much in form for the last 20 years, if you go to the maker and ask what power a machine takes to drive it, he says, "We generally use a pair of sixes." Now this to a man striving after exact information is disheartening. I tried indicating some of these engines, and have some hundreds of diagrams, but they give you little information owing to the leaky state of the glands, and the fact that, as the steam is generally so wet, they nearly always run with the drain cocks open. The diagrams show no signs of cut-off except at the extreme end of the stroke. Another difficulty we have is, that what we want to know is, not the maximum power taken by the machine in starting, but the maximum normal power required. A steam-engine has to be put down of sufficient size to develop the maximum power required; a motor, only the maximum normal power required. In connection with this matter I should like to mention that beautiful little device, Royce's time fuse, which, for motor work, is unsurpassed. Until recently, one always put a mercury cut-out in circuit with a motor, which, directly the motor load exceeded a given amount, opened. Of course, in time it had a lump of something heavy tied to it, which prevented it working at all. Now, by means of a time fuse you can have a given overload on a motor for a given time, which is exactly what we want, so that a motor may exert 50 per cent. more than its rated load for, say, three minutes without blowing the fuse or doing itself any harm; for we know that, with any motor worth its salt, it will give out any amount of power till it is stopped by the heating of the armature conductors. In one installation I have fixed these cut-outs on a switchboard, and put an electric bell and indicator in circuit, so that when a time-fuse goes it rings a bell and indicates the number of the circuit. Thus the foreman of the room is enabled to find out, if a certain machine blows its fuse several times, that there is something wrong either with machine or operator. I have tried many ways to arrive at the exact power required for various machines, but the most satisfactory course, where it is practical, is to drive the machine electrically. It is very often possible to take a motor round, and get a very good idea by driving with a belt. There is, however, no golden rule to be followed, but I would warn my hearers that when they test a machine they should be sure they test it under all the varying conditions under which it will ever work. It is surprising to find the difference in the power required by a machine if it is passing slightly heavier cloth than usual. Take a callender, for instance. The power it will take within several horse-power depends largely upon the mood of the attendant who sets it. He will climb up and insert a "tommy" in the screw, and twist until he thinks he has the requisite amount of pressure. Now, a quarter of a turn may make a difference of 20 per cent. in the power taken. Again, the conditions of the bearings makes a surprising difference. It was reported to me recently that the time fuse on a callender was always blowing. This callender took, under normal conditions, 80 amperes at 200 volts, or 22 e.h.p., and the time fuse was set to blow at 100 amperes after five minutes. I investigated the matter, and found it was quite a common occurrence for one of the callender bearings to get hot, not sufficiently hot to necessitate stopping, but this brought the power required up to 120 amperes, or 32 e.h.p. I cannot but think that with the simple methods now available of ascertaining the horse-power taken by different machines, designs will be somewhat modified, and that machines will be constructed to do the same amount of work with half the expenditure of energy; and it must always be borne in mind that saving of the energy required does not mean only saving in coal bills, it means saving in capital expenditure, boilers, engines, motors, etc. It may be that makers of this class of machinery have studied these questions, and have found difficulties in altering their machines; but in conversations I have had with several, they have admitted that had they designed a machine to be driven by electric motors, much complication and wasteful gearing might have been dispensed with. There is one other point in this connection which I approach with all humility, but it has struck me that in many cases speeds of processes might be increased, and so enable a given machine to get through more work. It has seemed to me that the factor which has controlled the rate at which the machine shall work has been, in many cases, the piston speed of the engine.

Now with regard to gearing and variation of speed. The problem here is to run your motor at a peripheral speed of approximately 3,000ft. per minute, which means for an average size of motor about 1,000 revolutions per minute, and to gear it to a machine which runs at about 50 revolutions. It is obvious that we have only three methods open to us—viz., (1) worm gearing; (2) double-reduction spur; (3) single-reduction spur and belt. It is undeniable that each of these methods may be satisfactory under certain conditions, but as it is always advisable to keep the speed of the motor up to the speed I mentioned, it will be found that the peripheral speed of spur gearing is too great. I have found that when the speed of even the best cut spur wheels exceed 1,800ft. per minute that there is excessive wear and objectionable noise. There is sometimes an opportunity of using a belt for the drive off the motor and then spur gearing, but as a rule either the moisture in the place or the want of room does not permit this. We then come to the third alternative—*i.e.*, worm gearing. This form of gearing has been in a very bad odour for the last few years. Its efficiency was undeniably very low as it was then constructed, and although it had its uses there was not the class of work to be done which could not be done almost equally well by spur or other forms of gearing. When, however, engineers found the necessity for combining a machine running at 1,000 revolutions with one running at 50 revolutions per minute, then it became clear that if worm gearing could be made more efficient it was clearly a satisfactory way out of the difficulty. The worm gearing which I have used in many cases has given surprisingly good results, and I append here some tests made of two practically identical machines doing similar work, one driven by means of worm gearing and the other by belt. This last will, of course, give better results than double-reduction spur. The particulars of the worm gearing as follows:

Test of Two Similar Machines, one Driven by Means of Worm and Wormwheel, the other by a Belt.—Motor speed in each case, 1,200 revolutions per minute; rate horse-power of each motor, 11; speed of driven wheel on machine where worm and wormwheel is employed, 100 revolutions per minute; speed of driven wheel on machine where belt driving is employed, 240 revolutions per minute. In each case the ultimate speed of the machine is the same—viz., 240 revolutions—but, in the case of the worm-driven machine, the spur gearing is in the ratio of 2·4 to 1; whereas, in the belt-driven machine, the ratio is 1 to 1. The particulars of the worm and wormwheel are as follows: worm diameter on pitch circle, 5in.; worm number of threads, 4; worm pitch, 6in.; wormwheel diameter, 22in.; wormwheel number of teeth, 48. The particulars of the belt driving are as follows: diameter of pulleys, 8in. and 40in. respectively; distance between centres, 12·0in. (See Table A.)

It is, of course, almost impossible to get two machines exactly similar. No. 1 is running somewhat faster than the worm-driven machine, consequently its efficiency is somewhat higher. I think it would be found, if errors could be eliminated, the efficiency of the two forms of driving would be practically equal. The importance of scientifically designing and fitting gearing where efficiency is to be considered cannot be over-estimated. The worms in all these cases were cut out of tool steel, while the wormwheels were of phosphor-bronze hobbed, thus ensuring a perfect fit. Each motor is provided with a thrust bearing, fitted with steel balls to take up the thrust. I have had occasion to use in different works three different classes of motors: (1) the enclosed watertight motor; (2) the enclosed ventilated motor; (3) the unenclosed motor. I cannot urge members of this society too strongly to use only enclosed watertight motors where the place is either steamy at any time, or where the machines themselves throw off water while working. The cost is doubtless increased since it may be assumed to enclose a motor, and keep to the same temperature limit as an unenclosed motor, or reduces the output 25 per cent.; but when you see the actual experience that motors have to go through, there can be no doubt that the additional expenditure is not only

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TABLE A.

Condition of test.	Machine No. 1.—Belt driven.					Machine No. 2.—Worm driven.					Superiority of belt over worm percentage.
	Volts.	Amperes	E.H.P.	Time taken.	E.H.P. hours.	Volts.	Amperes	E.H.P.	Time taken.	E.H.P. hours.	
Running empty	204	23	6·3	—	—	202	20	5·4	—	—	—
Cloth open..	200	38	10·1	5min. 15sec.	·88	200	42	11·2	5min. 30sec.	1·02	8%
Running single cross	203	55	14·9	4min. 55sec.	1·27	198	55	14·5	5min. 30sec.	1·32	9%
Running double cross	194	108	28	161 yds. per min.	·46	198	108	28 6	155 yds. per min.	·47	9%

wise but requisite. I have been surprised to find firms of standing suggesting that this was unnecessary, and that a wooden case was all that was required. With regard to the enclosed ventilating motors, the enclosing of course is the only expense, the temperature rise of the motor remaining the same. The unenclosed motors require no special comment, beyond that I think a better protection than a wooden box is a sort of wire cage. I think that under no circumstances should a motor be left absolutely unprotected. Motors which are to be left in the works, where they will receive practically no attention except oil, must be able to run absolutely sparklessly at all loads up to 30 per cent. overload without moving the brushes. These I have succeeded in getting, and at no undue cost compared to makers' lists. A word of warning with regard to carbon brushes on enclosed motors may save some the trouble which I have experienced. If you use carbon brushes in an enclosed motor you cannot keep your temperature down unless the E.M.F. is considerably higher than 200 volts, and this with a large amount of surface. The inability to use these brushes is, in my opinion, no particular drawback. Carbon brushes cover a multitude of sins, and much sparking may go on undetected for a time. In addition, as far as my experience goes, it is impossible to avoid the presence of foreign matter which will often cut the commutator, and if not checked very early will cause considerable damage. I have found that wire brushes, not gauze, once they get nicely bedded, will run for six months without any attention, provided, of course, the motor does not spark. I have recently been obliged to use some slow-speed motors, 350 revolutions for about 18 h.p., and have obtained some four-pole machines, which, up to the present, are giving every satisfaction, and whose cost, having regard to the speed, came out very reasonably.

The variation of speed is the next item. This is the sort of problem required to drive a callender which shall be able to run at any speed between zero and 50 revolutions per minute; its principal speeds, however, will be 25, 35, and 50 revolutions per minute. The method I have adopted in some cases is as follows: make the normal speed of the callender motor 35 revolutions per minute, plus the increase due to the gearing, so that when running at this speed there is no resistance in circuit with it. When the higher speed is wanted, this is obtained by putting resistance in the field—*i.e.*, by weakening the field and so decreasing the back E.M.F. and allowing more current to flow. This, of course, somewhat lowers the efficiency of the motor, but does away with any loss worth mentioning in the resistance. About 50 per cent. increase is probably about the maximum obtainable in practice without sparking. When a speed lower than 35 revolutions is required, it has to be obtained by putting resistance in series with the armature. This is, of course, wasteful. I do not think that water resistances are suitable, except for starting resistances, as if they have to be kept in circuit they require considerable attention, and become a nuisance. I have here a switch pillar which is, I think, very good. It is massive and self-contained. It cannot be injured, and the current cannot be put on too suddenly, as the attendant has to change the position of his hand before he can make a complete revolution, and it is quick break throughout.

One secret of success and economy in electric power installations is to consider very carefully the machine you have to drive, and to spend a long time in its company. No information as regards the most usual speeds at which a machine is run is obtainable as a rule. The wiring should be run on insulators strained tight and out of reach. Where it is brought down to a machine, it should be enclosed in gas barrelling 6ft. or 7ft. up. All motor wires should, in my opinion, be taken back to a distribution switchboard, on which one ammeter should be fixed, and the 'bus bars so arranged that any motor may be plugged in the ammeter circuit. I believe that both men and machines would be kept in better order if each machine had its own label saying the amperes it should take, and the foreman occasionally plugged the machines on the ammeter. If he found that a machine which was rated to take 60 amperes was consistently taking 70, the conclusion he would draw would be either that the machine was out of order, the attendant was running too fast, or that some heavier cloth than was expected was going through.

We now come to the last consideration and the most important—the cost and efficiency of electric driving. It cannot be denied that the cost is high. The figures I give here are figures based on actual work carried out, all of which has been put out to tender among the leading firms. I give the cost of so much per motor installed. It is made by selecting the cost of 20 different machines of the type most frequently met with in the trades I have mentioned. The horse-powers run from 3 to 20. The first example is one in a works which was exceptionally wet and steamy, so that everything had to be absolutely watertight:

Motors	£87	10	0
Switch pillars	10	0	0
Switchboard	16	0	0
Generator and engine	59	10	0
Gearing	34	0	0
Wiring	20	0	0
Erection	8	12	0
	£235	12	0

The next is an installation where it was not considered necessary that the motors should be watertight. They are enclosed to protect them from mechanical injury, but they are ventilated:

Motors	£69	0	0
Switch pillars	10	0	0
Switchboard	16	0	0
Generator and engine	59	10	0
Gearing	34	0	0
Wiring	20	0	0
Erection	8	12	0
	£217	2	0

In the two cases I have kept the figures which are not affected by the moisture, etc., constant, although, of course, in actual practice they varied somewhat. The item "Switchboard" may seem high, and probably might be reduced somewhat, but it does not include any luxuries. In one particular case there is the main double-pole switch and fuse for the dynamo, a pair of 'bus bars, and a single-pole switch, fuse, and the time fuse for each motor, two ammeters, and one voltmeter. The item for wiring is heavy, but the works covered a large amount of ground. The use of bare conductors strained tight would reduce this if approved by the fire insurance companies. The cost of the engine and dynamo may be somewhat higher than necessary, as it is assumed that all the motors will be on at once and at full power. Sufficient experience has not yet been gained to ascertain what proportion of the maximum load on the engine will bear to the rated outputs of the motors installed. The cost of the gearing is accounted for in my remarks on the subject. We may now assume that if a man has 20 engines in a bleach, dye, or finishing works which he wishes to replace with motors, it will cost him approximately £4,000; whereas the cost of 20 steam-engines complete, with piping, etc., would be only about £2,000. As a rule, we have to treat with works which already exist and are equipped with steam-engines; we have therefore to show a saving on the entire capital outlay—viz., £4,000. The directions in which we may look for savings are: (1) decreased coal bill; (2) decreased labour in stoking, etc.; (3) decreased labour in repairs, owing to steam joints blowing, glands leaking and requiring packing. I do not propose to go into these items very carefully, as you, as a body of engineers, quite appreciate the losses. On the first item, which is after all the most important, from tests which were made by Mr. Bryan Donkin on 100 engines selected impartially, it was found that this type of engine was consuming on an average 150lb. of steam per horse-power per hour. We have seen that we propose to use an engine which will give a brake horse-power hour for 20lb. We may with safety put our losses between the brake horse-power delivered to the dynamo and the brake horse-power delivered to the machine to be driven at 20 per cent., which would be made up as follows: dynamo losses, 5 per cent.; transmission losses, 2 per cent.; motor losses, 5 per cent.; gearing losses, 8 per cent.—total losses, 20 per cent. If you only use half the coal, of course you only require half the stokers, and also half the number of boilers. The maintenance costs have been certified by several owners, especially on the north-east coast, to be only 20 per cent. of their former maintenance costs when they used steam-engines. The amount saved by these items of course depends upon the size of the works and the amount used of each individual article. There are certain works at present where it is somewhat difficult to see how electric driving can help them; it is those works which require all the exhaust steam which their engines can give them for boiling purposes. To such, economy of steam consumption

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is no temptation, as it practically costs them no more to raise their steam to 100lb. pressure than to raise it above the pressure of the atmosphere.

I have only been able in this paper to touch on a very few of the points which I have thought would interest members. The subject is a very fascinating one, and is going to be in the future a very profitable one, because we are doing something more than saving coal: we are giving owners of works opportunities of carrying out their business on scientific lines, which, up to the present, has not been my experience.

PHYSICAL SOCIETY.—May 14.

Mr. SHELFORD BIDWELL (president) in the chair.

Mr. W. Watson described an instrument for comparing thermometers with a standard. The thermometers to be compared are inserted together in an enclosed vapour tube, the temperature of which can be maintained very constant at different parts of the scale. The apparatus is an adaptation of the arrangement designed by Ramsay and Young for vapour densities. It consists of a wide vertical glass tube, with a narrower tube attached at the top. The narrow tube bends downwards, and communicates with a closed vessel of considerable volume. A portion of the vertical tube is surrounded by a condensing jacket, and a manometer tube is inserted near the top. The object of the large vessel is to diminish errors arising from fortuitous changes of pressure, resulting from small leakages or "bumping" of the boiling liquid. Electrical heating of the bulb containing the liquid effectually removes the "bumping." The following liquids, used consecutively, give a range of temperature from 20deg. C. to 120deg. C.: carbon bisulphide, 20deg. to 46deg.; ethyl alcohol, 80deg.; chlorobenzine 120deg. The apparatus, when once started, requires very little attention. From results submitted by the author, the variations do not exceed 0·02deg. C. per hour. In constructing the various parts, the difficulties of glass-blowing are reduced by making the joints of indiarubber stoppers, attached to the glass with indiarubber solution. Each joint is jacketed with glycerine. If the above liquids are used in the vapouriser, the scales of the thermometers can always be read within the tube. It is only with water that the condensed vapour gives trouble.

Prof. Ayrton thought the apparatus would come into extensive use, as it did away with a number of errors.

Mr. Watson, in replying to a question of **Prof. Perry's**, said the fact of using indiarubber joints limited the available range of temperature. Working with blown joints, Ramsay and Young had found no difficulty with their vapour-density experiments at higher temperatures.

Prof. Carey Foster read a paper by **Mr. D. K. Morris**, of Zurich, on "**The Effect of Temperature upon the Magnetic and Electric Properties of Iron.**" The investigation related to the measurement of the magnetic permeability, hysteresis, and electrical resistance of iron simultaneously at different temperatures. The specimens are formed into annular rings made from iron strip. The strip is first lapped round with asbestos paper and mica, and then wound upon itself to the required thickness. A platinum wire is included in the mica lappings for thermometrical purposes. Upon such annular rings are the following windings: (1) a primary magnetising coil; (2) a secondary coil connected to a ballistic galvanometer; (3) an electrical heating coil. Further, the iron strip is itself connected to a Wheatstone's bridge for resistance measurements. The coil can be heated to 1,050deg. C. At the higher temperatures the surrounding air has to be freed from oxygen; this is done by enclosing the coil in a suitable vessel and exhausting with an air-pump; when most of the air has thus been removed, the residual oxygen is absorbed by an electrically-heated iron wire. Curves are drawn representing the changes of permeability at the different temperatures, and, at the same temperatures, the corresponding hysteresis loops are plotted. The hysteresis diminishes with temperature, it nearly vanishes at about 764deg. C.

At the suggestion of **Prof. Ayrton**, it was agreed that the discussion on this paper should be adjourned until the publication of the results.

Mr. Rollo Appleyard read a paper on "**The Formation of Mercury Films by an Electrical Process.**" If a sheet of damp leather, or similar permeable substance, is used as a separating diaphragm between two bodies of mercury, and a current is sent through it, a film of mercury is deposited upon the surface connected to the positive pole; and the film remains on the diaphragm after removal from the apparatus. If the diaphragm is replaced in the apparatus, and subjected to a current in the reverse direction, the film vanishes from that surface, and a second film appears on the other side. That is to say, the film is always on the side of the diaphragm connected to the positive pole of the battery, and there is no film on the negative surface. Different diaphragms and films were exhibited of filter paper, asbestos paper, plaster of Paris, etc. A current of about one-fiftieth of an ampere, or more, is necessary. A sheet of tinfoil included between folds of filter paper becomes perforated with pinholes when the current is passed between the outside surfaces. This happens whether the outside electrodes are mercury or metal plates. If the top electrode should be tinfoil, this also becomes perforated, as well as the included sheet. A further experiment was shown, in which a gold coin is placed upon the folds of filter paper; the current produces a gold discoloration, which penetrates the folds. This, it was suggested by the author, may help to account for the formation of metallic lodes and veins as they exist in rocks; and they may partly explain the "inductoscripts" of Mr. F. J. Smith.

Dr. S. P. Thompson said he did not know of any other example of an anode being more active, mechanically, than the cathode except the electric arc. He was surprised that the film should appear on the positive surface.

Mr. Shelford Bidwell thought selenium presented in some of its actions an example of the anode being thus active.

Prof. Ayrton said that if a vessel containing a substratum of mercury amalgam was filled up with water in which gold crushings were washed, the gold descended into the amalgam. This, however, might be due partly to gravity and partly to simple electrolysis.

Mr. Appleyard said he had no definite views as to the formation of the films. He believed it to be a secondary effect of electrolysis, aided by electric osmosis. The experiments of Mr. C. K. Falkenstein upon the electric tanning of leather, and the early results of Mr. Perret, helped the idea of electric osmosis; they were not sufficient, however, to justify that theory without further research. A careful chemical analysis of the deposits left in the folds of filter paper would be the best guide.

LEYTON.

The following is an abstract of the revenue account for year ending March 31 of the Leyton electricity works:

Dr.	£	s.	d.
Coal or other fuel, gas, etc., including all expenses of placing same on the works, £89. 1s. 6d.; oil, waste, water, and engine-room stores, £18. 6s.; wages at generating station, £176. 13s. 4d.; repairs and maintenance of buildings, engines, boilers, etc., dynamo exciters, etc., other machinery, instruments, tools, etc., accumulators, etc., £5. 10s. 6d.	289	11	4
Wages and other remuneration to linesmen, fitters, labourers, etc., £5. 8s. 3d.; repairs and maintenance, renewals of meters, switches, fuses, etc., on consumers' premises, including all materials and labour, installing, switches and meters, etc., £90. 11s. 8d.*	95	19	11
Attending, repairs, cleaning, painting, lamp renewals, carbons, etc.	26	1	8
Salaries and wages, £126. 17s. 8d.; stationery, printing, £32. 11s. 9d.; general establishment charges, £17. 5s. 6d.; insurances, £10. 18s. 3d.	187	13	2
Amount paid for stores not yet used	54	8	10
	653	14	11
Balance to net account	0	5	1
	£654	0	0

* All work under this item is in respect of work for which the department receives payment, which is shown on Cr. side thus (*).

Cr.	£	s.	d.
Sale of current per meter, £322. 18s. 6d.; rental of meters on consumers' premises, £3. 1s. 2d.	325	19	8
Public lighting	123	16	0
Receipts for work done on consumers' premises, repairs, installation fees, etc.*	124	15	6
Premiums	25	0	0
Stores on hand not yet booked out for use	54	8	10
	£654	0	0

PORTSMOUTH.

The electric lighting accounts of the borough of Portsmouth have just been issued, from which it appears that the amount borrowed has been £101,651, and the total expenditure up to March 31 last £99,744. We give below the revenue account, balance-sheet, and statement of electricity generated, sold, etc.:

REVENUE ACCOUNT YEAR ENDING MARCH 31, 1897.

Dr. To Generation of Electricity.				£	s.	d.
Coal, or other fuel, including dues, carriage, unloading, storing, and all expense of placing the same on the works	£1,967	10	10			
Oil, waste, water, and engine room stores	520	14	4			
Wages at generating station	790	9	5			
Repairs and maintenance as follows: buildings, £8. 17s. 10d.; engines, boilers, dynamos, exciters, transformers, motors, etc., other machinery, instruments, and tools, accumulators, and accessories, £814. 15s. 11d.	823	3	9			
	4,101	18	4			
Less received for old material	15	17	8			
				4,086	0	8

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To Distribution of Electricity.						
Repairs, maintenance, and renewals of mains of all classes, including materials, and laying the same	282	8	5			
Repairs, maintenance, and renewals of transformers, meters, switches, fuses, and other apparatus on consumers' premises	267	1	5			
Cost of materials and lamps sold, as *per contra*	130	0	8			
				679	10	6
To Public Lamps.						
Attending and repairs, including materials supplied				1,128	0	7
To Rents, Rates, and Taxes.						
Rents payable	22	15	3			
Rates and taxes	297	13	2			
				320	8	5
To Management Expenses.						
Salaries—viz., engineer's department	570	0	0			
Accountant and clerical staff	123	4	0			
Salary of collector	78	0	0			
Stationery and printing	54	8	7			
General establishment charges	147	16	8			
				973	9	3
To Law and Parliamentary Charges.						
Law expenses				65	0	0
To Special Charges.						
Interest on overdraft				151	12	5
Total expenditure				7,404	1	10
Amount carried to net revenue account				6 870	0	0
Balance to next account to provide for bad debts				46	19	11
				£14,321	1	9

Cr.	£	s.	d.
Balance from last account, £47. 2s. 4d.; less bad debts written off, 19s. 10d.	46	2	6
Sale of current at 5d. per B.T.U., £9,119. 16s. 6d.; less allowances, £9. 9s. 1d.	9,110	7	5
Sale under contract	70	0	0
Public lighting	4,518	10	0
Rental of meters and other apparatus on consumers' premises	273	12	0
Sale and repairs of arc or incandescent lamps, £206. 13s. 9d.; and other apparatus, £91. 16s. 1d.	298	9	10
Rents receivable	4	0	0
	£14,321	1	9

General Balance-Sheet.

Dr. Liabilities.	£	s.	d.
Capital account—amount received	101,651	0	0
Sundry creditors	1,436	13	6
Amount due to treasurer on revenue account, £4,458. 11s. 11d.; less amount in hands of treasurer on capital account, £1,907. 1s. 10d.	2,551	10	1
Revenue account—balance at credit thereof	46	19	11
	£105,686	3	6

Cr. Assets.	£	s.	d.
Capital account—amount expended for works	99,743	18	2
Stores on hand at March 31, 1897—coal, £45; oils, waste, etc, £18; general, £215. 2s.; lamps, £69. 14s.; motors, £69. 3s. 10d.	416	19	10
Sundry debtors for current supplied to March 31, 1897	5,090	6	9
Other debtors	43	4	3
Balance to debit of net revenue account	391	14	6
	£105,686	3	6

Statement of Electricity Generated, Sold, etc.

Quantity generated in B.T. units			900,490
Quantity sold: Public lamps	396,457		
Quantity sold: By contract	1,942		
Quantity sold: Private consumers by meter	440,993		
Quantity sold: total			839,392
Quantity used on works			37 034
Total quantity accounted for			876,426
Quantity not accounted for			24,064
Number of public lamps			257
Total maximum supply demanded (amperes at 2,000 volts)			330

COMPANIES' MEETINGS AND REPORTS.

WEST INDIA AND PANAMA TELEGRAPH COMPANY.

The fortieth ordinary general meeting of this Company was held at Winchester House, E.C., last Wednesday, Mr. C. W. Earle presiding.

The report stated that with the decrease of prosperity in the West Indies the Company's position could not be very brilliant. The expenses of repairing the cables during the last half-year had been £9,015, or £1,918 in excess of those for the corresponding period of 1895. The increase was owing to the fact that the Company's vessel, "Grappler," was engaged on cable work in very deep water for 147 days, as compared with 96 days in the previous period.

In moving the adoption of the report, the **Chairman** said the cable laid in 1875 between St. Croix and Trinidad was in a very bad state, and the ship had been working 40 miles in the direction of Trinidad, and was now awaiting fine weather to start on the work again. He could not tell what would be the result until further investigations had been made. Referring to the great competition with which they had to contend, he said that in order to meet it they had had to reduce their rates. The French company's cable between San Domingo and Martinique had been interrupted since 1895, and therefore they had not as yet felt the full force of this competition. The amount to the credit of revenue was £34 053, against £33,558 for the corresponding period of 1895, and the expenses had been £21,398, against £19,676, leaving a balance of £12,654, which was increased by the amount brought forward to £14,622. After providing for the dividends on the first and second preference shares they recommended a dividend of 6d. per share, tax free, on the ordinary shares, leaving a balance of £646 to be carried forward.

He concluded by moving the adoption of the report, which was seconded by **Mr. Holmes** and carried.

Mr. W. Bishop Kingsford was elected to a seat on the Board, and Mr. C. W. Earle, on retiring, was re-elected.

The auditors, Messrs. Deloitte, Dever, Griffiths, and Co., were also re-elected.

WESTERN AND BRAZILIAN TELEGRAPH COMPANY, LIMITED.

The thirty-third ordinary general meeting was held last Friday at Winchester House, Lord Richard H. Browne presiding.

The **Chairman** stated that the receipts of the Company for the half-year to December 31 last had been £71,315, or about £9,000 less than those of the corresponding period of 1895. There had been a decrease in their local traffic of £4,960 and of £4,196 in the international traffic. Their cable between Rio and Bahia was down for about four weeks in September. The cable there was doubled, but both cables were simultaneously interrupted. They also had several interruptions in the northern stations between Pernambuco and Para. A further increased loss on exchange had been sustained by them; and no dividend was paid on the shares held by them in the Platino Company. He did not, however, think that the outlook of the Company was altogether as bad as these losses might indicate; in fact, he thought they had cause for a certain amount of encouragement. There had been so far this year an improvement of over 50 per cent. in the receipts of the Platino Company as compared with those for the corresponding period of 1896. There was a balance of £4,935 at the credit of the redemption debenture fund, but, there being no further requirement for this, they proposed to transfer it to the reserve fund. The balance to the credit of the revenue account was £36,684, including the amount brought forward from the previous year. The debenture interest for the half-year absorbed £10,671; they had placed £5,000 to reserve, and they now recommended a dividend of 3s. a share, making a total payment of 6s., or 2 per cent., for the year leaving £6,405 to be carried forward. Their loss in exchange for the past year was £39,300 on the Western and Brazilian lines and £23,038 on the Platino lines, making a total of £62 338. There was no change in the position of affairs between the Government of Brazil and the Company as to the purchase of their cables. As regarded their prospects for the current year, much depended on whether they would have their cables interrupted or not. They had one interruption at the present time, but it was not serious, and if they had no serious break during the year there would be, as far as they could see, a considerable increase in their traffic, and they would also have the saving on the "Buccaneer." On the other hand, there was the question of exchange, and therefore he did not care to make any estimate or prophecy as to the result of the current year's working. He concluded by moving the adoption of the report and the payment of the dividend mentioned.

Mr. D H. Goodsall seconded, and the motion was carried.

BRUNNER, MOND, AND CO.

The report of the directors of Brunner, Mond, and Co., Limited, for the nine months ended March 1, to be submitted to the ordinary general meeting, to be held at Liverpool on Tuesday next states that the accounts show a balance to the credit of profit and loss account on the working of the nine months of £232,911, which, with £95,944 brought forward, makes a total of £328,854. The interim half-yearly dividend on the 7 per cent. preference capital, paid on February 27, absorbed £19,394; and the preference dividend now proposed absorbs £10 289. The interim half yearly dividend on the ordinary capital, at 20s. per fully-paid share, and 7s. per partly-paid share, paid on February 27, required £95,084; and the dividend to be now paid on the ordinary capital at 25s. per fully-paid share and 8s. 9d. per partly-paid share, making 30 per cent. per annum for the nine months, takes £118 855. The amount to be written off patents account is £500, the balance to be carried forward being £84,732. Dividend warrants will be posted on 5th prox. Additional members to the Board are to be proposed.

German Tramways and Light Railways Association.—In connection with the general meeting of this association, which will be held in Hamburg on August 6 and 7 next, a street railway exhibition is intended, lasting from August 5 to 9.

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CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Cologne.—Tenders will be received by the Municipal Authorities on September 3 for the working of about 12½ miles of electric tramway at Cologne. Particulars are obtainable for 3 marks (3s.). Application to die Registratur B.

Butzbach (Germany)—Tenders will be received on June 1 for an electric lighting system for the city. Particulars for three marks (3s.) on application to the Burgomaster (Grossh. Bürgomeister Joutz) at Butzbach.

Huddersfield.—The Electric Lighting Committee of the Corporation are prepared to receive tenders for the supply and erection of two steam-boilers at the electric supply station, St. Andrew's-road, Huddersfield. For full particulars see advertisement.

Morecambe.—The Urban District Council want tenders for a chimney shaft (129ft.), engine and boiler houses for the electric light generating station. Plans and specifications can be obtained from the Surveyor, at the offices of the Urban District Council, and tenders must be in by June 7.

Santiago de Chile.—The Chilian Government Telegraphic Department will receive tenders on June 19, at Santiago, for the supply of galvanised iron wire, insulators, Morse instruments, paper for same, etc. Particulars (a summary only, and in Spanish) can be consulted at the Musée Commerciale, Brussels; otherwise application is to Santiago.

Leeds.—The Corporation are prepared to receive tenders for the erection of a battery station in connection with the tramways at Kirkstall. Plans and specification may be seen and bills of quantities obtained on payment of a deposit of £2. 2s. (which will be returned on receipt of a bona fide tender) at the City Engineer's Office, Municipal Buildings, Leeds

Rio de Janeiro.—The Secretary of State for Foreign Affairs has received a despatch from H.M. Consul-General at Rio de Janeiro enclosing a translation of an official notice setting forth the conditions under which tenders are invited for the telephonic service of that city and its suburbs. The tenders are to be presented by June 30, and the conditions may be inspected at the Commercial Department of the Foreign Office any day between 11 and 6.

Bray (Ireland).—The Township Commissioners require tenders for supplying during ensuing 12 months, carbons, cables, house wires, switches, fuses, incandescent lamps, holders, casings, insulating materials, etc., and sundry articles more particularly specified in schedule, which will be forwarded, together with form of tender, on application to Mr. P. Macdonnell town clerk, Town Hall, Bray. Tenders to be delivered to the Town Clerk, properly sealed, and endorsed "Tender for ——," by 10 a.m. on June 7.

Bedford.—The Urban Sanitary Authority are prepared to receive tenders for the supply and erection at the sewage pumping works of two alternating current motors coupled direct to two vertical spindle centrifugal pumps, and the necessary cast-iron piping, valves, etc., for fixing and connecting the same. Specification and plan may be obtained from Mr. T. S. Porter, town clerk, at the Town Hall, on receipt of an application enclosing a deposit of £2, which will be returned on receipt of a bona fide tender. Sealed tenders, marked "Motors," must be delivered at the Town Clerk's Office not later than Tuesday, June 8.

Belfast.—The Electric Committee are prepared to receive tenders for the supply and erection of the following plant: Section B 5—switchboard, instruments, and connections; Section B 6—motor-generator and boosters. Specifications and conditions of contract may be obtained on application to Mr. Victor A. H. McCowen, Corporation electrical engineer, on payment of £1. 1s. per copy for each section, which sum will be refunded on the return of the specification with a bona fide tender. Sealed tenders, endorsed "Tender for ——," must be lodged in the office of Sir Samuel Black, town clerk, not later than noon on Thursday, June 3, 1897.

Sunderland.—The Corporation require tenders for the supply of high-speed three-crank steam dynamo. Specification and schedule of quantities can be obtained from Mr. J. F. C. Snell, borough electrical engineer, Dunning-street, on payment of a deposit of £2. 2s., which will be returned on receipt of a bona fide tender. The persons or firms whose tenders are accepted will be expected to pay the rate of wages to the workmen engaged in carrying out the work which is payable by the particular trade affected by the contract in the district where the work is executed Sealed tenders, addressed to the Chairman of the Highways Committee, Town Hall, Sunderland, must be sent to Mr. Fras. M Bowey, town clerk, Town Hall, Sunderland, by 26th inst. not later than 12 noon. Tenders to be endorsed "Tender for Steam Dynamo."

Wakefield.—The Guardians invite tenders for the following work at the new infirmary: (1) electric lighting plant, combined steam-engine and dynamo, belt-driven dynamo, motor-dynamo, motor, switchboard, storage cells, etc.; (2) complete system of wiring for the electric light, also bells and telephones; (3) vertical steam-engine, feed-water heater, tank, pumps, and pipe work, etc. Contractors wishing to tender for any of above sections must forward to Messrs. Shepherd and Watney, engineers, 71, Albion-street, Leeds, a deposit of £1. 1s. for such section, which will be returned on receipt of a bona fide tender. Specifications will then be forwarded to such applicants on or about May 13. Tenders must be delivered to Mr. H. Beaumont, clerk, Union Offices, Tetley House, Wakefield, in sealed envelopes, endorsed "Section No. 1, etc.," by noon on June 2.

RESULTS OF TENDERS.

Colchester.—The Electric Light Works Committee received the following tenders for the erection of an electric light station, consisting of a boiler-house, engine-house, cast-iron tank, and chimney shaft, to be built on land adjoining the Osborne-street depot:

G. Grimwood and Son, Sudbury (accepted)	£2 996
H. Everett and Son, Hythe-hill, Colchester	3 594
Dobson and Son, Butt-road, Colchester	3,689
F. Dupont, North-hill, Colchester	3,690
A. Diss, Stanwell-street, Colchester	3,740
W. Chambers, Magdalen-street, Colchester	3,775

BUSINESS NOTES.

Western and Brazilian Telegraph Company.—For the past week the receipts were £2,084.

Torquay.—It is more than probable that the electric light will be in use in the borough by the middle of September.

Beckenham—At the Urban District Council meeting Mr. A. J. Lees was elected chairman, and Mr. Borrowman deputy-chairman, of the Electric Lighting Committee.

Henley's Telegraph—Letters of allotment and regret have been posted for the new issue of ordinary shares of W. T. Henley's Telegraph Works Company, Limited.

Rand Central Electric Company.—The secretary reports that this Company are now furnishing a regular supply of electric power to mines on the Witwatersrand.

Consolidated Telephone Construction and Manufacturing Company.—The directors have resolved to declare a dividend of 2 per cent. for the year ended March 31.

West India and Panama Telegraph Company.—For the half-month ended May 15 the receipts were £2,622, as against £2,480 for the corresponding period of 1896.

Ealing—At the District Council meeting the Electric Lighting Committee was appointed as follows: Messrs. J. Box, R Baker Hays, H. Armriding, H. Kasner, and W. Thayers.

Change of Address.—Mr. Killingworth Hedges, M.I.C.E., has removed his office from 28 to 92, Victoria-street, and his laboratory to Emery Hill-street, Francis-street, Westminster.

Ashton.—At the Town Council meeting the chairman was requested to instruct Mr. Clirehugh, the electrical engineer, to proceed with the erection of the works and plant generally without delay.

Liverpool Overhead Railway—The traffic receipts of this railway for the week ended May 16 amounted to £1,352, as compared with £1,125 in the corresponding week of the previous year, being an increase of £227.

St. Austell.—The Urban District Council at their last meeting deferred the offers from the manager of the gasworks and Messrs. Veale and Co., electricians, to provide illuminated decorations for celebrating the Queen's Jubilee.

Bristol Tramways and Carriage Company, Limited.—The traffic returns for the week ended May 14 were £2,288. 1s., compared with £2,297. 15s. 3d. for the corresponding period of last year, being a decrease of £9. 14s. 3d.

Paris.—A Reuter's telegram from Paris says that several places of entertainment in the Champs Elysées were obliged to close their doors on Monday night in consequence of the failure of the electric light. The interruption was due to the breaking of a cable.

Dublin.—The Dublin Southern District Tramways Company have lodged a memorial to the Lord-Lieutenant in Council praying for an Order in Council to authorise the construction, maintenance, and working of certain tramways in Blackrock and Kingstown townships.

British Electric Traction Company, Limited.—Mr. Vincent Kitchener having accepted another position in the service of the Company, has resigned the appointment of secretary, and, as will be seen from our advertisement columns, the Company invites applications for the secretaryship.

New Agency.—Messrs. F. A. Putz and Co., of 19, Mansion House-chambers, E.C., have been appointed sole agents for the United Kingdom for the Vereinigte Electricitäts Actien-Gesellschaft vormals B. Egger und Co, in Vienna, and are keeping a small stock in London for that firm.

City and South London Railway.—The returns for the week ended May 16 were £1,000 compared with £864 for the corresponding period of last year, being an increase of £136. The total receipts for the half-year 1897 were £20,503, compared with £18,800 last year, being an increase of £1,703.

Mardy Electric Light Company, Limited.—This Company has been registered, with a capital of £2,000 in £1 shares, to carry on at Mardy, Glamorganshire, and elsewhere, the business of an electric light company, electricians, mechanical engineers, etc. Registered office: Mardy, Glamorganshire.

Chester.—The Electric Light Committee propose to have distributing and arc cables laid and to provide for arc lighting in Northgate-street to the junction of the Liverpool and Parkgate roads, and in Boughton, from City-road to the fountain at the junction of the Tarvin and Whitchurch roads.

Morley Electrical Engineering Company, Limited.—This Company has been registered, with a capital of £5,000 in £1 shares, to adopt an agreement, dated April 23, with W. M. Rennie and J.

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Graham, the general objects being sufficiently indicated by the title. Registered office: Troy-road, Morley, Yorkshire.

Howth Electric Tramway.—The Select Committee of the House of Lords have approved of the Great Northern of Ireland Railway Bill, by which powers are sought to construct an electric tramway round the Hill of Howth, and the Bill will accordingly proceed. The works are estimated to cost about £39,000.

Willesden.—The District Council have instructed Mr. W. H. Trentham, M.I.Mech.E., consulting engineer, of 39, Victoria-street, S.W., to report as to the best area for electric lighting and to furnish the Council with an estimate of the capital outlay, together with the probable revenue and working expenses. The population of Willesden is now nearly 100,000.

Llandudno.—At the Urban District Council meeting, Mr. Marks was appointed chairman of the Electric Light Committee. A lengthy report was read from Mr. Preece, the engineer, as to electric lighting and a destructor, at a total cost of £25,000. He urged promptitude of action if the scheme was to be ready for 1898 season. To facilitate this, it was agreed to give the committee power to act.

Appointment Vacant.—An assistant in the mechanical engineering department of the Merchant Venturers' Technical College, Bristol, is required in September. Salary £120 a year, increasing to £150. Candidates must send in their applications not later than Tuesday, May 25, and must state that they have read the particulars as to the post, which can be obtained from the registrar on application.

Yarmouth.—At the Town Council meeting the surveyor's statement as to electricity supply showed that the income was £187. 1s. 8d., against working expenditure of £168. 10s. 8d., leaving a balance of £18. 10s. 8d. to meet capital and sundry charges of £150 per month. An offer from the Great Eastern Railway of £36 per annum for lighting two arc lamps on the approach to Vauxhall Station was accepted.

The Leeds Vacancy.—The Electric Tramways Works Committee of the Corporation at its last meeting considered applications for the post of chief electrical engineer. It was decided to request six candidates to attend the next meeting of the committee. Their names are: W. Gentry Bingham, London; J. Burbridge, Leeds; Walter Emmott, Halifax; C. F. Fielder Smith, Blackpool; J. K. Stothert, Leeds; and W. Wood, Bristol.

Birmingham.—The General Purposes Committee had before them at their meeting the resolution of the City Council, instructing the committee to consider the desirability, or otherwise, of the Council purchasing the undertaking of the Birmingham Electric Supply Company, Limited; and also to ascertain whether, and upon what terms, the company were willing to transfer their undertaking to the Council. A sub-committee was appointed to make the necessary preliminary enquiries into the matter.

National Telephone Company.—The new head offices of the National Telephone Company will be on the Thames-embankment, on the site which was originally chosen for the erection of new offices by the Metropolitan Asylums Board. At the present time they are situated in Oxford-court, Cannon-street, but there are also five or six additional offices spread over various parts of the City and West-end. In the new building, the plans of which are in course of preparation, there will be a concentration of all the offices.

Guildford.—The General Purposes Committee reported at the Town Council meeting that they had considered the offer of the electric light company to lay a main for the supply of electricity to the public baths, provided a minimum charge of £25 per annum was paid in respect of the light, and that the Council also adopted the light at the offices in Tuns Gate, but the offer did not appear to the committee to be one which the Council could accept with advantage, and they therefore recommended them to decline it. The report was adopted.

Bridgwater.—A few weeks since a committee of the Town Council was deputed to visit other towns and institute enquiries relative to the advantages or otherwise of the substitution of electric for gas lighting. It is understood that they have obtained a good deal of valuable information in towns where the main thoroughfares are illuminated with the electric light instead of by gas, especially with reference to the comparative cost, and that they are likely to present a report at the next meeting of the Corporation recommending its adoption in Bridgwater.

Richmond (Surrey).—At the Town Council meeting the report of the Electric Light Committee stated that the committee had asked the electric light company upon what terms they would be willing to make a small experimental lighting district with a view of enabling the committee to come to a decision as to the lighting of a portion of the borough with electric light. In reply, the secretary wrote stating that the expense of the proposed experiment would be heavy; as an alternative they offered to undertake to supply 20 lamps for £520. The Council were recommended not to entertain the matter. The recommendation of the committee was adopted.

Manchester.—The electric lamps erected in three of the principal places of the city were to be brought into use for the first time last (Thursday) night. The ceremony of switching on the current was to be performed by the Lord Mayor and other gentlemen. The new lamps number 20, of which 12 are in Albert-square, two in St. Ann's-square, and six in Piccadilly, and it is understood that they will displace about 75 large gas lamps. Each lamp is said to have an illuminating power equal to that of 3,000 candles. The electric light will probably be brought into use ere long in some of the other central places of the city, but as to this nothing has yet been decided.

The Leeds Tramways.—The extension of the York-road tramway to Victoria Park, authorised by the Act of last year, has just been completed, and a few days ago a trial trip was made from Duncan-street to the new terminus. The inspection party consisted of Mr. Hannam (the chairman), Mr. Henry (the deputy-chairman), Councillors Sidney Smith, Batley, and Waring (members of the Tramways Committee), Mr. Prince (surveyor of highways), and Mr. Wharam (the manager of the tramways). The results of the experiment were completely satisfactory, and it is intended to commence running a through service from Boar-lane at once.

Glasgow Electric Wire and Rubber Company, Limited.—This Company has been registered, with a share capital of £50,000, divided into 5,000 6 per cent. cumulative preference shares, and 5,000 ordinary shares of £5 each, to acquire the business of the United Guttapercha and Rubber Company, Glasgow, certain patents relating to electric cables, and a secret process for the manufacture of golf balls. The purchase price is £30,000, payable as to £20,000 in fully-paid shares of the Company, as to £7,500 in cash, and as to the balance of £2,500 in cash or preference shares, at the option of the directors. This leaves a sum of £20,000 available as working capital.

Catalogues.—The St. Louis (Mo.) Iron and Machine Works Company have forwarded us an interesting book containing a full description of the St. Louis Corliss engine, with splendid illustrations and diagrams.—We have received a bulky catalogue from the London and Lancashire Electric and General Engineering Company, Limited, 47 and 48, Upper Thames-street, E.C., which includes, as far as possible, everything required in an electric installation. Books of this sort almost become works of reference. Messrs. Holden and Brooke, Limited, engineers, Manchester, have sent us their catalogue and price-list, containing patent steam dryers, valves, injectors, regulators, etc.

Colwyn Bay.—At the Urban District Council meeting, Mr. Blud moved that the Council proceed to appoint an electrical and consulting engineer, with a view to the erection of electric lighting plant in combination with a destructor to be placed at Groes. He described the present mode of disposing of the refuse as very unsatisfactory. Mr. W. Davies seconded. Mr. Porter opposed the erection of a destructor at Groes. Mr. Bevan said he had been returned to oppose the Groes site. He moved that the Council appoint the Sanitary Committee to select a site suitable for a destructor, but that it be not at Groes. Dr. Venables Williams seconded. The original resolution was carried.

The Birmingham Tramways.—The City of Birmingham Tramways Bill has been before the Select Committee of the House of Commons over which Mr. James Stuart presides. The object of the Bill is to authorise the City of Birmingham Tramways Company, Limited, to construct additional tramways and for other purposes. Mr. Pember, Q.C., Mr. Dugdale, Q.C., and Mr. G. L. Milward appeared for the promoters of the Bill; and Mr. Balfour Browne, Q.C., and Mr. Clode for the Colmore Estate Trustees, who opposed the Bill. After hearing the evidence the preamble was proved, and the committee went through the clauses of the Bill, which passed the committee stage, and was ordered to be reported for third reading.

Islington.—At the meeting of the Vestry to be held to-day (Friday), a report will be received from the Electric Lighting Committee stating that they have considered the desirability of revising the present scale of charges for the supply of electricity to private consumers, and have resolved to adopt the following scale on and after October 1 next—viz, for an average of one hour's consumption or under per day during the quarter of the maximum number of lamps alight at any one time, 7d. per unit; for an average of two hours per day, 7d. per unit for the first hour and 6d. per unit for the second hour; for an average of three hours per day or more, 7d. per unit for the first hour, 6d. per unit for the second hour, and 4d. per unit for the remainder.

Electrical Work in Japan.—The *Electrical World* says the rapid progress along all scientific lines in Japan, combined with frequent earthquakes in that country, which have proved very destructive to gas-pipes, has resulted in numerous electrical installations for lighting. Hardly any large town in the more accessible parts of the country is without a station, and there is an increasing demand for dynamos, motors, and other apparatus. The Japanese have already begun the manufacture of dynamos. The Mitsui-Bussan Company in Tokyo has already turned out some very creditable types of two-phase alternators. The most complete plant in Japan, and one that would be creditable to any city, is that of the Kioto City Electric Works in the town of that name.

Niagara Electricity.—The *Electrical Engineer* of New York says that the utilisation of Niagara power on the Canadian side has now reached an interesting stage. The Niagara Falls Commission notified the power company that it must begin operations on its Canadian plant by May 1 or lose its franchise, to hold which it has been paying £5,000 a year. The company has applied for an extension of time, but this privilege having been denied, it has faced the problem by actually beginning work. Details for the plans of the Canadian side have already been published in the *Engineer*, but it is still too early to say when the work will be completed or what the exact present intentions of the power company are as to the disposal of the power that it generates. It is said that large customers stand ready for it.

Lessons from Electric Lighting Stations.—On Saturday evening over 50 students from the engineering department of the Hull Technical Schools paid a visit to the electric lighting

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station of the Corporation. Previous to the visit Mr. C. L. Eclair Heath gave an interesting lecture, with limelight illustrations, at the Osborne-street Technical School on the construction of high-speed engines, such as Willans, Raworth Universal engine, Chandler's silent engine, together with special appliances for feeding boilers with injectors. The students were met at the station by Mr. A. S. Barnard and his assistant, Mr. S. E. Bastow. This is the second of the series of visits to works which are being arranged by the chief lecturer on engineering (Mr. Heath), and it is hoped shortly to take the students to some of the larger works at Sheffield and other towns.

Glasgow.—A conference has been arranged between representatives of the Corporation Committee on Electricity and the Tramways Committee with reference to the supply of electric power for the experimental trolley tramway between Mitchell-street and Springburn. It has been suggested on the part of the tramways department that an electrical station should be erected at Springburn for working the new system. The Committee on Electricity, on the other hand, are of opinion that the power station at John-street should be utilised for this purpose. Arrangements are in progress for the lighting of the street electric lamps from the Waterloo street station, and when these are completed the John-street station will not be required for lighting purposes. In these circumstances, it is thought that with some comparatively slight alterations it could be made available for working the tramways, the cost of putting down entirely new plant being thus avoided.

Sunderland.—The Highways Committee at the Town Council meeting recommended extensions of electric mains, estimated to cost altogether £1,853, and that Fawcett-street, North Bridge-street, High-street West, and Borough-road be lighted with electricity. The number of arc lamps proposed to be erected is 50 of 600 c.p. each, at an estimated cost of £1,900. Alderman Bruce, in submitting the recommendation, explained that the contract with the gas company for the lighting of the town would soon expire, and the company had already intimated that, in consequence of advances in wages, an increased price would be demanded in the new contract. They also gave notice that if the electric light were introduced into any streets, an increase of 6d. per lamp would be charged for gas. The committee hoped to persuade the company not to put themselves into such an invidious position as they would be in by opposing the electric light in such a manner. The recommendation was agreed to.

The Lighting of the London Markets.—At the meeting of the Court of Common Council a report was submitted from the Central Markets Committee upon an application by the solicitor of Messrs Sax for permission to transfer the lease of the buildings in course of erection in Charterhouse-street, and the concession for lighting the Central Markets, to Messrs. Jacob Van der Burgh and Sir John Morris, K.C.S.I. The committee recommended that the application be complied with, under the general conditions laid down by the Court. Mr. Brooke Hitching moved that the report of the committee should be printed, and its consideration adjourned. Mr. Morton, in seconding the amendment, said he thought it desirable that the Court should know something more about the matter. The Commission of Sewers had, he said, been "taken in" once. Mr. Smallman said that was not the case. If the Commission of Sewers had known as much some years ago as they did now different terms might have been made, but at the time they were the best that could be obtained. The report of the committee was ordered to be printed.

Canterbury.—Major Tulloch, one of the Local Government Board inspectors, has held an enquiry respecting the application of the Town Council for authority to raise a loan of £23,000 for the installation of the electric light. The town clerk (Mr. H. Fielding) conducted the case for the Corporation, and the opponents of the scheme were represented by Mr. Dickens, Q.C., with whom was Mr. Percival, and by Mr. Worsfold Mowll, solicitor. The Town Clerk opened the case and called a number of witnesses, among whom were Dr. Netherclift, Mr. Frank Wacher (surgeon), Mr. R. Hammond (the consulting engineer), Mr. Campbell (city surveyor), Mr. F. W. Cross, Alderman Cross, Alderman Mason (chairman of the Lighting Committee), and Mr. S. S. Warren (ex-councillor). The cross-examination was chiefly directed to show that it would be unfair that the ratepayers should be burdened with the cost of the electric light when other works of improvement were more urgently needed, especially a new town hall, which, it was alleged, had been shelved in favour of the electric lighting scheme. The enquiry occupied about five hours.

Mexican Electric Works Limited.—This Company has been registered, with a capital of £320,000 in £5 shares, to carry on the business of generators and distributors of electric energy for the purposes of light, heat, and motive power, or otherwise, in the United States of Mexico and elsewhere in America, and with a view thereto, to adopt and carry into effect two several agreements expressed to be made between Messrs. Siemens and Halske, of Berlin, of the first part, and this Company of the other part; generally to carry on, in all or any of their respective branches, the businesses of electricians, mechanical engineers, manufacturers of and dealers in all apparatus and things required for or capable of being used in connection with the generation, distribution, supply, accumulation and employment of electricity, and, in particular, to construct, lay down, and carry out all necessary cables, wires, lines, generators, dynamos, accumulators, transformers, lamps, plant and machinery; to apply for, purchase or otherwise acquire, any patents, licenses, and concessions; to construct and maintain rail and tram roads, wharves, factories, warehouses, shops, stores, and other works and conveniences. The registered office is at 65, Old Broad-street, E.C.

Rowley.—At the District Council meeting the General Purposes Committee reported that the solicitors for the promoters of the light railways (the British Electric Traction Company) had written desiring to know the objection which the Council had to them, and they recommended the clerk to state that the Council were generally opposed to such railways in their district. The clerk had also reported that he had received the draft of the order for which the company were intending to apply to the Commissioners. They recommended that the order be handed to the Council's solicitor, with instructions to investigate and advise upon it. Mr. Sellon, engineer to the British Electric Traction Company, attended the meeting, and explained that it was proposed to construct the light railway from Dudley to Cradley Heath. He laid before the Council the company's intentions. The tramway would be worked on the electric system, and the Dudley Corporation were in its favour. The Chairman said the tramways would damage the highways seriously, but the question was who would benefit? They had decided to call a town's meeting, and the Council would let Mr. Sellon know what the result was. The report was adopted.

Pembroke.—A special meeting of the Township Commissioners has been held to enquire into the application of the Dublin United Tramways Company, in connection with the proposed extensions and alterations of the tramway system in the township, to be carried out under an Order in Council. These consist of a line along Waterloo-place and a line through Irishtown, and a line through Irishtown and Ringsend to join the Sandymount line. Sir Robert Jackson, C.B., chairman of the Board, presided. Mr. Collins, from the office of Messrs. Casey and Clay, solicitors to the tramway company, and Mr. Nugent, attended the meeting. Mr. Collins stated that, owing to unavoidable circumstances, the secretary of the company and a number of the directors were in London, so that he had no authority to give on behalf of the company any undertaking to execute the work recommended by the township surveyor in his report. At the same time he (Mr. Collins) was not prepared to say that the requirements mentioned would not be carried out. He would, therefore, ask that the meeting be adjourned until that day fortnight. The matter was accordingly adjourned for a fortnight, this being agreed to on the motion of Mr. Lidwill, seconded by Major Gibbs.

Kensington.—The Special Purposes Committee reported at the meeting of the Vestry that they had had before them a communication which had been received from the Kensington and Knightsbridge Electric Lighting Company, Limited, intimating that if the necessary alterations were made to consumers' wires and fittings to allow of the pressure being increased from 100 to 200 volts, the charge would be 5½d. per unit instead of 6d., and that the charge from July 1 next would be further reduced to 5d. per unit where the house was furnished with the higher pressure supply. The committee learned from the lighting engineer that a considerable saving would be effected in the cost of lighting at the town hall if the suggestions of the company were acted upon, it having been pointed out that had the current for the past year been supplied at the contemplated charge of 5d. per unit, the saving effected would have been about £37. The committee recommended that the necessary alterations to the fittings at the town hall should be carried out to allow of the pressure for the supply of electricity being increased from 100 to 200 volts; that the lighting engineer should be instructed to prepare a specification for the carrying out of the necessary alterations, and that tenders should be invited for the execution of the works during the summer recess.

Liverpool.—There has been a correspondence going on with the Corporation as to the payment of certain of their workmen for working overtime. A letter was received from Mr. J. Gill Boyer, district secretary to the Amalgamated Society of Engineers, stating that it had been brought to the notice of his committee that the Corporation employés (fitters and turners) do not receive the rates for overtime agreed upon. The shops complained of are respectively electric supply depôt, custom house, and the water department, situated in Pall-mall. The society held that, as ratepayers, it was not right to pay to engineers less rates than private firms do: in point of fact the rates should be higher, as the Corporation of the city of Liverpool had not to contend with outside competition. To this the town clerk (Mr. Harcourt Clare) replied: "I have to inform you that a committee of the Corporation have enquired into the conditions under which their men are employed, and they find that the terms of employment and the circumstances under which work has to be carried out by the Corporation are, generally speaking, so substantially different in character from those applicable to private establishments, that the same system of employment and payment cannot be applied to both cases. The committee, however, are quite of opinion where the conditions of employment by the Corporation are identical with those under which men work for private firms that the Corporation should pay the rate of wages and observe the hours of labour which are agreed to between employers and employed in private establishments."

Portsmouth.—In introducing the Electric Light Committee's report at the Town Council meeting, Alderman Ellis said, with regard to the balance-sheet for the past year, that the committee had been able to make a reduction in the cost per unit of coal, stores, wages, etc., and only maintenance exceeded the amount of last year. The management expenses had gone down from ·43 to ·29. Last year he told the Council that the cost per unit of electricity sold was 2·06d., or a fraction over 2d. per unit. This year the cost per unit was 1·70d., or rather under 1¾d. per unit. Of all the electric light stations in the United Kingdom, the only town which beat Portsmouth in the lowness of cost of production was

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Edinburgh, where the cost per unit was 1·67d. But in Edinburgh the coal cost only half what it did in Portsmouth, and he was sure that the Council would agree with him that the committee had done remarkably well in keeping the cost below that of all the towns in the kingdom except Edinburgh. At Brighton the cost per unit was 2½d. As to the pounds, shillings, and pence of the year's working, last year he had to admit a deficit of £400, but this year, after paying all charges, he had said he hoped to hand over something like £1,300. The actual amount far exceeded that, because it was over £2 300, and nearly £2,400. This was very satisfactory; still he was disappointed, because at Christmas he hoped it would be £3,000. His judgment would have been right but for the increase in the maintenance charges through misfortune. They had had a series of accidents, all of which had cost money. Next year, instead of the maintenance cost going up 8 or 9 per cent., it would no doubt go down, and he would be able to show a far better balance than now.

Dover.—The Town Clerk stated at the Town Council meeting that the estimate of the electricity supply company for lighting and illuminating the Granville Gardens and the sea-front in accordance with the plans submitted, were: Granville Gardens, £35 for installation and maintenance; 14 hours per week £2. 16s. per week; for illumination each extra hour, 4s. per hour. Sea front, £45 for installation and maintenance; illumination per week of 14 hours, £20; each extra hour, 30s. per hour. He also stated that he had received a letter from the secretary of the Dover Gas Company stating that in improving the illumination of the Granville Gardens they were willing to extend the system adopted throughout the town by the Council last year in any way that the Corporation might wish. The total cost of the illumination in the gardens last year was £5. 10s. 9d. Councillor G. Mowll remarked that last year there was a very wet season, and four nights out of five no lights were lit at all. In fact, it was utterly impossible to light the gas. Councillor Finnis said he thought the matter could be referred to the Park Committee. He could not see how they should go into the expenditure of £35 for the first installation, and £2. 16s. per week afterwards, when last year the cost of the whole season was the sum mentioned, and was sufficient to illuminate all the flower beds. A motion to refer the matter to the Park Committee was carried. Councillor Mackenzie subsequently referred to the question of illuminating the sea-front. He said he supposed that it had not been referred to the Park Committee, and he thought the matter should be taken into consideration. Although rather expensive, it proved last year to be one of the greatest advertisements Dover ever had, and in Jubilee year he would like to see some special steps taken. It was decided to defer this for future consideration.

Newington.—There was considerable uproar at the last meeting of the Vestry on the discussion of the electric lighting question. The Clerk read the following letter from the Board of Trade: "Sir,—With reference to the previous correspondence on the subject of the application for the Newington electric lighting order, I am directed by the Board of Trade to inform you that after carefully considering the representations which have been put before them, they have decided to proceed with the application. I am to add that the decision has been communicated to the representatives of the Ratepayers' Committee, and the Newington and Walworth Ratepayers' Association." The reading of the letter was received with loud cheers by the Progressives Mr. Cole having received permission to move a special resolution, proposed the following: "That this Vestry feeling as previously expressed by resolution that the distribution of electrical energy will prove of material advantage to the inhabitants of the parish, hereby thank the Board of Trade for the very careful consideration which they have given to the representations made to them, and for their decision to lay the order before Parliament for their consideration." Mr. Dawes seconded. Mr. Davis moved an amendment that the first part of the resolution, with which he entirely disagreed, should be deleted. The Board of Trade had no doubt given a great deal of consideration to the subject, for which they should be thanked. But after the long enquiry that had been held he was very much surprised that they had come to the opinion they had. He was absolutely certain that the scheme would be an utter failure, and he was sorry that the Progressives did not have pluck enough to let the matter stand over until after the election, so that the people could say whether they wanted such a thing. The ratepayers had never had an opportunity of expressing their opinion on the matter. If the parish were polled they would find that quite two-thirds were opposed to the scheme. Mr. Hester seconded the amendment. The amendment was put and lost, and the motion was carried amid enthusiasm.

Heating at Niagara.—The Niagara Falls Power Company's power station is electrically heated. The power-house is divided into the dynamo-room and the office quarters—a fact which makes necessary two series of heaters. The heaters in the offices are on a secondary 100-volt circuit, and this circuit is fed through transformers which reduce the voltage from 2,000 to 100. In the office portion of the power-house there is about 175 h.p. in heaters of the American pattern. The office occupied by the electrical superintendent is about 20ft. by 15ft., by 9ft. or 10ft. high. In this room are two heaters, each of 7 h.p., making a total in the room of 14 h.p., and in very cold weather both are necessary to give comfort. In the dynamo-room there are 15 heaters, three circuits of five each, and each circuit takes up about 200 h.p. However, it has never yet been found necessary to use all three circuits. The current for heating the dynamo-room is taken from the 'bus bars, while that for heating the office portion of the building is taken from the primary of the circuit which feeds the street railways. The maximum amount of power used in heating the dynamo-room and office portion of the central station is about 420 h.p. or 430 h.p., but "this is not counting the heat from the dynamos, which is, indeed, an important factor so far as the dynamo-room is concerned." At the present time there are three dynamos in the station, each of 5,000 h.p. capacity, and as a general thing two of these machines are running at the same time. The heaters in the dynamo room are made of two circular rolled-iron plates, which are about ¼in. thick and 24in. in diameter. Bolts hold these plates parallel, about 4ft. apart, one above the other. Each plate has about 28 holes in it, and the diameter of each hole is about ½in. In each of these holes is placed a porcelain insulator having a pretty large head, and through the insulators No. 6 iron wire is strung. There are 38 coils, and each coil is about 1½in. in diameter, the distance between convolutions being about twice the diameter of the wire; at least, it is such that the resistance of the heaters will take about 65 amperes at 440 volts, so that all five heaters, in series, will consume 2,200 volts at 65 amperes.

Norwich.—A special meeting of the Town Council has been held to receive a report from the Law and Parliamentary Committee upon the Bill promoted by the New General Traction Company, Limited, to authorise the construction of electric tramways in Norwich and Thorpe. This report was presented by Mr. W. H. Hackblock, who said several committee meetings had been held, and the committee had appointed a sub-committee to go into the clauses minutely. This was very necessary because, as the Council were aware, the committee up to the last meeting of the Council had been more occupied in debating the merits of the Bill of one company against the Bill of another than in going into the details of the particular Bill itself. Certain new provisions had been introduced into the Bill without their sanction, and contrary to the arrangements which had been come to, so that the Bill wanted careful watching. He therefore moved, "That full power be delegated to the Law and Parliamentary Committee, or any sub-committee thereof, to deal with the Bill of the New General Traction Company, Limited, to construct tramways in Norwich, including power to require the Bill to be withdrawn, in accordance with the undertaking given by the parliamentary agent of the company on January 30 last, and that the town clerk be authorised to affix the corporate seal to any resolution, order, or notice that may be considered necessary to carry out the above resolution." The sub committee felt that those gentlemen who were watching the Bill in London might have a certain amount of authority in dealing with those other gentlemen who had charge of the Bill. The powers with respect to withdrawing the Bill were not powers which were likely to be used, because it was only natural that with such an undertaking as they had that the Bill should be withdrawn at their request at any time, the sub-committee would not be likely to take upon themselves the weight of asking for the Bill to be withdrawn under the clause in his resolution. There were certain new provisions in the Bill which not one of them would ask the Corporation to agree to and approve. Whether it was worth while to go into the details of the measure that day he left to the Council to decide. He asked that power should be given to the committee to watch the Bill through. Mr. L. Tillett seconded the motion, and it was agreed to.

Jubilee Illuminations.—Electricians and electrical engineering firms are already full with orders for illuminations to celebrate the Diamond Jubilee. One very imposing scheme of decoration has been ordered by the London and North-Western Railway Company for their offices in Parliament-street and Bridge-street, Westminster. The principal features of the façade, with the central dome surmounted by a jewelled crown, are now being wired by the same firm that undertook the illumination of the Great Wheel. The design also includes the letters "V.R." and a motto which ingeniously introduces the initial letters of the official title of the company—"Longest, Noblest, Wisest Reign." In this installation alone 3,000 lamps will be needed. One firm is producing an eight-rayed star, with five 8-c.p. lamps attached to each arm. When the wheel is revolved the whole 40 lights merge into a quivering sheet of flame, the outer edges of which acquire the prismatic hues of the rainbow. A very small motor is needed to keep the star rotating. It will probably be seen on June 22 on the façade of one of the great co-operative stores. Another device, which was employed with great effect at Paris during the fêtes given in honour of the Tsar of Russia, is the screening of small electric lamps of 2½ c.p. with balloons of various colours, made of celluloid, which is waterproof and semi-transparent. When these spheres, gently glowing with blue, red, or white light, are hung in garlands, built up in pyramidal form, or are made to pick out the various portions of a Union Jack, the effect is decidedly novel. They are capable of producing bold designs, as each balloon is 7½in. in diameter. Lamps are also screened in letters composed of cut crystal; but, perhaps, the prettiest mode is presented by floral designs, the glass shades representing coloured blossoms, and the foliage around them being of metal. An illuminated portrait of her Majesty, with lamps bordering the frame, which has coloured emblems, is another pattern. Coats of arms are similarly composed, with sometimes the addition of the dates 1837-1897, and the motto, "A Glorious Reign." But the simplest form of electrical device in the market is the Imperial crown, which consists of a wire framework, with sockets for 75 lamps of 8 c.p. or 16 c.p. These lamps can be readily detached and, as they are of the ordinary pattern, may be used in the office or household after the Diamond Jubilee is over, so that the outlay is limited to the framework and the wiring. According to the *Daily Telegraph*, most of the electric supply companies have determined to make an inclusive charge of 3d. per lamp per night.

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PROVISIONAL PATENTS, 1897.

MAY 10.

11558. Improvements in electrical gas-lighting apparatus. James Frederick Bennett and Robert Henry Marples, Hermitage street, Sheffield.

11575. Syntonised telegraphy without line wires. Oliver Joseph Lodge, 6, Lord-street, Liverpool.

11578. Improvements in or relating to carbon plates, rods, or the like for galvanic batteries Frederick James Gillibrand, 26, Castle-street, Liverpool.

11594. Application of electricity to the working of artillery and for other purposes. Giulio Martinez, 52, Chancery-lane, London.

11603. An improvement in plates for secondary voltaic batteries. Edward Riley, 28, Southampton-buildings, Chancery-lane, London.

11622. Improvements in apparatus relating to the distribution and use of alternating or pulsating currents of electricity. Rookes Evelyn Bell Crompton and William Ashcombe Chamen, 55, Chancery-lane, London.

11626. Improvements in regulating or governing electric generating plant. Edward Tremlett Carter, 40, Chancery-lane, London.

MAY 11.

11634. Improvements in electrical radiators and water boilers for cooking and heating purposes. John Chambers, 7, Staple-inn, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, October 22, 1896, being date of application in New Zealand.)

11635. Apparatus for recording the time occupied in telephonic conversations. Eduard Bödege, 37, Essex-street, Strand, London.

11701. Improvements in the construction of dynamo-electric machinery. Alfred Soames, 24, Southampton-buildings, Chancery-lane, London.

11702. Improvements in electric cables. Theodor Petersen, 24, Southampton-buildings, Chancery-lane, London.

11714. An improvement in holders for electric glow lamps. Henry Charles Gover and Charles Faraday Proctor, 28, Southampton-buildings, Chancery-lane, London. (Complete specification.)

11716. Improvements in the electric laying of cannon or torpedo tubes. James Eastwick and Illius Augustus Timmis, 2, Great George-street, Westminster, London.

11717. Improvements in devices for enabling railway travellers to apply the brakes by electrical means. Edwin James Preston and Arthur Bernard Gill, 77, Chancery-lane, London.

11741. Improvements in electric arc lamps. Edgard Weber, 45, Southampton-buildings, Chancery-lane, London.

MAY 12.

11760. An electric disinfector. Harry Kimber, 82, Kingston-crescent, Landport, Portsmouth.

11787. Improvements in metal rails, fixtures, and fittings for railway roads, tram roads, and electric and other railways. William Brough Berrey and James Smethurst Warburton, 5, Neville road, Waterloo, near Liverpool.

11800. Improvements in and connected with the formation of galvanic batteries. Saturnino de la Precilla, 9, New Broad-street, London.

11808. Improvements in incandescent electric lamps. Arthur Woodley, 90, Cannon-street, London.

11844. Improvements in voltaic batteries and electrolytic decomposition cells. Gerald Carlyle Allingham and William Fennell, 53, Chancery-lane, London.

11846. Improvements relating to electric lamps for cycles. Thomas Gidley Howden, 22, Southampton-buildings, Chancery-lane, London.

MAY 13.

11861. Improvements in or relating to electric accumulators or storage batteries. Otto Lindner, 41, Rue Gallait, Brussels.

11891. Improvements in apparatus for making or breaking an electric circuit at the end of a prescribed period of time. John Davidson, 45, Southampton-buildings, Chancery-lane, London.

11945. An improved arrangement for reducing the apparent resistance in telephone conductors. Emil von Szvetics, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

MAY 14.

12019. An improved apparatus for maintaining a constant temperature of metallic wires heated by an electric current. Robert Bergland and Baron Richard de Wendel, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

MAY 15.

12028. Sulphuring carbon plates for galvanic batteries. Robert William Atkinson and Sydney Ferris Walker, 44, Loudoun-square, Cardiff.

12063. Improvements in electricity meters. George Hookham, 7, New Bartholomew-street, Birmingham.

12068. An improved incandescent electric lamp. John William Hebb, 8, Quality-court, Chancery-lane, London.

12073. Improvements in secondary battery plates and in moulds for making them. Henry William Headland and Headland's Patent Electric Storage Battery Company, Limited, 77, Chancery-lane, London.

12084. Improvements relating to electromotors. Alfred Soames and Walter Langdon-Davies, 24, Southampton-buildings, Chancery-lane, London.

12087. Switch apparatus for the graduated inclusion and exclusion of resistances in electrical circuits. Siemens Bros. and Co, Limited, 28, Southampton-buildings, Chancery-lane, London. (Siemens and Halske, Germany.)

12088. Improvements in apparatus for controlling electric motors. Siemens Bros. and Co., Limited, and Arthur James Stopher, 28, Southampton-buildings, Chancery-lane, London.

12089. Apparatus for controlling electric motor-generators at a distance. Siemens Bros. and Co., Limited, and Paul Traugott Julius Estler, 28, Southampton-buildings, Chancery-lane, London.

12090. A self-locking electrical signalling instrument. Siemens Bros. and Co., Limited, and George Forrest, 28, Southampton-buildings, Chancery-lane, London. (Complete specification.)

SPECIFICATIONS PUBLISHED.

1896.

4788. Electric batteries. Jacques. (Amended specification.)

8802. Switchboards to be used for telephonic or telegraphic purposes. Shore and Heap.

12635. Electrical switches. Senior and Dundas.

13488. Electric incandescent lamps. Bamberg.

13496. Incandescent electric lamps. Sander and Clifford.

13891. Incandescent electric lamps. Roothaan, Roothaan, Alewijnse, and Schuurman.

14197. Incandescent electric lamps. Roothaan, Roothaan, Alewijnse, and Schuurman.

1897.

2701. Electric propulsion. Nash.

5859 Electrical switches. Dorman and Smith.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	9¼-9¾
Brush Company, Ordinary	3	1¼-1⅜
—— Non. Cum., 6 per cent. Pref.	2	1¼-1½
—— 4½ per cent. Debenture Stock	100	104-108
—— 4½ per cent. 2nd Debenture Stock	100	96-99
Callender's Cable Company, Debentures	100	109-114
Central London Railway, Ordinary	10	9¾-10¼
——	6	5¼-6
Charing Cross and Strand	5	11¼-12¼
Chelsea Electricity Company	5	8¾-9¼
—— 4½ per cent. Debentures	100	112-115
City of London, Ordinary	10	23-24
—— 6 per cent. Cumulative Pref.	10	17-18
—— 5 per cent. Debenture Stock	100	131-136
City and South London Railway, Consolidated Ordinary	100	58-60
—— 4 per cent. Debenture Stock	100	137-139
—— 5 per cent. Pref. Shares	10	15¼-16
County of London and Brush Provincial Co., Ordinary	10	12¼-12¾
—— 6 per cent. Cum. Pref.	10	14¾-15¼
—— 4½ per cent. 2nd Debenture Stock	10	14¾-15¼
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	1¾-2¼
—— 5 per cent. Debentures	—	90-95
Edison and Swan United Ordinary	3	1¾-2¼
—— 5 per cent. Debentures	5	3-4
—— 4½ per cent. Debentures	100	105-110
Electric Construction, Limited	2	1⅝-1¾
—— 7 per cent. Cumulative Pref.	2	2¾-3¼
Elmore's Copper Depositing	1	¾-1
Elmore's Wire Company	2	1-1¼
W. T. Henley's Telegraph Works, Ordinary	10	18-19
—— 7 per cent. Preference	10	18½-19½
—— 4½ per cent. Debentures	100	105-113
House-to-House Company, Ordinary	5	8½-8¾
—— 7 per cent. Preference	5	9½-10
India Rubber and Gutta Percha Works	10	20½-21½
—— 4½ per cent. Debentures	100	104-107
Kensington and Knightsbridge Ordinary	5	11¾-12¼
—— 6 per cent. Pref.	5	8-8½
London Electric Supply	5	1¼-1¾
Metropolitan Electric Supply	10	17-18
—— 4½ per cent. First Mortgage Debenture Stock	100	120-124
National Telephone, Ordinary	5	6⅜-6⅝
—— 6 per cent. Cum. First Pref.	10	15-17
—— 6 per cent. Cum. Second Pref.	10	15-17
—— 5 per cent. Non. Cum. Third Pref.	5	6-6½
—— 3½ per cent. Deb. Stock	100	105-109
Notting Hill Company	10	14-15
Oriental, Limited, £1 shares	1	1¼-2
—— £5 Shares	5	8½-9
—— £4½ shares	4½	7¼-8
Oriental Telephone and Electric Company	1	⅝-¾
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	102-104
St. James's and Pall Mall, Ordinary	5	15¼-16¼
—— 7 per cent. Pref.	5	10-11
Telegraph Construction and Maintenance	12	34-37
—— 5 per cent. Bonds	100	103-106
Waterloo and City Railway, Ordinary	8	10¾-11¼
Westminster Electric Supply, Ordinary	5	15-16
Yorkshire House-to-House	5	8¼-8¾

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NOTES.

Physical Society.—At the meeting of the Physical Society to-day (Friday), the papers to be read are on the "Perception of the Difference of Phase by the Two Ears," by Dr. A. A. Gray, and on "The Isothermals of Isopentane," by Mr. Rose-Innes.

Publications Received.—We have to acknowledge the receipt from the Massachusetts Institute of Technology of the current number of the *Technological Quarterly*. From Cassell and Co. comes Mr. P. N. Hasluck's "Dynamos and Electric Motors"; and from Macmillan and Co., Mr. Lewis Wright's "Induction Coil in Practical Work." These we hope to notice in due course.

The Cinematograph.—Another cinematograph fire is reported from Paris. It took place in an establishment on the Boulevard Poissonnière, and occurred through a mistake of the youth in charge of the apparatus. The immediate flare up caused a stampede on the part of the 20 persons or so who were waiting to see the pictures, and the operator also fled. The fire was soon extinguished, and no accidents occurred.

Correction.—It is regretted that in the fourth line from the end of the summary of Mr. Tremlett Carter's speech at the Institution of Electrical Engineers on May 13 (p. 659 of our issue of May 21), the words "reduced for" got printed as "reduce the." This, of course, makes the sentence in which it occurs meaningless, but it is hoped that our readers had no great difficulty in seeing what was intended all the same.

Permanent Magnets.—Some time ago Dr. Carl Barus, writing in *Terrestrial Magnetism*, was most particular in enforcing the rule that where great permanence of magnetism is the principal desideratum, rods tempered glass-hard should not be used as essential parts of magnetic instruments What Dr. Barus recommends is to steam your magnet for a day or two, or even longer if it is a big one. Steam at 100 centigrade seems to atone for a quantity of errors.

Obituary.—Mr. John Ramsbottom, of the London and North-Western Railway, died on the 20th inst. at Fernhill, Alderley Edge, in his eighty-third year. Mr. Ramsbottom gave his name to the system of laying water-troughs between the rails, from which engines can pick up water when travelling at a high speed. This was introduced by him on the North-Western, to which it was for long practically confined. Quite recently, however, it has been taken up by the Great Eastern and several other lines.

Acetylene in the Laboratory.—A proposal in connection with the use of acetylene in laboratories, made by Mr. H. G. Söderbaum in the current number of the *Berichte*, has been reproduced in *Nature*. It appears that the gas can be employed for the quantitative precipitation of copper in ammoniacal solution, and for its separation from metals like zinc, which are not precipitated by ammonia. Acetylene is said to possess the advantage over sulphuretted hydrogen, which is usually employed, that it yields a precipitate which can be filtered and washed very rapidly, and which does not easily become oxidised and pass into solution.

Lightning.—Either the lightning conductor is not erected or, being erected, for some reason does not act. In Essex this week there was a case where rather more than the usual amount of damage was done. On Tuesday, St. Clement's Church, at Leigh, Essex, was struck by lightning. The turret and belfry were entirely wrecked, and the church was filled with smoke. The clock was demolished, and the *débris* blocked the steeple stairs. Three large stained-glass windows were smashed. The damage is estimated at £1,000. The flag turret remains unsafe, and the whole of the ivy on the north side of the church was completely burned.

The Spacing of Poles.—Messrs. Stark and Schwarz have been saying in the *Elektrotechnische Zeitschrift* that in Germany they do not place their poles at the most economical distance for overhead lines. The usual distance between poles is smaller than is necessary, and it is quite worth while to make calculations very carefully to show the best distance. Obviously, a general solution of the problem cannot be given, and it is quite possible that they may be right in suggesting that there is room for the consideration of every line, if not every pole, on its own merits instead of merely following the rough-and-ready rules which practice has shown to come well within the limits of safety.

Current from Coal Direct.—The New York *Electrical World* publishes regularly a digest of current electrical literature. On counting up all the original articles bearing on direct production of electricity from fuel which were considered worth notice during the last four years, it is found that there were no less than 120 of them. Our contemporary's "digest" is a very good one, but it is certain that it does not include every electrical publication in Western Europe, not to mention what may come from Russia and Japan; so it may fairly be presumed that these 10 dozen are not all the important contributions to the subject that have appeared. And yet we seem little nearer to the desired result than ever we were.

The Glasgow Telephone Dispute.—In the House of Commons last week, Mr. Faithfull Begg asked the Secretary to the Treasury, as representing the Postmaster-General, if he could state the exact form of enquiry which would be held in Glasgow in connection with the request of the Corporation for a telephone license, and their complaint regarding inefficient service against the National Telephone Company, and when the enquiry would be held. Mr. Hanbury replied that, as the Glasgow Corporation now appeared to think any enquiry unnecessary, it was, of course, unnecessary to state more than he had already stated—namely, that the Government were willing to agree to a public independent enquiry into the complaints made by the Corporation. This is a very pretty House of Commons way of answering, but what is going to be done in the matter? And if nothing, why not?

The Workman's Compensation Bill.—For various excellent reasons, the *Electrical Engineer* in general avoids dealing with questions which have become a matter of party politics, but it is no violation of this rule to call attention to a long and important letter to the *Times* on the subject of the Workman's Compensation Bill. The writer is Mr. G. Blake Walker, the president of the Midland Institute of Mining Engineers, and the letter deals with considerations which, whether or not Mr. Walker's views are well founded, should not be shirked because it is supposed that they belong to a class of subjects on which it would not pay politically for either party to speak out. The subject is discussed from the point of view of the coal-mine, but the underlying principles are the same in an engineering or any other works.

Word Counting.—It is part of the mission of Mr. Henniker Heaton to endeavour to prevent the post and telegraph people thinking too much of themselves and the wisdom of their ways. He has been asking the Secretary to the Treasury, as representing the Postmaster-General, whether, as he had consented by special official notification to charge "shan't" as one word and "mother-in-law" as one word, he would so far relax the rule as to permit

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"Charing Cross" to go as one word in telegraphing; and whether he was aware that "Kentish Town," a postal and telegraph office, was charged two words in a telegram, but "Woodford Green" was charged as one word. Also he wanted to know why "stepfather" was charged as two words and "grandmother" one? Mr. Hanbury had practically nothing better to say in reply than that the anomalies were the result of concessions. Now what the public wants is not "concessions" nor to save an occasional halfpenny, but a little commonsense and a reasonable rule that anyone can remember.

Openings.—The Blackwall Tunnel was opened on Saturday. Our special humorist says it ought to be called the Whitewall Tunnel, because it is all glazed white brick; but that is another story. When the Prince of Wales went to open it, the chairman of the London County Council presented him with a golden key. It is a matter of art to open a gate on horseback; when seated in a carriage the physical difficulties are insuperable. So the chairman had to open the golden gates himself. At Sheffield the day before they did things in a different way. There the Queen went to open a new town hall. "The gold key, attached by an electric wire to the lock in the gates, having been handed to the Queen by the chairman of the Building Committee, she touched the handle with her fingers, and amidst loud roars of applause the gates flew open." At Blackwall the long vista of the incandescent lamps is rather fine, but in their present state the insulated wires, showing black and ugly against the smooth white walls, do not improve the appearance of the shapely arch. It may be added that, though the tunnel has been declared open for ever, it is now shut again until Whitsuntide.

Motorcarts.—It is stated that about 50 motor vehicles have been entered in the competition for the 1,100 guineas which have been offered by the proprietors of the *Engineer* as prizes in four classes of self-propelled carriages. The motorcarts are now undergoing preliminary trials and inspections by the judges at the Crystal Palace, and will leave the Palace for a "race" to Birmingham on June 1, returning to the Palace within 50 hours for inspection and award of prizes. The judges are Sir Frederick Bramwell, Mr. J. A. F. Aspinall (chief mechanical engineer to the Lancashire and Yorkshire Railway), and Dr. John Hopkinson, F.R.S. The secretary is Mr. H. Graham Harris. According to the Paris correspondent of the *Daily Telegraph*, "something like a revolution in street traffic is imminent," as one of the large cab companies has decided on starting 500 motorcars on July 1, and this is to be but a prelude to other changes in the same direction. The French are in advance of us in the matter of motorcarts, but announcements of this character have been made so often, and so little has followed, that one is somewhat sceptical of the immediate coming of the "revolution."

Running in Parallel.—The New York *Electrical Engineer* says that American electrical engineers are apt to look with complacency on their record of work accomplished in the furtherance of the industry, and while they might well be entitled to a temporary rest from their labours during the past 15 years, questions if they can claim to have brought central-station practice up to its highest state of perfection. It would have been perilous for anyone but an American to have said as much, but our New York contemporary has done it. The particular cause of the remark appears to be the fact that the central-station engineer in the States will not run his alternators in parallel. The majority of American alternating stations, in fact, are running what has very aptly been characterised as a collection of small central stations arranged for the sake of convenience under one roof, each feeding separate and individual circuits and regulated independently of all others. When to the disadvantages of such independent operation within the station are added the inconvenience and the disturbances caused thereby on the outside circuits, it is indeed a matter of surprise that no serious attempt has been made to introduce a different system. However, our New York namesake is going to educate the American electrical engineer into better ways.

High-Frequency Stimulation.—According to the experiments of Prof. D'Arsonval on the physiological and therapeutic action of high-frequency currents when these are kept well outside the range of merely destructive action, among the principal results obtained are the increase in the oxidation taking place in most of the organs. The amount of expired carbonic acid gas is largely increased, and such currents also increase the production of heat in the subject. There is also an action on the nervous system, but not on the sensory nerves. The currents penetrate deeply into the interior of the body, and are not localised on the surface. They are not felt, as the wave period is too short for the nerve to transmit. The immense alteration in the tolerance of the human body for alternating currents as soon as their period gets well beyond that of sound waves was one of the most startling results which followed the first investigation of high-frequency currents. That it should be so is comprehensible enough, but detailed experiments are wanted over the region where the change takes place, as it is possible that in this way very valuable information from a physiological point of view may be obtained. Although, as Prof. D'Arsonval has shown, the high-frequency current is by no means without any action on the body, its practical value in medical work seems to be at present as nearly as may be nil.

The Cataracts of the Nile.—The purpose of the cataracts of the Nile is clearly the supply of power for electrical distribution. Only people would give their attention to such frivolous matters as reading and writing, pyramids, obelisks, mosques, canals, and irrigation instead of inventing the dynamo. Prof. Forbes has reported on cataract number one, but there are plenty more behind; and another report from Dongola, drawn up by Mr. Garstin (Mr. Garstin is not a consulting electrical engineer, but the Under-Secretary of State for Public Works), looks forward to the development of the province through attention to natural advantages, such as the cataracts, where the water power may be utilised for the generation of electricity. He says, "considering that the fall of the river between Hannek and Wady Halfa is some 80 metres, and that in the fourth cataract south of Merawi there is a further fall of 49 metres, it requires little technical knowledge to understand the possibilities in the future for the development of this country with such a magnificent source of power lying, so to speak, at hand." This is probably the first time in history that the cataracts have been spoken of as an advantage by anybody except the dervishes, who did not want the British and Egyptians to get up stream too quickly. But, seriously, though there is fall enough, it is a nasty channel, and very hard ground for excavation work. Moreover, there is the difference in the stream at flood time and at low Nile to complicate matters.

The Magnetisation Limit of Iron.—A paper by Mr. Henry Wilde on the "Magnetisation Limit of Iron," read before the Royal Society, begins with a reference to a former paper on the influence of temperature upon the magnetisation of iron, in which was described a method of determining the magnetisation limit of magnetic substances, by which, with a single pole of an electromagnet, a more exalted degree of magnetisation was

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indicated, as measured by the force of traction, than had previously been attained. In the present paper Mr. Wilde says the magnetisation limit of iron, as deduced from these experiments, was 381lb. per square inch of section, and it appeared at the time that the extreme limit was well within 400lb. per square inch. He has recently repeated these experiments with other specimens of iron of different lengths, and has increased the magnetisation limit beyond this. Definite lengths of annealed charcoal iron wire of circular section, 0·57in. diameter, as measured by a micrometer screw gauge, were cut from the same piece of wire, and mounted for suspension over the electromagnet, which was excited by a current of 40 amperes, and the force of traction was measured by the weight required to detach the iron wires from the magnet, with results which are tabulated, and which show that when the length of the iron wire is 0·2in., the tractive force is at the rate of 385lb. per square inch of cross-section. For successive increments of length of 0·2in. up to 1·0in. the force is 385lb., 397lb., 414lb., 420lb., and 422lb., and beyond this length no higher degree of magnetisation was obtained. That the magnetisation limit (422lb. per square inch, or 29·67 kilos. per square centimeter) was virtually arrived at in these experiments was shown from the fact that, when the current transmitted round the electromagnet was reduced from 40 to 26 amperes, the amount of the tractive force remained constant. The paper concludes with the description of an experiment to show that no higher degree of tractive force is be expected from the double-pole method of determining the magnetisation limit of magnetic substances than has been obtained by the single-pole method.

Royal Institution.—Last week's Friday evening discourse at the Royal Institution was delivered by Lord Kelvin on the subject of "Contact Electricity of Metals." Dr. Frankland was in the chair, and, among others there were Lord Rosse, Sir Frederick Bramwell, Sir James Crichton-Browne, Dr. Huggins, Mr. Crookes, Prof. Fleming, Captain Abney, Prof. Dewar, Prof. Hughes, Prof. Ayrton, Mr. W. H. Preece, Sir Henry Roscoe, Prof. Rücker, and Mr. Ludwig Mond. The audience was indeed a very large one. Lord Kelvin exceeded the customary hour of a Royal Institution discourse by something very like 50 per cent. What he said forms the subject of another note. The Friday following a Royal Society conversazione is often not a bad one for exhibits in the library. In the case of last week, however, the most noteworthy exhibit was Mr. Kamm's "zerograph." This is a telegraph instrument with a typewriter keyboard. It "types" the message at both the sending and receiving end, which seems giving hostages to fortune in the matter of errors in transmission. The machine is just a little too complicated for description in three lines. It takes two current impulses for each letter or character to be recorded. The first current starts the synchronous motion and the second current stops it. All the necessary mechanical actions are brought about by electromagnets fed from a local source of electricity. Prof. Hughes was seen examining it carefully. Another exhibit, shown by Mr. Goold, was an interesting demonstration of the overtones in the vibration of steel bars. To-night we are to have Prof. Moissan, and next week Mr. Preece is to discourse on the Marconi telegraph. It is noticeable that Mr. Preece calls it "signalling" through space without wires, not telegraphing. The word telegraph once meant any signalling apparatus which would send a message. The approved design was a highly developed form of semaphore, like a railway signal with a joint in the arms. But the word has now become specialised by two generations of use, and it is well to keep it for the current in the wire and let the wave going unconstrained in the dielectric, whether it be long or short, come under the classification of signals.

The British in Canada.—It has been already stated that for the Toronto meeting of the British Association the Local Executive Committee have issued a large number of invitations to foreign scientific men. Many of these have been accepted, and it is believed in the Dominion that the meeting will not fall behind any meeting held in the United Kingdom. As might be expected, American scientific men will be present in large numbers. The presidents and members of the staffs of Clark and Johns Hopkins Universities and of the Universities of Pennsylvania and Chicago will attend, and the Botanical Society of America, the American Association of Teaching Engineers, the American Mathematical Society, and probably also the Geological Society of America, will meet in Toronto on August 16 and 17 in order to enable their members subsequently to join the British Association. The dates of other meetings, not at Toronto, but as close to it as the Canada line will allow good Americans to get without leaving the States, have already been given. The interest felt in Canada is something more than scientific, and nearly every Canadian public man of any eminence will be present. It is realised that the occasion will be one to demonstrate to Europe in general and the mother country in particular the increasing importance of the colony. The Governor-General will be present at Toronto, and his Excellency and Lady Aberdeen will give a reception to the members of the association in the new legislative buildings. Another reception will be given by the Hon. G. A. Kirkpatrick, the Lieutenant-Governor of the Province, and Mrs. Kirkpatrick. It is arranged also to give a public dinner in honour of Lord Lister, Lord Kelvin, and the president-elect of the association, Sir John Evans. As to the excursions, the Canadian Pacific Railway Company, it is now ascertained, will give first-class return tickets from Toronto to the Pacific Coast for about £13, and the journey may be made at any time between July 1 and October 1. This is less than the single fare. Even in these days the people on this side are not numerous who have seen the North Pacific, and it is probable that nothing but the amount of railway travelling that it takes to get to its shores will make the European realise the size of the Canadian Dominion.

Discharge in a Gas.—In the *American Journal of Science* for this month there is a short article by Mr. Trowbridge, describing some experiments on the resistance of spark-gaps. In a former number experiments were described, which led to the conclusion that the chief resistance in a highly rarefied medium is at the surface of the electrodes, and when this is overcome the passage across rest of the medium (the author says the ether) offers but little resistance. Various conclusions follow, some of which will be hardly accepted without dispute. It is concluded that at least 100,000 volts are necessary to produce the Röntgen rays. The discharges in the experiments were oscillatory when such rays were produced, and the energy at the moment of emission of the rays was not far from 3,000,000 h.p. acting for one-millionth of a second. No difference of resistance was found between a 6in. spark and one of 3in.; and the compression of air to four atmospheres made no difference in the resistance, nor differences in the material of the gas. The difference of resistance between spheres and points or planes seemed inappreciable, and heating the gap made no change in the resistance, nor did a magnetic field affect it. It is contended, therefore, that it might be maintained that a lightning discharge a mile long under certain conditions encounters no more resistance than one a foot in length. (That Ohm's law does not apply

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without modification to spark-gaps is well known, but this is carrying things to very great lengths indeed.) In the author's view, disruptive discharges are of the nature of voltaic arcs, each oscillation being an arc, and a minute spark precedes the formation of it. In fact, the medium is first broken down and the arc follows. Something of the same kind is supposed to occur in the vacuum, and, further, that under very high electrical stress the ether breaks down and becomes a good conductor. So far as is known, the basis of experimental fact seems hardly strong enough to bear the weight of all this conclusion. At any rate, before talking of "ether" it is well to specify its properties. Assuming that conduction is something analogous to a slip, it is of course possible to specify of a hypothetical substance that this should occur under extreme pressure, just as a solid goes when the limits of elasticity are passed. But ethers of this sort are not much use for the only purpose for which there is any demand for them—namely, to reduce to one simple conception all the laws under which action is found to take place. The ether must be something much simpler in construction than the molecular solid of physics and chemistry.

The Institution.—One has become so accustomed to using the house of the Civil Engineers that it seems strange for the Electrical Engineers to meet at the Society of Arts. The attendance last Thursday was hardly a large one, but the debate was not brief. Mr. Bright began, Mr. Preece followed, and then the stage management, so to say, was at fault, for Mr. Luke came in before Mr. Gadsby. Both these gentlemen wished to speak about the Madras tramways, but the first speaker had the latest information, and the last speaker the fullest description. Mr. Luke, who had not read Mr. Trotter's paper, saw a diagram on the wall which he at once recognised as Madras (Mr. Gadsby had brought it), and concluded that it belonged to the paper, and that the audience knew all about it, so he started off in a considerable tangle. Prof. Ayrton described how he and Profs. Boys and Rücker drove about Southwark, Kennington, and Clapham in a cab taking the magnetic deflection produced by the City and South London Railway. One result, in the form of numberless curves, adorned the reporters' table. Another result, if the writer understood correctly, will be that the three new electric railways to be made in London will use an insulated return. Prof. Ayrton contended that by English law the earth underneath the telegraph company's office in Cape Town ought to belong entirely to the company, and the tramway should not have any right to disturb it electrically or otherwise. The trouble is that the English lawyer has such pedantic notions as to what constitutes a trespass and what is a reasonable remedy. What the view of the Cape Town law is, one would hardly like to state offhand, for that is not English law at all, but Roman law with Dutch modifications and statutory additions; and none of our Colonies which have it would be willing to give it up in favour of English law on any conditions. Moreover, it is subject to appeal to a court which is not specially conversant with it, and would probably go more or less by the light of what its members trained in the law of Scotland thought of it. However, as Sir Henry Mance, who, as he said, is a telegraph man, considered it was not unreasonable to ask a cable company to take its earth a mile or two to sea (he always did so himself), which it appears is all that is wanted, the interesting point of what are the views of Roman law on a subject which it never contemplated, is not likely to be decided. It is to be noted that at Madras the tramway paid without question. Then came Mr. Mordey with his paper. Mr. Mordey has for some time been known to cherish the design of improving the spelling of dynamos. Now he is going to improve the machine also. The new dynamoes are to differ from the old dynamos in having small field magnets, a more complicated armature winding, and laminated carbon brushes. The discussion of these (and probably other suggestions) will wind up the session.

Contact Electricity.—Lecturing at the Royal Institution on the difference of electric potential developed on two unlike metals being brought into contact, Lord Kelvin began with a series of gold-leaf electroscope experiments. He showed that when a zinc plate and a copper plate were brought into contact with one another and then separated, one was charged positively and the other negatively. The effect was much increased by a succession of contacts. Attempts had been made to explain away the experiments as being due to chemical action, and it was said to be the result of the oxidation of the zinc by moisture. The lecturer proceeded to prove that this explanation would not hold by putting a little water on the zinc and copper plates, and showing that if the last contact between them was water the instrument gave no divergence. Another modern explanation of the observation which dated from the time of Volta was the action of the air. But experiments in all sorts of vacuums up to a Crookes tube showed that the air was a disturber and diminisher of the effect; the less air there was the better, and no air at all would be best. For the more delicate work the electroscope was abandoned, a fine quadrant electrometer lent by Dr. Hopkinson being used. It was explained how, when measured against a battery cell, the contact difference of potential was about one volt. Lord Kelvin was very severe on all the text-books, "at least, all the books I have ever seen," for not starting the explanation of the galvanic battery on this basis (surely Lord Kelvin has not forgotten Fleeming Jenkin), and then he proceeded to deal with the problem of where the energy comes from that effects the small redistribution of electricity consequent on the alteration of potential. Various suggestions have been made, the difficulty being in every case that the quantity is so small that you cannot test them by measurement. Lord Kelvin finds the necessary source of energy in the force of the chemical affinity of the copper for the zinc. Prof. Roberts-Austen had shown that the combination of melting copper and zinc developed 36 thermal units. The effects—electrical or chemical action—passed into one another when the distance became comparable to the molecular dimension—that is, at about one hundred millionth of a centimetre. Lord Kelvin also exhibited the curious effect produced by rubbing a glass rod, half of which was rough and the other half smooth, with a cat's skin. One half became positive to the other. This and other differences of potential due to roughness of the surface in two similar substances (rough metal is negative after contact with smooth) he explained on a single-fluid theory of electricity. "If we imagine electricity as a fluid sticking to the surfaces," it was easy to imagine that the projections and sharp edges of the rough surface would part with some of it more easily than the uniform surface of the smooth metal (and presumably, therefore, the latter would carry off an undue share on separation). Reference was made at some length during the lecture to the radiations which are continually given off by uranium, and which, though, of course, very weak, have properties almost similar to the Röntgen radiations. Lord Kelvin preferred at present to assume that there was some chemical action between the uranium and the air to supposing that the energy of the radiation was derived from a transference of heat, which would violate the second law of thermodynamics. The lecture concluded with a disapproval of

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the new views expressed, that the teaching of electricity should begin with the phenomena of the galvanic battery or of electromagnetism, instead of with the older facts of positive and negative electricities, of friction or contact. "I say, get back to rubbed amber and rubbed sealing-wax, and you will have much more scope for seeing into the bottom of electricity than if you begin with electromagnetism," and on this ground he begged physicists generally to take up the reinvestigation of the effects of contact electricity generally.

Arc Light Practice.—Mr. C. Wiler begins a paper read before the Chicago Electrical Association on the subject of arc lighting in America and Europe, with the remark that in America arc lighting was considered a necessity while it was a luxury in Europe. Mr. Wiler gives a general summary of the position. Series arc lighting predominates in America. Arc lighting by constant-potential circuits was developed much later than in Europe, but it has come into extensive use there since 1891, especially in large cities for private lighting. Most of the large direct-current supply stations for light and motive power both in America and Europe use the three-wire system with 220 volts across the outers, in Germany in conjunction with storage batteries. Plants, which serve mainly for arc lighting on the European continent, use the two-wire system with a pressure from 110 to 650 volts. The turning on or off of public street lamps, which are connected with constantly supplied circuits, is mostly done by hand when the area covered is small. When the supply extends over a large area, street lamps are turned on or off from the station or the distribution point. Each circuit, with from 2 to 12 lamps in series, is controlled from the station switchboard, or from the distribution centre, where the necessary measuring instruments for each circuit are placed. Alternating-current arcs are coming into a more extensive use, especially in the European Continental countries, where this method is no longer regarded as much inferior to direct-current lighting. The success is to some extent due to moderate frequencies, to the use of the very best carbons, and to the prevailing tendency of using lamps with a very fine adjustment and slow feed. Alternating street lamps are connected in America with an individual transformer, the secondary voltage of which is 30 to 40, the primary mostly 1,000 or 2,000. This does not require a great amount of wire, allows an economical distribution over a large area, makes the lamps independent of each other, and avoids a complicated lamp mechanism. It has the drawback of requiring a special transformer for each lamp. When alternating arc lamps are connected with incandescent circuits, the lamp voltage is obtained either by the introduction of sufficient resistance, by a transformer, or by a choking coil. Mr. Wiler, however, thinks very highly of the English practice of rectifying the current for the arc circuits. "The rectifier system fills a long-felt want in England, as is amply demonstrated by its rapid introduction." As to the lamp itself, the clutch and rod is the American standard; the clutch or brake wheel in connection with a gear and a rack rod, the English. The rack, the chain or ribbon in connection with a train of wheels is the standard on the continent of Europe. The arc in American lamps is mostly travelling. The interior of the globe, the lower carbon-holder and the lamp rod are not protected against the weather. With these concessions, a greater simplicity has been obtained than in foreign lamps, which are mostly of the focussing type and encased. English lamps are very simple in construction; those of the other European countries, however, show strongly the hand of the clock-maker. They are often fitted with contrivances which are easily put out of order and are very delicate. In England the electrical regulation of the lamp is mostly mechanically differential, while in Germany, as well as in many other countries, the shunt lamp—fitted with a shunt magnet, which strikes, regulates, and feeds the arc—has displaced the differential type to a great extent. There are a few remarks on carbons and globes, and a table compiled by Blondel in 1895 is reproduced.

Electric Railway Possibilities.—At a recent meeting of the Chicago Electrical Association, Messrs. Hayward Cochrane and E. J. Swartout read a paper on the "Requirements of High Speed and Heavy Electric Traction." The paper consisted mainly of the authors' opinions on the most practical results possible in this direction. The authors proceed upon the assumption that electric traction on railways should follow the methods of steam traction now in use, and that each train should be hauled by an electric locomotive, while the remainder of the train is made up of passenger carriages or goods wagons, instead of following the analogy of the tramway, where it is either every vehicle carries its own motor, or at the utmost one has the combination of motorcar and trailer. The latter system ought to be the most economical, but the former is almost a necessity of the case if, as some people believe, the next great field of electrical engineering is to be the adaptation of existing steam railways for electric service. In America, interest in the subject is very general, and the discussion of ways and means for the application of electricity to railway working is bringing out a number of suggestions which will take form later in practical use. The American idea is apparently to use electrical traction for branch lines. On this side of the water we are considering it for the suburban ends of lines which carry a heavy traffic through tunnels, and where its adoption is not so much a question of economy as ventilation. In either case it would seem that the electric locomotive, which can be attached to the existing rolling-stock, is the only thing that meets the case. The New York *Electrical World*, however, in commenting on Messrs. Cochrane and Swartout's paper, doubts whether this is the best method under all circumstances, and points out that "as long ago as 1886 Mr. F. J. Sprague advocated the use of motors on each truck—or at least upon each car of a train—the whole to be controlled from one point by some simple system of manipulation." It appears that Mr. Sprague will have the opportunity to put this method to a practical test in the equipment of the South Side Elevated Railway in Chicago. Our contemporary, after remarking that long lines cannot be operated economically by a direct-current system, doubts if any form of alternate or multiphase current motor now in the field lends itself to the demands of traction service. The method proposed by Messrs. Cochrane and Swartout contemplates the installation of a rotary transformer on each locomotive, with direct-current motors on the axles. The efficiency of such a system could not be very high when the loss in three transformations is reckoned. What is wanted is a system of transmission practicable over long distances, and such a one might be more available for railway purposes than a more efficient system which was limited in range. Such a long-distance system would permit the installation of the generating station in the most economical situation, would frequently allow the use of water power where that is available (that need not be counted on in this country), and in many cases would be able to utilise coal at the mines. The cost of delivered power under these circumstances might be brought within the limits imposed by competition with steam-worked lines.

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THE CIVIL ENGINEERS' CONFERENCE.

The opening meeting was held in the Town Hall, Westminster, on Tuesday last, when the president, Mr. J. Wolfe Barry, addressed an audience numbering about 800 gentlemen. We are indebted to the *Standard* for the following report of the president's speech: "After a few words of welcome to those present, and of special congratulation to those who had just completed the Blackwall Tunnel, he glanced at the history of the institution since its formation in 1818. He continued: It can now be truly described as a body which is representative of every walk of our many-sided profession in every part of the globe. Thus its ramifications extend not only to every city and town of the United Kingdom, but its members and representatives are to be found in every country to which British enterprise has extended. From the small beginning of 1818—which had not attained to a growth of 200 members of all classes in 1828, who, from the difficulties of intercommunication between different parts of these islands, must have been mainly, if not exclusively, Londoners—we have increased by leaps and bounds so that we now number 6,200 members, associate members, and associates, and 900 students, making a total roll of 7,100. It is not too much to say that in this past 60 years a new and most important profession has arisen, second to none in its responsibilities and in its value to humanity at large. A little more than 5,000 of our members are in the United Kingdom and 2,000 are abroad; and, as almost all the students and most of the associates are to be found at home, we may probably say that, of our corporate members now carrying on their profession, from one-half to one-third are in our colonies or dependencies or in foreign countries. Of the 5,000 members, associate members, associates, and students in the United Kingdom, 1,950 of all classes are living or practising in the Metropolis. In many of the great towns of the kingdom we have important local associations directly connected with the institution, through well-intended and highly-successful efforts to benefit the students of our professions. The number of members and associate members in the various local associations is as follow: Birmingham and the neighbourhood, about 200; Glasgow, 150; Manchester, 200; Newcastle-on-Tyne, 120; Leeds, 150. All these associations, while mainly established for the benefit of the students, occupy in other respects important positions, and are very loyally and pleasantly devoted to the best interests of our institution, while fulfilling the interesting purpose of assisting the local students by their support, advice, and guidance. Though we are largely cosmopolitan, we cannot but be very sensible of the great value of our metropolitan headquarters or central home of the whole body. Experience has amply proved how much our absent brethren turn to it for advice, for reference, or for the support of their views and interests, how ungrudgingly they accord to the council of the institution their loyal co-operation, and how freely they place at its disposal the benefits of their local influence and knowledge. Without this mutal interdependence, the institution would be but a poor representative of our profession; and itshould be the aim of us all to strengthen and increase the bonds which now unite us in the knitting and development of which so many past presidents and councils have taken the greatest. It is with the view of further strengthening the bonds of union that the congress of this year has been instituted; and I venture to hope, not only that it will have the results which we all have so much at heart, but that it may be the precursor of many more annual gatherings of a similar nature. It is a new departure, and we have much to learn with regard to conducting it to the best advantage, both for the important objects which we have in view, and for the convenience of the members who attend it. It may interest you to know that 800 members have expressed their wish to be present at the meetings, and of these a very large part are country members. I think the above number does not adequately represent the actual number who may be expected to be present. Apart from visits, our desire has been to encourage by means of short papers read at the meetings of the sections an interchange of ideas and the imparting of the most recent information on all the multifarious subjects which together are included in the expression civil engineering. Thus we have found that seven sections naturally present themselves as indicating that amount of specialising which in practice our profession finds desirable. In a congress of this sort we must specialise, if we are to be useful; but, of course, it will be understood that it is hoped and expected that in attendance at the various sections there will be a considerable amount of overlapping, so that persons may attend those meetings at which subjects which interest them are to be discussed, whether those subjects are or are not those to which they have specially devoted themselves. The sections into which the congress is divided are as follow: (1) Railways; chairman, Sir B. Baker. (2) Harbours, Docks, and Canals; chairman, Mr. Harrison Hayter. (3) Machinery and the Transmission of Power; chairman, Sir Frederick Bramwell. (4) Mining and Metallurgy; chairman, Mr. Forster Brown. (5) Shipbuilding; chairman, Sir William White. (6) Waterworks, Sewerage, and Gasworks; chairman, Mr. James Mansergh. (7) Applications of Electricity; chairman, Mr. W. H. Preece. The list of the vice-chairmen and honorary secretaries, all of whom are specially qualified for the work of each section, will be found in the printed notices. The papers to be read at these various sections are all short, and each is to be looked on more as introducing a subject for discussion than an exhaustive dealing with the matter in hand. The idea which we have had in view is to encourage by all means the conversational interchange of ideas and knowledge rather than any set debates. I think that we engineers as a body are always ready to give our brethren the benefit of any experience or knowledge which we may have happened to gain. I do not think that ours is an acrimonious profession; we may have our contests before tribunals of various kinds, but I think we are free of mean jealousies and of what I may almost call the crime of importing personal animosities into our professional struggles. Dr. Johnson says, "Knowledge is of two kinds; we know a subject ourselves or we know where we can find information upon it." I think this congress will be useful in the direction of both these descriptions of knowledge, and that nothing can be better for those who are facing new problems than being able to meet and discuss their progress or their difficulties. Again, we have thought that a congress would be very beneficial as bringing about an acquaintance with the personality, as well as with the work, of so many who up to now have not had the advantage of meeting each other. I should like it to be distinctly understood that any repetitions of this congress, so far as my views and the views of the present council are concerned, will be like this--namely, a metropolitan congress. It is not intended to be a peripatetic congress, meeting this year in London, and another year elsewhere. The object which we have had before us is to bring those who live out of London into London not to take Londoners and others elsewhere. I think any other object would be undesirable. London is so large that it is naturally the centre to which all local associations can occasionally turn with advantage to themselves and with manifest benefit to Londoners. Further, it contains what I have justly termed the home of the institution, associated not only with so much of present interest, but still more with the important memories of the past—with Telford, Walker, Rennie, the two Stephensons, Brunel, Locke, Vignoles, and others who have gone before us, and with so many of the fathers of the profession who, happily, still adorn our society. The home, further, contains our unrivalled library and a fund of engineering information. Lastly, by arranging the congress at the usual time for our annual conversazione, we are able to meet socially and to show some hospitality to our brethren. All these considerations point, in my opinion, unmistakably to London as our rallying point, and I see no reason for any other arrangement. I hope in this opinion I am in agreement with the views of those who are here and who have considered the subject. It is no part of my duty to occupy you any

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longer, and, therefore, with these remarks, let me once more speak to everybody a word of hearty welcome, and permit me now to dismiss you to the work of the various sections, with the earnest hope that this congress may be a conspicuous landmark of the progress of our noble profession and in the usefulness of our institution, which has had, and I am persuaded will have, so fine a career of usefulness.

The Transmission of Power by Electricity.

BY WILLIAM HENRY PREECE, C.B., F.R.S., VICE-PRESIDENT INST.C.E.

The utilisation of the waste energies of nature is the highest function of the engineer. Millions upon millions of units of energy are being expended on rending rocks, on grinding stones, on changing river beds, and on carving the surface of the earth into hills and valleys. Their transport to centres of civilisation means not only the permanence of the structure of the face of nature, but the exercise of true economy. The relative merits of the different modes of transmitting power can be determined commercially solely by the arbitrement of £ s. d., and scientifically by their relative efficiencies—that is, by the ratio in each case of the power utilised at a distance to the total power delivered at the source. Supposing we have available at some convenient spot, at all hours and seasons, 100,000 gallons of water falling every minute 45ft., it will be capable of delivering 1,000 kilowatts (1,340 h.p.). If electricity is generated from this power there will be wasted :

	Kilowatts.
In the turbine	250
,, dynamo	60
,, circuit	15
,, motor	50
Total	375

So that of the 1,000 kilowatts delivered by the water, 375 kilowatts are wasted and 625 kilowatts are utilised at the final point of application. The total efficiency is therefore 62·5 per cent. It is quite clear that the energy wasted in the circuit is to be eliminated only by taking materials to the fall and establishing factories there. But the transport of material may cost more than the waste in the circuit. Hence, we have to compare the cost of transport against the cost of the upkeep of the line and the value of the waste of energy in it.

There are three effective modes of transmitting power—electricity, water, and air. What we have broadly to discuss is their relative efficiency. How much of the total energy available at the initial or generating point can be delivered at the final or useful point? In other words, how much have we lost in transit and conversion? What price can we get for our commodity as delivered, and what profit do we make on the transaction? Each method of transmission is limited by the strength of materials, the loss of energy, the heat generated and physical difficulties overcome, the dangers to person and property, the capital expenditure, and cost of transmission and delivery. Now it is the peculiarity and value of electricity as the medium of transmission that the energy wasted on the line can be kept a constant quantity independent of its length, but the cost of upkeep must of course increase with its length. Hence, the principal item we have to consider is the upkeep of the line and the capital that has to be expended on its erection. A main of copper of one square inch sectional area carrying 1,000 amperes would waste in heating up the conductor one kilowatt (or 1½ h.p.) in every 40 yards. If it carry 500 amperes, it would waste the same energy in every 80 yards; and if only 50 amperes be used, in every 800 yards. Hence the value of reducing the strength of the current. It is entirely under our control, for the weight of copper in the mains for the transmission of the same power with the same loss varies inversely as the square of the pressure. One thousand volts will deliver 1,340 h.p. (1,000 kilowatts) through a square inch main at a distance of 5·6 miles, but with a loss of 50 per cent. of the energy generated. Ten thousand volts will deliver the same power at a distance of 27·5 miles, and 20,000 volts will deliver it at 110 miles, with a loss of 2·5 per cent. At shorter distances the waste can be reduced still further. The pressure applied, as in water, is limited by the strength of materials, and to the stresses brought to bear upon them. It is difficult at present to insulate more than 20,000 volts. Indeed, the maximum pressure used in England and Germany is 10,000 volts, while 6,000 volts is the apparent maximum in the United States of America. Were it practical to use higher pressures, it would be possible to deliver power by electricity at distances of about 200 miles from the place of generation, so as to compete favourably with steam. But with the present price of coal in this country, and with practical pressures, the radius of economical delivery does not exceed 40 miles. The same argument applies as much to the actual transmission of the water itself, from the fall to the convenient spot where its energy is extracted, as it does to the transmission of the energy in the electrical form from the points of transformation to its delivery at the point where it is applied. The distance to which it is practical and economical to transport energy is thus controlled by the cost of generating energy at the given point of application, and this depends on the price of fuel at that spot. Coal is thus the predominant element. Egypt is a typical case of the possibilities of the transmission of power by electricity. On the Nile there are at Merawi and Wady Halfa magnificent cataracts where immense quantities of energy are running to waste. Is it not possible to utilise this waste energy in Cairo or its neighbourhood? Certainly it is, but at what price? How will it compare with the cost of fuel from England? There are many instances of economical and successful utilisation of water power in the United States and Canada. The following is a list of a few typical instances :

Place.	Power-house. H.P.	Power-house. Kilowatts.	Distance in miles where utilised.
Niagara	20,000	15,000	21
Sacramento	11,000	8,250	24
Ogden	11,000	8,250	36
Big Cottonwood	7,000	5,250	14
Concord	5,000	3,750	4
Portland	4,600	3,500	12
Fresno	2,300	1,700	35
Quebec	2,200	1,650	8
San Francisco	1,000	750	12

There is a remarkable example of successful transmission of power in Italy, from Tivoli to Rome, a distance of 18 miles; 50,000 gallons of water per minute falling 160ft. at Tivoli are equivalent to 2,400 h.p.

75 per cent. of this = output of turbine... = 1,820 h.p.
90 per cent. of which = output of dynamo = 1,620 h.p.
18 per cent. of which = loss on line ..... = 292 h.p.
Making delivery at Porta Pia..... = 1,328 h.p.
90 per cent. of which is utilised in Rome = 1,196 h.p.

Thus 50 per cent. of the power of the waterfall at Tivoli is used in Rome. Switzerland teems with successful installations, and there are numerous examples in Germany and in France. At Foyers, Worcester, Keswick, Windermere, Lynton, electricity is obtained from water power, but in no case is any great distance covered. At Worcester the Corporation have established their generating station for lighting the town some two miles away on the River Teme, a tributary of the Severn. Here some 250 h.p. is obtained from a 10ft. fall, and the advantages obtained through the reduction in generating costs have fully justified the experiment. The cost of generating per unit was under 1½d., although it was necessary to generate 200,000 units out of a total of 333,000 from coal. The net cost of generating the units produced from the water was under 0·8d. per unit. It has been proposed to burn coal at the pit's mouth and to transport the energy extracted as electric currents to London. So far as can be seen at present it is cheaper to transport the coal. The cost of coal does not form the sole charge in producing electricity. Management, labour, repairs, depreciation, and interest on capital expended are much more important items in steam plants. Assuming that it is required to transmit 1,000 kilowatts, and that the total annual quantity of energy transmitted is 3,000,000 kilowatt-hours—an amount of electrical energy easily produced from 5,000 tons of coal. If the cost of transporting coal 100 miles is 5s. per ton, the annual bill for transport will be £1,250. This represents only 0·1d. per unit produced, and is less than the interest on the capital required to be expended on the construction of the line.

Power in Cities.—In most of the cases mentioned above it would have been probably impossible to transmit power otherwise than by electricity, but when the transmission of power by electricity is considered in relation to the supply of power to the inhabitants of a town, to railways and to tramways, to various separated portions of machinery, such as in large works, on board ship, in coal and other mines, the rivalry of other methods is encountered.

The advantages claimed for electricity are ease and cheapness of distribution, facility in application to nearly every type of machinery, efficiency in generation and in transformation to power, cleanliness and safety, reliability and convenience for repairs. As an illustration of the transmission of power in large cities, let me take London as the best example, and assume that it is desired to work both the metropolitan railways by electricity. Clearly the power-house should be on the river bank, for we must be dependent on coal, and we should be where coal is cheapest; but whether the coal be used direct as fuel, or converted into gas first by the Dowson or Mond process is a matter for consideration foreign to this discussion. Mr. Humphrey (March 16, 1896) estimated that by the use of the Mond gas-producer plant, it was possible under certain circumstances to produce a kilowatt-hour for 0·184d., and this could be easily distributed and applied on a coach on the railway for a cost not exceeding 1d. per unit.

For Workshop and Home Use.—The horse-power lost in

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shafting is little known. Mr. C. H. Benjamin, of Cleveland, tested 16 different factories of all kinds in that city. He found that from 50 to 80 per cent. of the horse-power developed was absorbed by the shafting before it reached the machine where it was to be utilised. For small powers the horse from the point of convenience beats everything. But its food corresponds with the "waste" of other systems, and though, if we regard its efficiency in converting fuel into energy, it stands, perhaps, at the head, yet the price of its food and the waywardness of its health makes it the least efficient of all machines in a commercial and economic sense. Oil and gas for small powers are more convenient, but not so economical as steam, while electricity, if it can be supplied at 1½d. per kilowatt-hour, is the most convenient and economical, for it is always ready if supplied from a central station. It requires no boiler: and it is accompanied by no danger. It is handy; it is placed where it is wanted, and used only when it is wanted. You pay only for that which you have used. It is useful not only for small trades, but it is invaluable for domestic purposes, for sewing-machines, ventilation, pumping, cooling, lifting, and for many other purposes. It is, however, but little used in England at present. High prices, ignorance, and fear have kept it in the background; but it is rapidly and successfully coming to the front. The efficiency of the dynamos which transform energy into electricity and the efficiency of the electric motor which transforms electricity into power are unequalled. Dynamos and electric motors are now commercially made at moderate prices with efficiences of from 94 per cent. up to 96 per cent. Broadly speaking, it may be said that there is no practical difficulty whatever in transmitting energy to great distances by water, oil, coal, gas, air, or electricity. Their relative merits depend first on their relative efficiencies in production and application, but their financial success depends solely on the cost of transport. There are many cases where each must be paramount. There are others where the balance is questionable and where other conditions, such as space, convenience, cleanliness, safety, silence, must be considered. Electricity, however, bears the palm for long distances.

The Transmission of Power.

BY JOHN HOPKINSON, JUN., M.A., D.SC., F.R.S.

The section of the subject of the transmission of power upon which I have been requested to address a few remarks to the section is one with which I find it extremely difficult to deal. All other methods of transmitting power than by electricity and water is an extremely large subject which it is really impossible to handle in 10 minutes. Further, it is a subject which is very old and trite, and upon which it is impossible to say anything at all of an original character. In fact, I may say that to Messrs. Preece and Ellington have been allotted in this matter the cream, and to me has been allotted the skim milk. That being so, even though the time during which I shall have to occupy you is so short, I shall venture to touch upon their subjects as well as mine; in fact, to improve the quality of my skim milk by stealing a little of their cream.

The methods of transmitting power which are well known to all of us other than by electricity and water power appear to be those of ordinary gearing and shafting, of transmission by ropes, and of transmission by compressed air or by steam. Consider for a moment the broad characteristics of these five modes of transmission. The losses of energy in four of them are, in fact, very similar, and closely analogous to the ordinary well-known losses by friction. This is obviously the case in water-power transmission, in transmission by gearing, in transmission by ropes, and it is, I think, also the case in transmission by electricity, for the loss by electrical resistance is closely analogous to the loss by frictional resistance; and in the transmission of power by electricity the main source of loss is really by resistance. On the other hand, the losses in the case of transmission by compressed air belong to a totally different class. When the air is compressed it is inevitably heated, and when it expands, doing work at the receiving end of the system, it is inevitably cooled. The heat of the compressed air cannot practically be retained, but it is lost by conduction through the containing chamber and through the pipes which convey it. Again, in expansion the heat of surrounding bodies cannot be kept out of the cool air, and hence results a loss of power which is not analogous to a frictional loss. The methods of diminishing these losses are totally distinct in kind from those which would be adopted in the other four methods of transmission. We must look for them in the direction of avoiding as far as possible the conduction of heat to and from the working material through surrounding bodies, or in some system of regeneration having the same end in view—viz., avoiding the equalisation of temperature by conduction. This peculiarity of transmission of power by compressed air, although it involves very serious losses when applied in unsuitable cases, possesses also particular advantages for particular purposes. I refer to such work as that of tunnelling in such situations as the St. Gothard, the Vorailberg, or the tunnel about to be made on the Simplon route. Here the air which is forced into the tunnel for the purpose of propelling the drills is afterwards used for ventilation, and the fact that it is cooled in doing its work is an additional advantage in cooling the end of the tunnel. These are advantages which are absent from the other four methods of transmitting power, and render it, I think, certain that for this particular purpose compressed air is the method which will be universally employed in the future.

Comparing now the other methods of transmission one is at once struck by the great flexibility of transmission of power by electricity. The electrical conductors can, of course, be taken through all sorts of positions without trouble or inconvenience, and are very easy to repair. Further, transmission electrically can be effected at very much greater distance than can be conveniently done by any other method. It would seem that electricity must be the agent when transmission is to be made to long distances, as from where there exists a great water power to the points at which that power can be used, and in very many cases where it is advantageous on account of its convenience. One sees electricity coming into competition with transmission by ropes or cables, both for tramways and in its use for cranes. For tramways there is no doubt that electricity has practically taken possession of the field on account of its cheapness in all cases except those where the traffic is extremely heavy, or where the gradients are extremely severe, so that there are points at which there would be insufficient adhesion between the wheels and the rails. With regard to cranes, of course all of us are familiar with the type of rope driving which was in use 20 years ago, in which a high-speed rope was used for driving cranes by means of friction wheels. The far greater convenience of electric transmission will, I think, entirely supersede the rope-crane.

Comparing electrical transmission with the use of shafting and gearing, we already see that in many factories power is transmitted electrically, and a large amount of gearing is rendered unnecessary. It has there the advantage that buildings may be constructed and machinery arranged without regard to gearing and shafting. For many purposes, however, electrical transmission has a formidable competitor in transmission by water pressure; each has its own field. It is inevitable that with electrical transmission of power high speeds of rotation must be used, and for many purposes this is inconvenient; for example, for lifts and cranes working at a slow speed. But notwithstanding the fact that there seems undoubtedly to be many places where hydraulic transmission will permanently be better suited to the purpose than electrical transmission, there can be no doubt that there are many cases in which at the present day hydraulic transmission is used which will ultimate be effected by electrical transmission of power. Consider, for example, the case of transmission upon our ships of war. Here we have at the present time, as a rule, transmission of power either by means of water pressure or by means of steam pressure. The consequences of the destruction of a steam-pipe by a projectile would be extremely serious; and in any case the destruction either of a steam-pipe or of a water-pipe would involve a very considerable amount of trouble in repair, whereas the breaking of the continuity of an electrical conductor would be easily and quickly made good. In conclusion, I would remark that in transmission of power electricity acts really as a mechanical gearing. As I pointed out at the outset, the losses are essentially of the same kind as frictional losses, and quite distinct from the losses in transmission either by compressed air or by steam, which depend essentially upon thermodynamic laws.

The Transmission of Power by Water.

BY EDWARD BAYZAND ELLINGTON, M.I.C.E.

These notes have reference only to the high-pressure system of transmission which is now generally understood when the term "hydraulic power" is used, and it is assumed that fuel is required for its production. The most distinctive feature of hydraulic transmission is that a heavy medium is employed, having no elasticity. Velocities must be kept low to avoid shocks and to prevent excessive loss by fluid friction. These characteristics have an important influence on the economy of the central stations. The main engines are kept running with a constant load notwithstanding variations in the draught on the mains. The speed alone varies. There are thus present the conditions of a high efficiency—viz., high pressure, low velocities, and constant load. A hydraulic press is the typical mechanism, and involves the most direct application conceivable of these essential elements. But a simple hydraulic press is not the most perfect application. The motion under full pressure is a small part of the total, and in most presses the efficiency calculated on the work done is low. Maximum efficiency is met with in hydraulic hoists for lifting coal trucks, for here the advantages of non-elasticity and pressure are utilised to their fullest extent, and something like 95 per cent.

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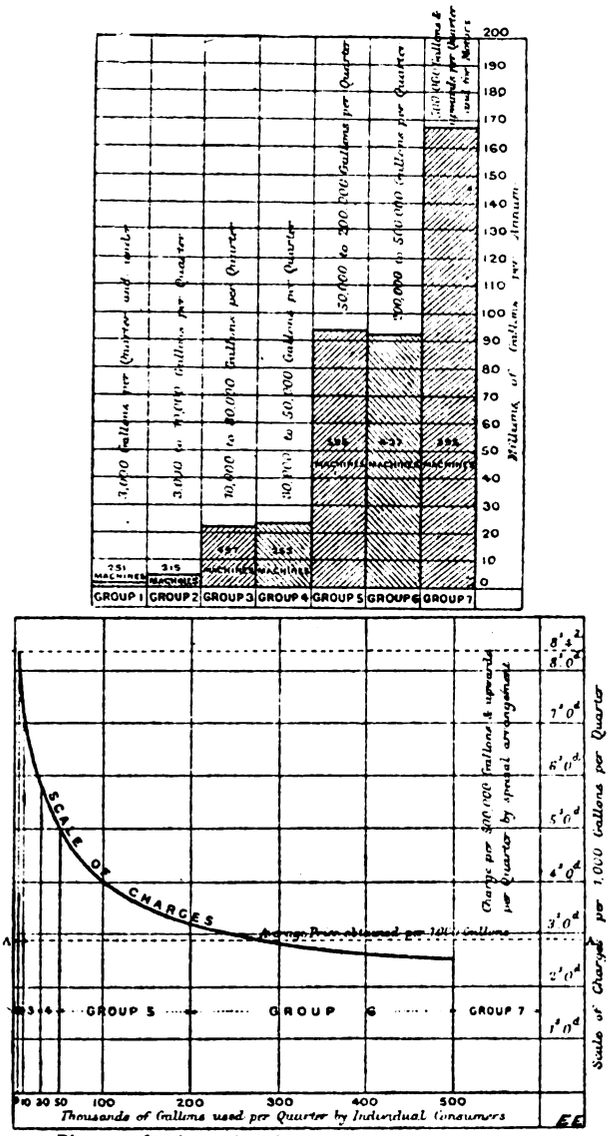
of the power conveyed is converted into useful work. Such machines are little more than reversals of the accumulators at the central station. The efficiency figures for hydraulic transmission are :

Loss at the central station	15	per cent.
,, in transmission, say.....	5	,,
,, in use, say	5	,,
Net power utilised	75	,,
Indicated horse power at central station.....	100	

This efficiency can be realised over an area of, say, four square miles served from one station, but as the designs of the machines vary with the purposes to which the power is applied, the 75 per cent. may drop to 25 per cent., or even less, and when, further, the power is supplied from public mains under a sliding scale of charge, there may be great differences in the actual cost of doing apparently the same amount of work.



Diagrams showing various Groups of Power-Consumers and the Charges for Power.

In order to compare different methods from a scientific standpoint, the precise conditions require to be accurately defined, and the best that can be practically attained under the special conditions assumed. Though no one system of transmission can be pronounced to be absolutely the best under all circumstances, it is clear that in such cases of transmission as are required for lifting and pressing the hydraulic method has many marked advantages. No brake is required. Lifting and pressing are intermittent work. The full pressure and power at command is immediately applied without loss. Thus economy as well as safety is obtained. There is a loss of power at light loads, but they are lifted at an increased speed. Speed has an important bearing on efficiency, and no data are reliable for purposes of comparison without reference to it. It is unusual to work lifts at less than 100ft. per minute, but speeds of 500ft. to 600ft. per minute are often required. Within such limits the efficiency of the same apparatus may vary greatly. There is also the question of the type of machine. Broadly stated, a hydraulic-ram lift, though the safest and simplest and the least costly to maintain, has in most cases a low efficiency. The only reason for the adoption of ram lifts for considerable elevation is their greater safety. Hydraulic power is admirably adapted for pumping and working many machine tools direct, while hydraulic engines and turbines are available for driving general machinery. Their efficiency is fairly high, and the power can be automatically adjusted to the load. A good deal of care, however, is necessary to prevent waste. Hydraulic power is a most valuable adjunct to the ordinary water-mains for fire extinction. Nearly 100 miles of hydraulic mains are now available throughout the districts in London where the most valuable property is situated, and at every point on these mains 500 h.p. could be immediately applied to a fire. In this application of hydraulic transmission the efficiency is low, and the cost per horse-power high, but the apparatus is nevertheless as near perfection as can be obtained.

An important matter in connection with transmission of power for general public use is the proper basis of charge. When it is considered what great differences there are in the cost of creating and distributing power of any kind depending on the nature of the plant and the average output per horse-power provided, the principle of a sliding scale seems *primâ facie* to be reasonable. The diagram shows roughly the sliding scale of charges adopted in London. The line A shows the average rate obtained in 1896 for the quantity sold ; nearly 95 per cent. of the quantity pumped was accounted for, but a good deal was used for various purposes at the central stations. The diagram further shows the quantity of power supplied, and the number of machines at work, the total being divided into seven groups. Forty per cent. of the total was taken at 2s. per 1,000 gallons and under. If an all-round rate the same as the average were charged, nearly the whole supply to the seventh group would cease, as consumers would supply themselves. The 40 per cent. supplied to that group only required 25 per cent. of the maximum pumping plant in use, and at the uniform rate the total plant would produce about 25 per cent. less revenue. The distribution and general charges are together greater than the central-station charges, and the former clearly have relation to the number of services and the number of machines. Notwithstanding the very wide difference in price per 1,000 gallons, the percentage of net revenue obtained is approximately the same at the highest and at the lowest rates, and it hardly seems commercially practicable to transmit power for the general purposes of a town from central stations on any other basis than that of a sliding scale.

What is the rate at which power must be supplied in order to render private producing plants superfluous ? Where steam power is used for hydraulic transmission it is very doubtful whether any private plant is run at a total cost of less than 1s. 6d. per 1,000 gallons at 750lb. pressure, which is the rate from the public mains for 3,000,000 gallons per quarter. While this rate is low for lifting purposes and other intermittent work, it is altogether too high to displace private steam plants for driving general machinery except in special cases. To do this power must be supplied at about one-third the price, or, say, at not more than 1d. per Board of Trade unit. At present this seems impossible. If the central stations were at the collieries, and the coal and water cost nothing, the maximum saving in expenses in the case of the hydraulic system in London in 1896 would have been £5,000, and the maximum horse-power to be conveyed 2,000. The capital outlay required to convey this even 20 miles would render it impracticable. If the Kent coalfield extends within 15 miles of London the problem would assume a different aspect. The experiment must apparently be first tried in the provinces. If the power were conveyed electrically in order that it could be profitably used at the hydraulic power stations in London in place of steam, 2,000 h.p. would have had to be supplied at not more than £2 per horse-power per annum, or, on the basis of actual output, at ¼d. per unit, with a load factor of 34 per cent., nearly the highest factor obtainable with any general distribution of power.

The whole question of transmission of power is dominated by the commercial factor. Every system in practice falls short of its theoretically obtainable efficiency, and is handicapped and confused by the multiplicity of the commercial interests involved. When seeking to obtain the highest efficiency in a given plant, specialisation and complication of parts, initial outlay, supervision, and maintenance are matters of no concern ; but in the long run the pressure of these commercial elements will compel the sacrifice of mechanical efficiency. All systems are more or less useful and necessary in the areas within which power is required. The question of long-distance transmission seems primarily a question of the capital outlay required to convey the power, and the conversion of the most economical power for transmission into other systems required must take place in the immediate neighbourhood of its consumption.

Discussion.

Sir Frederick Bramwell (the chairman), in introducing the discussion, said that the papers had not exhausted by any means all that could be said as to methods of transmission of power. He had in his mind two other systems, the first of which had been

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abandoned. This was the method of transmitting power by exhaustion, which system had been used in some of the London docks. The other method of transmitting power was by gas, which was, perhaps, the cheapest system of any. He would remind those present that in order to get a good discussion, brevity and lucidity were the chief essentials.

Mr. F. J. Sprague said he had devoted considerable attention to the design of electric lifts and elevators, and he did not agree with Mr. Ellington that the hydraulic lift could carry all before it. The electric motor was exceptional in its power to return energy when working with the load. He had in his mind 100-h.p. lifts to deal with loads of from 15,000lb. to 20,000lb. If 50 such lifts were grouped on the one system, and each lift allowed to take up to a maximum of 200 h.p. for an instant, the whole system would never require to be supplied with more than 300 h.p. to 400 h.p., although the aggregate power was at least 5,000 h.p. In this estimate he allowed for 75 per cent. of the lifts being at work at the same time.

Prof. George Forbes remarked that he must necessarily confine his remarks to a few points, as the subjects under discussion were so wide. The question was often asked him, how far did they transmit power at Niagara? In this instance, although a system had been adopted which would enable transmission to a great distance, the company had no desire to distribute their power widely if customers could be found in the near vicinity. The profit from the sale of electricity when competing with coal at 7s. 6d. per ton was naturally greater at a small distance from the station. Hence the local demand had been particularly encouraged, and the company were able to supply electrical energy in practically any form as to voltage, etc. In answer to the question as to what distance power could be transmitted by electricity, he would point out that energy was transmitted through the Atlantic cables, over 3,000 miles long. The real information wanted was, how far could power be transmitted commercially by electricity. In considering that point, so many variables—such as the pressure to be used, the cost of the development of the power, the cost of transport, material, and labour—prevented a uniform conclusion being arrived at. The main factor was perhaps the value of the energy transmitted at the place to which it was delivered. In some cases he did not think 1,000 miles too high a limit. He had been asked if it was feasible to transmit power from the Zambesi falls to the goldfields of Mashonaland and Matabeleland. At the first consideration he had thought the distance too great, but a further consideration suggested new economies from which he had developed a practical scheme. One feature in this scheme was that the gold stamps were worked continuously throughout the 24 hours, and that the power would be very valuable to the gold companies. He had also had a 250-mile transmission scheme before him for the Auckland gold mines, New Zealand. As regarded the Nile transmission scheme, although a preliminary survey had been made, the final surveying party did not start until September. After he had made his report he would be pleased to give figures. He hoped to find that the English manufacturers would rise to the occasion, so that the orders for the large machines required would not have to be placed in America or Switzerland. The following rough summary might be of interest to the members: assuming the capitalised value of the water power to be £10 per horse-power, that copper cost £80 per ton, and that the maximum potential difference between any part of the system and earth was 7,500 volts, he estimated that the first cost of transmitting a horse-power was as follows: 100 miles, £20; 200 miles, £44; 300 miles, £80; 400 miles, £130.

A gentleman whose name we could not catch commented on the development of the distribution of gas on the prepaid system. He said that the Gaslight and Coke Company alone took in their penny-in-the-slot meters nine tons of coppers each week.

Mr. F. Walker said that the inference from Mr. Sprague's remarks was that there was no return of power when using hydraulic lifts. This was wrong, as every engineer who had to do with hydraulic coal tips and docks would know. In fact, where the coal were delivered in a high level, a considerable amount of power was often obtained in this way. Modern hydraulic tools and presses also had arrangements by which idle motion could be effected with low-pressure water, hence giving economy. As regards distance, it was no uncommon thing to find lengths of hydraulic pipes of from five to ten miles in docks. In these lengths a 20lb. loss of pressure was extraordinary. The speaker doubted Mr. Preece's quotation as to the loss of power in shafting—*i.e.*, 50 to 80 per cent. He thought 20 per cent. a more likely figure. Comparative figures as to the cost of coal in the boilers in a large engineering factory equipped with either electrical or hydraulic distribution, would be more valuable than the comparison of the prices charged by supply companies for power.

The **Hon. R. C. Parsons** commented on the results obtained from the different tramway systems of Birmingham, and said that the electric cars had cost more than either the cable or the steam cars. Also he had worked out the costs for a 150-h.p. sewage pumping plant, and had found an hydraulic system at 750lb. the best.

Mr. T. Parker said that Mr. Parsons's figures *re* Birmingham were self-explanatory if the context were known. The electric cars were driven by accumulators, and he considered that the figures obtained over five years' working were exceedingly valuable to the profession. As regards the pumping plant, he could not understand the result. Mr. Parker had put down a plant in the Forest of Dean with electric pumps which were still working, and had given no trouble. He considered that the Blackpool tramway was the pioneer electric tramway, and that an Act of Parliament, and not any want of engineering skill, was responsible for the slow adoption of electric trams in England. In reference to the chairman's remarks, he did not think the gas-engine installation at Belfast had given satisfaction, as steam-driven sets were being introduced for extensions.

Mr. Alexander Siemens found fault with the next to last paragraph in Mr. Ellington's paper. He considered the matters detailed—such as initial outlay, supervision, and maintenance—were of great concern when looking for the highest efficiency. He pointed out the capacity of well-designed electric motors for overload, and mentioned an electric pump which had been at work at Tunbridge Wells since 1874; the only repairs required being a new commutator.

Prof. W. E. Ayrton pointed out that comparison was being made between the costs of a comparatively young system (electricity) with others which had been fully developed for many years. There was no doubt that increased pressures would be used in electrical transmission schemes, and he said that the figures obtained in five years' time would be more truly comparable.

Dr. E. Hopkinson remarked that the question of distribution had hardly been referred to. There were certain branches of engineering to which electric motors were specially applicable, and nothing was more convenient in this respect than a centrifugal pump. In this case no gearing was required. In other instances he had remarked on the large comparative cost of the gear interposed between a motor and its work. This cost often amounted to 50 per cent. of the motor cost. He also referred to the facilities which electricity afforded for speed regulations.

Mr. Mark Robinson commented on the use they had made in their works of electrical distribution, and said that electrical driving of tools was being largely used in their new works at Rugby.

Prof. Barr agreed with Prof. Forbes that no general statement as to the best system in any case could be made. The individual requirements and conditions always needed special consideration.

Mr. Paxman said that he had naturally had a leaning towards the older systems. With coal at 5s. per ton a horse-power could be obtained from a steam engine for $\frac{1}{10}$d., which required a good deal of beating. He did not believe that compressed air would come into general use.

Mr. Arthur Rigg referred to the need in hydraulic engines of varying the water consumption with the output required, and described an apparatus he had devised to that end.

Mr. W. W. Beaumont said that each system had advantages in special cases. In tunnelling work, the increase in volume of the compressed air at the face was exceedingly useful.

Sir Frederick Bramwell, in closing the discussion, gave the following comparisons: with gas at 2s. 9d. a brake horse-power could be obtained for $\frac{3}{4}$d. per hour; with electricity at 4d. a unit the same output costs $3\frac{7}{10}$d., and with water at 3s. per thousand at 750lb. pressure, a brake horse-power costs $4\frac{1}{2}$d.

Mr. Preece then replied, and, after referring to the compressed-air system in use for the transmission of telegraph messages in London, upheld his figures as to the power lost in shafting.

Mr. Ellington also replied to the remarks on his paper, and said that some hydraulic pumps would be tested at the Wapping station of the General Hydraulic Power Company to be visited that afternoon.

Should Generating Plant be Mounted on Springs?

BY JAMES SWINBURNE, M.I.C.E.

This is really part of a larger question: Should moving machinery be mounted on springs? The question concerns both the health of the moving machinery and of the people who may be moved by it. In central stations and in passenger steamers, the shaking caused by machinery is most serious: in flour mills, for example, it is rather a question concerning the gear itself. Perhaps this was a rather exaggerated statement, as the buildings were often damaged by vibration.

If we consider, say, a direct-acting pump in space, it is a system that of course cannot move its centre of gravity as a whole. If then its pistons and plunger move in one direction, the rest must move in another direction, the distance depending on their masses. Any imperfectly balanced machinery must therefore move its bed-plate if freely suspended. A perfectly balanced engine is thus an engine whose centre of gravity never varies relatively to its bed-plate. This definition is really too small, because a moving system, such, for instance, as two cranks at 120deg. on opposite ends of a shaft do not change their centre of gravity, but give the bed-plate a rocking but non-translational movement. A gas-engine with a flywheel, similarly, tends to rotate its bed-plate at each impulse, round an axis parallel to that of the shaft. A balanced engine is therefore really one which does not move its bed-plate if freely suspended. Such an engine is practically never realised.

When an engineer sees an engine bed-plate moving, his first instinct is to bolt it down: it then moves a little less, but still moves, and he has a sort of feeling it must shake itself to pieces if allowed to move. Bolting down an engine to a bed of concrete is merely increasing the size of its effective bed-plate, but the whole bed-plate, including the concrete, must now be moved. It rests on the earth, moves slightly, and communicates vibration to neighbours who are longing to be compensated for disturbance. Sometimes the concrete bed-plate is isolated by mounting it on felt; that means that the larger bed-plate is mounted on rather imperfect springs. A

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rather striking case is that of church bells. Bells are very much out of balance, and the bed-plates are mere cages of timber; so the bed-plates would tend to move a good deal. The bell people do not like to see it move, so they wedge it to the steeple, and the result is a cracked steeple. The consequence is, that you often hear that such a church has a very fine peal of bells, but they cannot be used as the steeple will not stand it. Though this may be a relief to people whose ears are in tune, it might be cheaper not to make bells than to make them and hang them so that they cannot be used.

The question is, if the bed-plate of an engine wants to move, why should it not have free play? As far as the engine goes, a little thought will show that all its parts are subjected to smaller stresses if the bed-plate is free to move. An engine will therefore wear longer if it is allowed to move its bed-plate. As to the foundations, if the bed-plate is allowed to move, no foundations to speak of are needed, and there is no vibration communicated to the ground. The writer has tried this arrangement on a small scale. There is a small dynamotor on one of the top floors of Mr. Crookes's house which is very much out of balance, and rendered the house uninhabitable at first. It is now on springs, and makes no noise. There is also a dynamotor for electrolytic work in the writer's laboratory. It is on springs, and no one has any inkling of a chance of complaining. In passenger steamers the throb of the engine is exceedingly unpleasant; in fact, many people would rather go by a slower boat than travel 21 knots, and be at the same time shaken 42 more knots by his pedometer. Mounting marine engines on springs seems rather a bold suggestion, and perhaps we ought not to begin there. The moving systems are so heavy in proportion to the fixed (or "attached" is the better word) that the marine engine is a particularly difficult case.

The idea of mounting engines and dynamos on springs was mooted by the writer in *Industries* in 1892. The editor, in addition to being a sound engineer, is a man of caution, so the communication came out as an anonymous letter. Mr. W. W. Beaumont has, however, done a great deal of real work on the subject, especially in connection with flour mills. He has introduced his "vibromotor" principle. This principle is simple. "If gear wants to wobble, let it wobble." The idea seems sound; the discussion will perhaps throw new lights on it.

DISCUSSION.

Sir Frederick Bramwell said he was surprised to hear Mr. Swinburne's remarks about church bells. He thought that bell-makers understood their business, and that a separate scaffold inside the tower was usually erected to support the bells; also the axes of the different bells were not arranged parallel.

Mr. Alexander Siemens referred to a gas-engine his firm had put on a second floor in Westbourne-grove 18 years ago. Vibration trouble ensued when the engine was placed on timber balks, but a cushion of two layers of felt and one of rubber stopped the nuisance. It showed what a small amount of spring was required. The idea of springs was worth trying on a large scale. Still, a large number of complaints as to vibration were much exaggerated.

Prof. Ewing said it was customary to teach a student that any machine could be evolved from the simple slider crank chain, by fixing one element of the mechanism. Mr. Swinburne now proposed not to fix any element at all. Of course, however, relative fixing would be employed. If an engine was suspended in a cradle on springs, a certain critical speed would be found at which violent oscillations would occur due to synchronism. To avoid this, it would be necessary to use something between the spring and the machine which was capable of dissipating energy when subjected to a varying strain. A dashpot would do this. An indiarubber galvanometer suspension was a good illustration of what he meant. The imperfect elasticity of rubber quite damped out rapid oscillation. The sleeve bearings on the Parson turbine were another instance on a larger scale. A series of concentric tubes with oil in the interstices supported the bushes in these bearings, and the oil film damped any incipient vibration.

The **Hon. C. A. Parsons** remarked that at the Hotel Cecil the steam-turbine were at first placed on a wood base. The noise could then be heard in certain rooms, and the following course was adopted. Three or four layers of perforated rubber interleaved alternately with iron plates were put under the turbines. The holes in the rubber allowed more damping without affecting the viscosity. In the Manchester-square station there was no need to apply this cushion, as very large foundations had already been put in before the turbines were installed.

Sir Henry Mance thought that too much was made of the vibration emanating from electric lighting stations. He had endeavoured on a still night to find the vibration in the buildings surrounding the Manchester-square station when the old engines were at work, and failed to do so. In fact, the vibration caused by a cab passing was often 20 times greater than any vibration due to engines running. The electrical companies had, in his opinion, been blackmailed in this respect.

Mr. C. E. P. Spagnoletti said that when the electrical machinery was laid down at Paddington they had many complaints from their neighbours. He had investigated the matter with mercury, and failed in every case to get the surface agitated, whereas a passing cab caused a violent motion. He also referred to the peculiar local distribution of vibration in certain cases.

Mr. J. Wolfe Barry described an installation of fans driven by steam-engines which were said to give annoyance to the neighbourhood. He had conclusively proved in this case that the vibration did not come from the engines, but that the air delivered by the fans caused windows to vibrate, which in turn affected the floors.

Mr. W. H. Preece confirmed the last speaker's experience that the air often transmitted vibration to buildings. In a bad case at the General Post Office they had found that the exhaust steam caused vibration in the pipes when a certain number of engines were running. They had stopped the same by putting a large chamber in the pipe, which damped the vibration. Another instance quoted was in connection with the Savings Bank Department in Queen Victoria-street. As soon as the electric plant was started, a lawyer in the next building complained strongly. They noted the vibration with an incandescent lamp, as the filament was very sensitive to any motion. The lawyer agreed, and the filament showed that he had cause to complain. It was found, however, that the vibration did not cease when the plant was shut down, and that the Metropolitan Railway Company was the offender.

Mr. J. Wolfe Barry agreed with Mr. Preece that railways gave trouble in this respect. While he was articled to Mr. John Hawkshaw, he had to investigate this point with reference to the line near the Greenwich Observatory. After experimenting on the effects of various soils on the vibration, they tried a railway running over dry peat in Ireland. This gave very good results, as practically no vibration was transmitted to a distance.

Mr. R. E. Crompton said the question of resonance of certain rooms was always a trouble to engineers, as the effects were altered by moving the furniture round. He did not hold entirely with the idea of spring suspension. They had put the Vienna engines on a layer of some 9in. of springy asphalte, and found the vibration increased. He also referred to some gas-engines somewhat similarly mounted, which gave great trouble owing to the pipes being unable to give to the required extent. As regarded the vibrations transmitted by the air, he had noticed them, but had not been able to measure them by any vibrometer.

Mr. W. W. Beaumont said that the proposed system would be advantageous in many cases. He gave examples of the large forces excited if rigid control was obtained, and said that the forces to be resisted decreased almost as the increase of lateral play. He also reiterated Prof. Ewing's remarks as to the need of some energy-absorbing suspender to damp rapid vibrations.

Mr. Swinburne then replied.

The Application of the Steam-Turbine to the Working of Dynamos and Alternators.

BY THE HON. CHARLES ALGERNON PARSONS, M.I.C.E.

The steam-turbine has been developed into a motor, which utilises steam with a high degree of economy. It possesses considerable simplicity, and as its speed of revolution is high, and it runs with perfect steadiness, it is manifestly a suitable motor for the driving of dynamos and alternators. The first compound steam-turbine directly coupled to a dynamo was constructed in the year 1884. It ran at 18,000 revolutions per minute, and gave 6 e.h.p.; successive improvements were introduced, and it was further adapted to condensing. Within the last five years, direct-coupled turbine-dynamos and alternators of 500 e.h.p. to 700 e.h.p., both condensing and non-condensing, have been constructed and put to work, and at the present time above 30,000 h.p. of these motors are at work in England.

The Compound Steam-Turbine.—The compound steam-turbine of the "parallel flow type" consists of a series of parallel-flow turbines set one after the other on the same shaft, so that each turbine takes steam from the preceding one, and delivers it to the next. The steam entering by an inlet all around the shaft, passes through the successive turbines of gradually increasing area of passage-way, and is expanded by small increments of volume at each turbine, till it arrives at the next series of turbines; these are of larger diameter, and consequently greater peripheral speed and capacity, and they allow of further gradual expansion. The steam then flows to the last series of turbines, where, the expansion being completed, it passes to the exhaust-pipe. The rows of turbine blades are formed of hard brass, and accurately shaped; those keyed into the shaft project outwardly, and nearly touch the case; those keyed into the case project inwardly between the moving rows, and nearly touch the shaft. The turbines are so proportioned that the steam passes from one row to the next throughout the entire turbine with the most suitable velocity for economical working under the prescribed conditions. On the right are the dummy or rotating pistons to balance the end pressure of the steam.

In the compound steam-turbine of the "radial flow type" the rows of turbine blades are keyed into and project from the faces of moving discs attached to the shaft and fixed discs attached to the casing. The course of the steam is outwards, through the rings of blades, then inwards, and again outwards through the blades on the succeeding disc, and so on, and the expansion is completed in passing outwards through rows of turbine blades on both sides of the large disc. The end pressure is here, as in the case of the parallel-flow type, balanced by a revolving piston. The bearings are of special but simple

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construction. Around the bush in which the shaft revolves, are placed three concentric loosely-fitting tubes, truly bored and centred; the action of these tubes being to form concentric extremely thin layers of oil around the shaft, which acts as a cushion and prevents hammering or vibration of the shaft arising from any small errors of balance that may be present in the moving parts. The bearings are kept continuously supplied with oil by a pump, and in the case of large plants, an oil-cooler is fitted, through which the pump forces the oil to the bearings. Generally the bearings are fed from open oil-boxes, but sometimes they are closed, and the oil forced in under considerable pressure.

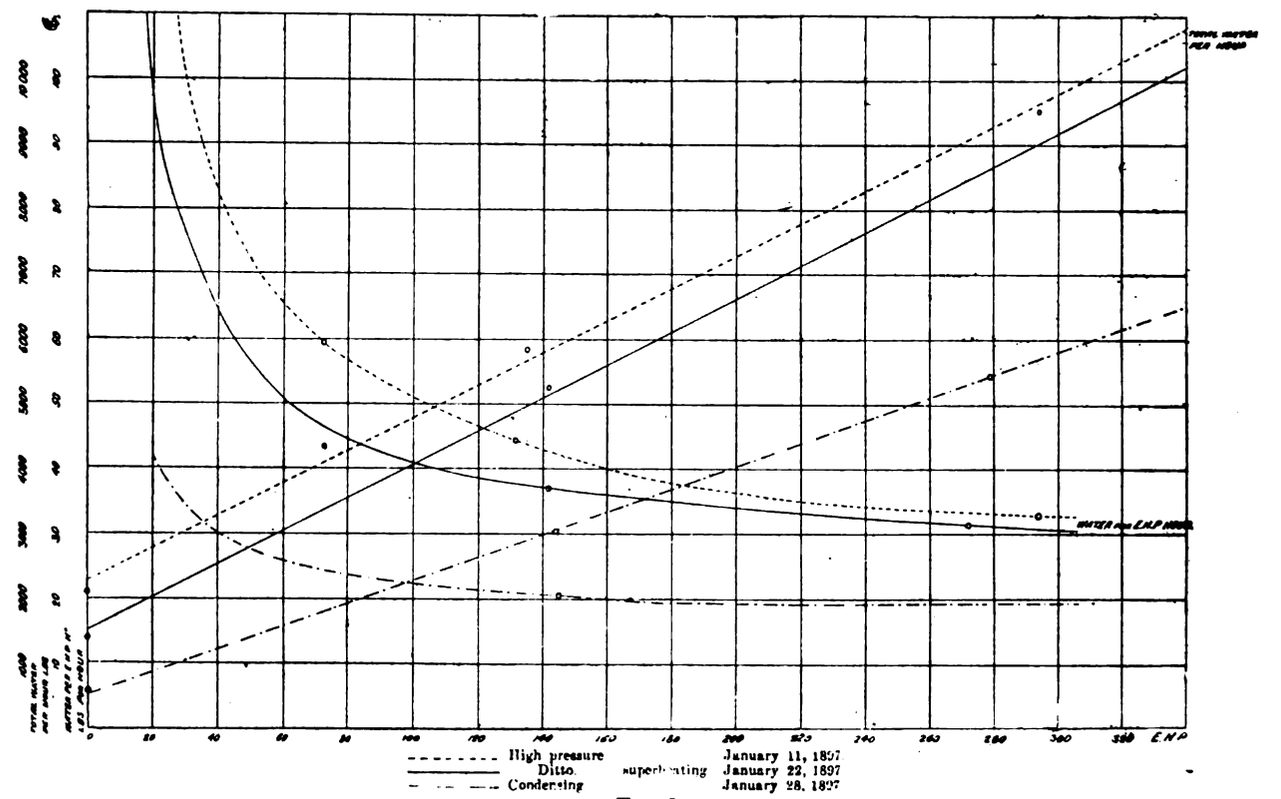

FIG. 1.

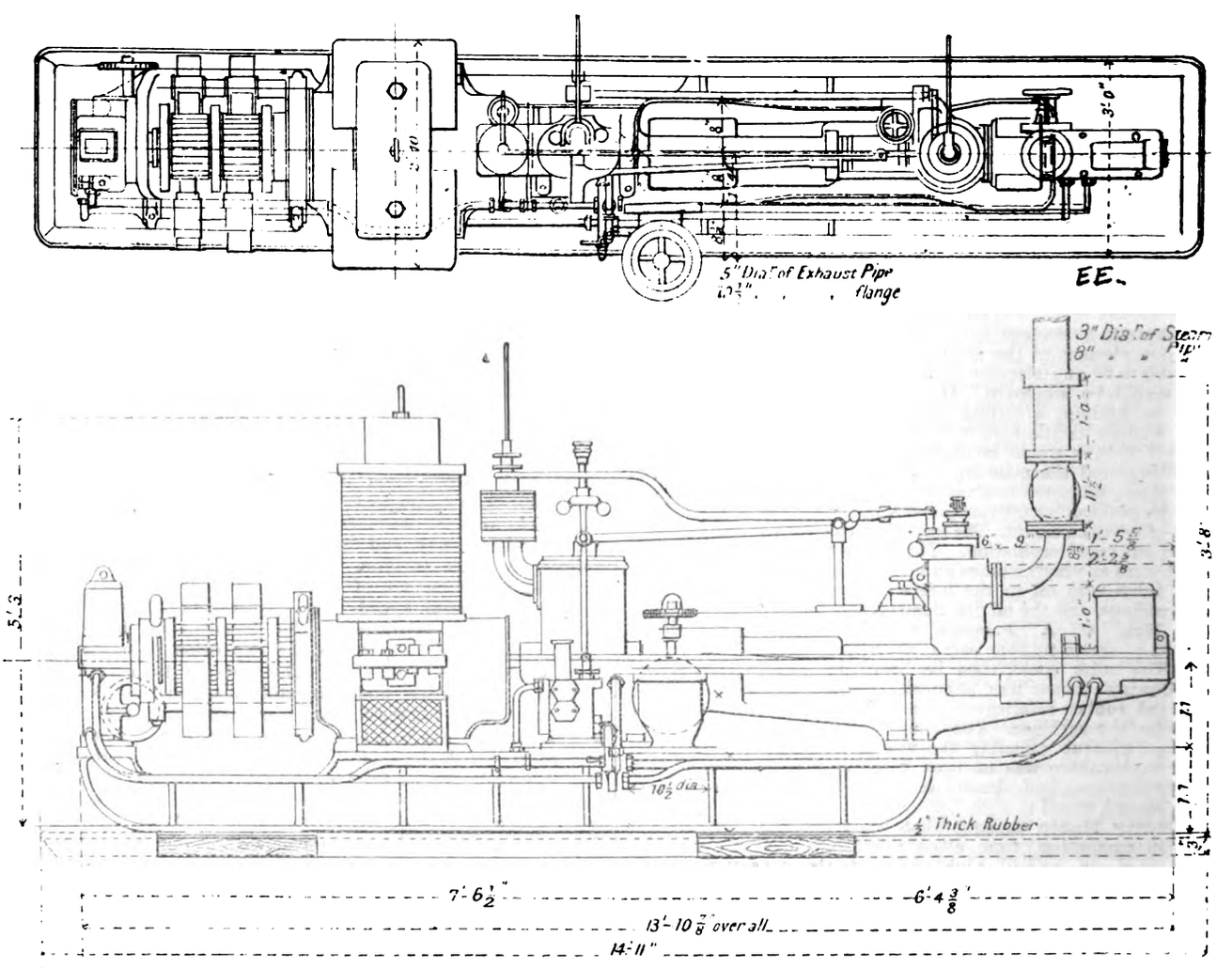

FIG. 2.

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The Governor.—The governor chiefly used has been one in which the steam-admission valve is worked by a steam relay, the valve of which is controlled by a solenoid, and the action has been rendered more sensitive, and the economy of the motor at light loads improved, by superimposing a reciprocating motion to the position of the relay valve, the action being to eliminate friction and stop hunting, as well as to admit the steam in blasts at full pressure, and of larger or shorter duration, according to the work required from the motor. In some cases the solenoid has been replaced by a centrifugal governor of ordinary type.

The advantages of the turbine for driving dynamos and alternators may be summarised as follows: (1) smaller first cost of plant; (2) smaller cost of building and foundations; (3) smaller cost of upkeep; (4) reduction of engine-room staff, the machinery being smaller and lighter, and more easily managed and controlled; (5) ease and rapidity of running up plant; (6) impossibility of injury to turbines through priming; (7) a total absence of grease in the exhaust steam or condenser; (8) the smaller first cost of plant, especially in the larger sizes, enables more spare plant to be kept ready suitable for the load, and consequently effecting a considerable saving of coal; (9) a small consumption of steam at average load in the larger sizes and abnormally so in the large sizes of the condensing types; (10) greatly diminished vibrational disturbance to the ground and building, owing to the absence of reciprocating parts.

A radial turbine was tested by Prof. Ewing in August, 1892. This machine has since that date been in constant use by the Newcastle and District Electric Lighting Company. The repair account of this company for the whole of their machinery and boilers has averaged 0·08d. per unit over the last four years.

Fig. 1 gives the consumption of a 200-kilowatt turbo-generator 1,000 amperes at 200 volts, with drum-wound armature, the turbine being of the parallel-flow type, and suitable for working either condensing or non-condensing. Eleven of the 350-kilowatt turbo-alternators are in use at the Metropolitan Company's stations.

Fig. 2 shows a 75-kilowatt plant, continuous current, 105 volts; four of these generate the current for the Hôtel Cecil.

DISCUSSION.

Prof. Ewing said that Hero, of Alexandria, was the first recorded engineer to make a steam-turbine, and that it wanted a hero to develop the steam windmill into an efficient motor. The great success of Mr. Parsons in this respect was hardly recognised up to the present by engineers. In the large size an efficiency had been obtained equal to that of a modern triple-expansion engine. The beautiful mechanisms invented and applied to the turbines were too numerous for individual mention, but he considered the result a magnificent success.

Mr. Barker, the resident engineer of the Cambridge electric light station, gave his experience of 4½ years' working of the Parsons turbine, which had fulfilled his expectations.

Mr. T. Parker was highly interested in the paper, and asked for figures as to the cost of maintenance and repair.

Mr. Macfarlane Gray asked about the leakage of steam, and suggested that this could be measured by holding the turbine and sending intermittent blasts of steam through it.

Mr. J. Swinburne said that the advantages of the turbine over a reciprocating engine were as follows: any temperature could be used, as no internal lubrication was required; also the steam was never admitted to a cold chamber or surface. He wondered if a gas-engine could be constructed on the same principle.

Mr. J. G. Simpson, of Newcastle, referred to the good work done by the turbines in the station there.

Mr. R. W. Weekes said he had had opportunities of watching the Parsons turbines in London both at the Manchester-square station and at the Hotel Cecil. In the first-named station the absence of vibration compared to what had been found with the previous engines was most marked. As regards the Hotel Cecil, a high degree of superheat was used; and the figures of cost proved the economy of working. Thus, although the coal cost over £1 per ton, the total cost of production, including 15 per cent. for interest and depreciation, came out under 2d. per unit for at least two months recently. The exact figures he would give for the report.

Mr. R. E. Crompton said that as Englishmen they were proud of Mr. Parsons. The use of higher speeds saved so much in first cost. He, too, should like to hear something as to the leakage of steam.

Mr. Parsons, in reply, said he had found increased pressure and temperature of the steam to give increased efficiency. At Newcastle the cost per unit for repair and maintenance had for the past four years averaged ·13d., which was an exceptional low figure.

The Decimal System in Engineering Measurement.

BY HENRY RIALL SANKEY, CAPT. R.E.(RET.), M.I.C.E.

Broadly speaking, the decimal system is used in engineering in this country whenever calculations other than mere checking have to be made, or when very accurate dimensions have to be expressed; and in either case, in mechanical engineering, the decimals are generally those of the inch, its square, or its cube. The reason of this is fairly obvious. As regards calculations, decimals are, on the whole, far simpler than vulgar fractions, and they allow of the ready use of the slide rule or tables of logarithms. It is true that occasionally simple vulgar fractions have to be dealt with, as, for instance, one-sixth in the case of the formula for the strength of a rectangular beam. In such cases the vulgar fraction would obviously be used; to convert the decimals would correspond to using a slide rule or a book of logarithms to multiply 6 by 5, or some such simple sum.

In the case of accurate dimensions in mechanical engineering, 1-64in. is far from being a sufficiently small dimension; hence the use of the terms bare and full, and as, for interchangeable work, such vague dimensions are very unsuitable, recourse is naturally had to the use of 1-100in. and 1-1,000in. The writing down of accurate dimensions is also very cumbrous even when they can be expressed by 1-64in. Compare, for instance, 11in. + 15-16 + 1-32 + 1-64 bare with its decimal equivalent 11·98in. No doubt the same dimension may be more briefly expressed as 11/63-64in., but this form is not generally used in practice, and there are obvious reasons why this should be so.

It will be observed that the decimal expression has only been carried to the second place, and this is because the uncertainty in 1-64in. "bare" is of the order of 1-100in. If the decimal expression is extended to the third place, an order of accuracy is reached, expressed by 1-1024in. on the binary scale, fractions which are not practically workable. When dimensions of no special accuracy have to be stated, the natural tendency to successively divide the unit by 2 gains the upper hand. Notwithstanding this tendency and the prevailing custom, it can scarcely be doubted that it would be preferable to state all such dimensions in decimals of an inch. If decimals of an inch are adopted, the system is still incomplete, owing to there being 12in. to the foot, 3ft. to a yard, and so on.

It is here that the metric system has a great advantage—it is a decimal system throughout. As experience in such a matter has more value than mere theory, a statement of the results of introducing the metric system of linear measurements into the works of Messrs. Willans and Robinson may be of interest. In the first place, it is desirable to say a few words about the class of work and method of manufacture carried out at the works in question. The Willans central-valve engine and the Niclausse water-tube boiler are manufactured each in certain definite standard sizes, and the parts required are made to gauge and template in large batches, and have to conform to fixed dimensions within specified limits of accuracy, in order that strict adherence to the interchangeable system may be maintained. In the machining and examination of the parts, gauges and templates are used as far as possible to the exclusion of the measuring rule. Whether inches or millimetres are used is therefore not a matter of much importance. At the marking-off table the measuring rule is, of course, more used, and the question of convenience in the unit of measurement, and its divisions, is of greater importance; the parts are, however, dealt with in batches, and the convenience or otherwise of the unit of measurement, and its divisions, tells once, only, for each dimension for the whole batch.

The circumstances that led to the adoption of metric linear measurements are not of general interest, and for reasons which need not be entered into here they were only applied to the Niclausse boiler and to certain sizes of the engine. The earlier sizes being still made to drawings figured in feet and inches; thus the two systems are concurrently at work in the same shop. There would have been no advantage in refiguring these drawings with equivalent millimetres, and to make new parts to millimetres to interchange with old parts made to inches would be impossible without going to several places of decimals. The old gauges and templates were marked with the millimetre equivalent to the third place of decimals, but this was merely to accustom the men to sizes expressed in the new system. It may be mentioned that the men were supplied with rules marked with millimetres on one side and inches on the other. The expense involved consisted principally in providing a complete set of gauges. New templates and jigs had also to be made, but only a portion of their cost is properly chargeable to the introduction of the new unit, as the greater number of them would have been required in any case. The only difficulty met with has been in connection with the screw threads. Hitherto the ordinary Whitworth and gas threads have been retained; but, for reasons connected with the manufacture of the engines abroad, the body of the bolt or stud is turned larger than usual, the excess being 0·3mm. for ¼in. Whitworth, and 2mm. for 1½in. Whitworth; intermediate sizes are in proportion, all being brought up to even millimetres. The bored holes are then able to take the corresponding screw cut to the standard used by the French makers of the engine, who use the thread of the Société d'Encouragment, which is slightly larger than the Whitworth, and which, it is stated, promises to become universal in France; it is now adopted by the French navy and railways.

The metric dimensions were introduced in May, 1893, and, after four years' working, the following is the result: No difficulty has been experienced in getting draughtsmen to use

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the new measures. No serious mistakes have been traceable to the change, and very few minor ones. The draughtsmen are practically unanimous in favour of metric measures, finding it easier to design, to check, and to read millimetre drawings. Taking all fractions into account, little more than half the number of figures formerly used are now required to express a dimension. An average case would be 3ft. 1⅜in., which on a millimetre drawing would be figured 949 ; and an extreme though possible case is 3ft. 1/3-32in. +1·64in. bare, which becomes 942·4. The need to use decimals of a millimetre is very infrequent, but in the case of inches the use of fractions is, of course, the rule. A cylinder, for example, might be figured 2ft. 6in. on an inch drawing and 770 on a millimetre drawing ; the piston body must have a certain clearance, say 1-32in. in one case, or 1mm. in the other, in which case it must be figured 2ft. 5/15-16in. on the inch drawing, whereas on the millimetre drawing the dimension becomes simply 768, and the use of fractions is wholly avoided. The proportions between dimensions are more readily appreciated when expressed in millimetres ; thus the ratio between 27mm. and 49mm. is much more easily apprehended than between 1/1-16in. and 1/15-16in.

A point of some importance is that the ordinary foot and inch ticks or marks are not required, and with them disappears the possibility of having 2in. added to each 10, or deducted from each foot in a dimension. A case of this kind occurred in which two 13in. flanges intended to come together were shown on different drawings ; in one of them a tick was introduced after the one, and that flange was made 1ft. 3in. With millimetres a cypher might possibly be put in, or omitted ; but a dimension 10 times too big or too small would at once be noticed as absurd. In the drawings, scales 1, ½, 1-5, 1-10, and occasionally of 1-25, 1-50 are used. It is found that this number of scales is amply sufficient. No mistakes have been made in marking off work to millimetres. The men preferred the old system at first, the new figures conveying little idea of size ; but they are now much in favour of the millimetre, and find drawings so figured easier to read. The shop where the difficulties of the change would be most felt is that in which the tools and gauges are made ; the foreman says that it was a little awkward at the outset—for about two days. In the works manager's opinion, the metric system would prove even more advantageous in shops where measurements are taken from the rule than where gauges are used. He considers it easier to teach men the use of the rule with the metric than with English measures.

Discussion.

Mr. T. Parker said he was greatly interested by the paper just read, and thought that a difficult subject had been most fairly treated. Personally he preferred the inch as a standard of length, and considered it much more convenient than the centimetre. He, however, would like to work with decimal parts of an inch. Considering the vast volume of engineering trade done annually in which the inch was used, he did not think a change was feasible.

Prof. R. H. Smith did not think there was anything to be gained on either side from physical convenience, as either could be worked to with equal facility. The most convenient unit of length was varied with the branch of the profession ; in one, $\frac{1}{1000}$in. might be useful, whereas in another branch a yard might be always used. It was very difficult to get the civilised countries to work together in the matter of standards, but he would point that the countries using the metric system were satisfied with it. On the other hand, there was a great difference of opinion in this country and America as to what system was best. He concluded that it would, therefore, be impossible to get the countries using the metric system to make a change, to conform to a proposed change in our system.

Mr. W. H. Allen upheld the use of the inch with decimal division. He had introduced this into his works some two years ago, and also the practice of using inches only in dimensions. This gave great satisfaction, and practically no trouble. The workmen had readily taken to the new system of dimensioning drawings.

Mr. R. E. Crompton said it must be remembered that England and America were really the two leading mechanical nations. Other nations might perhaps be pressing them hard in the race, but he considered these two held the premier position as manufacturers of machinery. To scrap all the gauges now in use in the two countries would cause endless confusion. The change from the millimetre to inches would cause less trouble. He upheld the use of decimal parts of an inch, and said that the sizes of wire and plate were awkward to express in millimetres.

Mr. Mark Robinson referred to the reason why his firm had taken up the metric system. This was done solely on commercial considerations, so that the Continental licensees of the Willans engines could work in conjunction with the parent firm as regarded interchangeability of parts. New types were being got out at the time, and it was as easy to dimension them in millimetres as inches.

Prof. W. E. Ayrton mentioned the fact that a Bill was now before Parliament to legalise the use of the metric system in England. He humorously referred to the large numbers of significant figures in the table of equivalents appended to the Bill.

Mr. Alexander Siemens said that the metric system was most conveniently inter-connected as regards units. We were always taught to multiply and divide on the basis of 10. It was Watt who first suggested the metric system. He proposed it as an international one to Laplace, and Louis XVI. called an international congress to discuss the matter. Unfortunately, the Revolution and the war between France and England prevented the congress meeting. Although our Colonial trade was a valuable one, yet the exports to foreign countries, most of which used the metric system, was nine times that to the Colonies. The introduction of the C.G.S. unit in Germany took some time to effect, but two years after the new standards were legalised they became compulsory, and by that time they were fully appreciated.

Dr. John Hopkinson said that the system in question was introduced in Messrs. Chance's work for the lenses 40 years ago, and that although feet and inches were employed in the mounting of these lenses, no trouble had issued from the dual systems in the one shop.

Captain Sankey then replied.

The Equilibrium System of Feeding Electric Railways.

BY CHARLES ERNEST PAOLO DIANA SPAGNOLETTI, M.I.C.E.

There can be no doubt that the subject of electric traction is one that has a great future before it, and is commanding the serious attention of many leading engineers. Its very rapid progress and development in America is now in this country and on the Continent producing the idea that it is likely to become the prominent motive power. The author therefore ventures to bring before the conference for discussion and critcism a system for working long lines of railways by electricity. The author will not refer to existing systems, but will simply describe the method he desires to bring under notice.

The great desideratum in working an electric railway is that the potential on the line should be practically equal at any and all points of the conductor, and the best way, in the author's opinion, of obtaining this desired end is by working on a system of equilibrium, which he proposes to do in the following manner. For example, take a line of railway, say, of 100 miles in length ; at each end of this line establish a generating station connecting the positive poles of direct-current shunt-wound dynamos to each end of the conductor, the dynamos being equal in their output. If the current so sent is insufficient for the requirements of the line and number of trains thereon, place at intermediate convenient points additional generating stations connecting the positive poles of similar dynamos at each of these stations to the main conductor. The result will be that each station sending the same current—*i.e.*, the positive into the conductor or feeders—equilibrium is established, and no current will flow until a train is on the line. Now, at whatever point or points a train or trains may be taking current from the conductor, the potential will be practically the same, because the loss by resistance of the conductor from the distant station or stations will be made up from the station or stations at the opposite end, and to which the train or trains are nearer. The resistance of the conductor being equal throughout, the loss from dynamos must be the same at any given distance, and they will balance themselves. In each generating station the author uses shunt-wound direct-current dynamos, with an automatic electric governor to regulate the throttle-valve on the steam-pipe, so that whenever the line is free from trains, which is not often likely to be the case, and equilibrium is established, and no current is flowing in the conductor, the throttle-valve is closed, and the steam regulated accordingly.

The author does not wish for a moment to create an alarm in the minds of locomotive engineers, or a fear that if electric railways become general their occupation would be gone. They would only have to turn their attention to stationary engines instead of locomotives, as the latter would disappear as a requirement of a railway company. Electric motors would be attached to the axles of the various vehicles running on the line, and their own dead-weight, with their live or dead weight cargoes, would afford the necessary friction on the rails. The unnecessary load of large engines, weighing some 80 tons or more, would not have to be carried throughout the journey.

With regard to the cost of such a system, there would be as a set-off the value of the locomotives, tenders, water-cranes, coaling or coking stages, at various parts of the line, with the necessary attendants. The sheds for stabling engines would no longer be required, and would save a large expenditure in buildings and maintenance. Large steam-worked turntables would not be wanted, the permanent way would suffer less wear and tear, bridges over which trains would run would be subjected to less strain, stations, by the absence of steam and smoke, would not need so frequently painting, and there are several other minor matters which tend towards economy. The author believes a very considerable saving would be the result of the introduction of electric working as against the expenses and repairs of a railway locomotive department, against which there would be the electric plant, cables, stations, conductor, feed-rail or overhead trolley system, motors, etc.; and if average cost of engine and tender be taken at £2,300 each, and a railway has a thousand or more engines, there would be an enormous

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surplus in favour of the electric system, either in first cost or conversion of system.

Very great convenience would be afforded to those requiring special trains. A carriage could be provided at once, and the delay consequent on getting an engine and waiting until she is sufficiently in steam to take the journey (perhaps half an hour or more) would be saved, as by the electric system the journey, if about 20 miles, could be run while the engine is getting ready. The economy of such a system is marked, as there would be no waste in the consumption of power, whereas an engine required for one or two coaches would be quite capable of taking a dozen. It would also be possible for railway companies using a system of this kind to have generating stations at all intermediate large towns *en route*, where they could from the same building work the trams of the town, making them tributaries to the line, as well as affording local convenience and economy.

DISCUSSION.

There was little discussion of moment on this paper. More information about the system was asked for, but the time at the disposal of the meeting prevented much being given.

The Conversazione.

Owing to the large number of members in London and wishing to be present, the council were obliged to arrange two evenings for the conversazione. Tuesday and Wednesday respectively were the selected evenings, and on each occasion a large company was present. The arrangements throughout reflected great credit on the organisation, and the cloakroom accommodation and attendance afforded a pleasing contrast to what is usually found at such functions. The president and Mrs. Wolfe Barry received the guests at the head of the grand stairs on the first floor. The string band of the Royal Artillery discoursed a good programme of music during the evening, and vocal music, under the direction of Mr. William Coates, also added to the enjoyment of those present. A large number of exhibits were arranged in the different rooms. The following demonstrations also took place at intervals, including Mr. Robert Paul's theatrograph; a demonstration by Mr. Thomas Andrews, F.R.S., of the effects of fatigue on steel rails; an exhibition of views by Dr. Common, F.R.S., illustrating the eclipse of the sun expedition to to Vardö, 1896; a demonstration by Mr. Alfred Schwartz, of measuring to one-millionth of an inch; an exhibition of views taken by Dr. Tempest Anderson, illustrating the crossing of the Col du Géant in 1896; and a demonstration by Mr. Campbell Swinton of Röntgen X-rays, with exhibition of adjustable Crookes tubes. A valuable collection of paintings and drawings lent for the occasion were displayed on the walls of the library, etc.

CITY AND GUILDS OF LONDON INSTITUTE.

ELECTRIC LIGHTING AND POWER TRANSMISSION.

The following are the questions set by the Examinations Department of the City and Guilds of London Institute, 1897:

HONOURS GRADE.

Candidates in honours must have previously passed in the ordinary grade. They may select their questions from one only of the following sections:

Section I.—Electrical Instruments, etc.

Answer questions Nos. 9, 13, and 18 of the ordinary grade, together with not more than *six* of the following:

21. Describe in detail a wattmeter for use on alternating-current circuits. What precautions must be taken in its construction, and what is the exact nature of the error likely to be met with in its use? (30 marks.)

22. Give sketches illustrating the construction of a coulomb-meter and an energy meter, each intended to be used on alternating-current circuits. What errors are to be looked for in such meters? (30.)

23. Describe a frequency meter, also some form of phase indicator for measuring the difference in phase between two alternating currents. (20.)

24. Give detailed sketches of a galvanometer, with all modern improvements, to be used for testing the insulation of somewhat short lengths of well-insulated cable. (30.)

25. Describe in detail a voltametric method of calibrating an ammeter, and a potentiometer method of calibrating a voltmeter, and draw attention to the precautions that must be taken to secure accuracy. (25.)

26. What is the nature of the error produced in an electromagnetic voltmeter used on an alternating-current circuit if the frequency be changed? How can this error be partly compensated for? And mention any types of voltmeters, should such exist, which require no such compensation. (30.)

27. A condenser loses half its charge in an hour: what is the percentage loss per minute? Would such a condenser be considered a good or an inferior specimen? If a good condenser be connected through a resistance with a constant-pressure circuit, and then be removed and discharged through another resistance, what is the proportion of the energy spent in each of the resistances? (25.)

28. You are required to construct a resistance box for ordinary use. What material should the wire be composed of? What resistance would you make the coils have? What gauges of wire would you employ for the different coils? How would you adjust them? And what arrangement would you construct for enabling the number of coils in the circuit to be altered in the ordinary use of the box? (30.)

29. Describe in detail the construction of a Clark standard cell. (20.)

30. Draw a section of a well-insulated charge and discharge key, and of a universal shunt box.

Section II.—Dynamos, Motors, Lamps, etc.

Answer questions 1, 5, and 11 of the ordinary grade, together with not more than *six* of the following:

31. A shunt dynamo, run at constant speed, is used to charge accumulators; show how the current alters as the charging is continued. How would you wind a shunt dynamo to give approximately constant current when run at constant speed and used to charge accumulators? (30.)

32. Give a sketch of an induction motor and explain its action. Draw a curve showing the way in which the torque is connected with the speed of rotation. What are the advantages and disadvantages of this type of motor? (25.)

33. A pressure of 1,000 volts is maintained between the terminals of a motor-dynamo, but falls to 900 when a current of 100 amperes is flowing through the motor portion. It is desired that the dynamo portion shall produce a P.D. of 100 volts at no load, rising to 110 at full load: how would you wind the fields? (35.)

34. Describe in detail the method of determining the commercial efficiency of a 100-volt 1,000-ampere dynamo. (25.)

35. Two alternators run in parallel by even-running high-speed engines give currents whose sum is considerably greater than the joint current on the external circuit. How would you find what was wrong, and how would you remedy the defect? (30.)

36. Compare the merits of exciting alternators (1) with an exciter for each machine, (2) one or more exciters exciting the alternators in parallel, (3) two exciters, coupled in parallel, exciting all the alternators in series. (25.)

37. Give sketches describing the best-known arc lamp mechanisms, and state which type you would prefer to employ on a constant-pressure circuit. Give full reasons. (25.)

38. The liquid in all the cells in a battery of accumulators has the right density after charging, but one of the cells, although of the same size as the others, has a much smaller capacity: what is the cause, and what remedy would you employ? (20.)

39. A shunt-wound steam dynamo in parallel with many others is not giving its full output: what would you do? (25.)

40. Explain in detail the method adopted for switching alternators into parallel, and mention the various precautions that must be attended to in the operation. (30.)

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THE

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TO CORRESPONDENTS.

All Rights Reserved. Secretaries and Managers of Companies are invited to furnish Notice of Meetings, Issue of New Shares, Installations, Contracts, and any information connected with Electrical Engineering which may be interesting to our readers. Inventors are informed that any account of their inventions submitted to us will receive our best consideration.

All communications intended for the Editor should be addressed C. H. W. Biggs, *139-140, Salisbury Court, Fleet Street, London, E.C Anonymous communications will not be noticed.*

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BOUND VOLUMES.

Vol. XVIII. of new series of "THE ELECTRICAL ENGINEER" *can be had bound in blue cloth, gilt lettered, price 8s. 6d. Subscribers can have their own copies bound for 2s. 6d., or covers for binding can be obtained, price 2s.*

INDUCTOR ALTERNATORS.

It is somewhat reassuring to find that the long lane has a turning; or, to drop metaphor, an English firm has at length put an inductor alternator upon the market. We congratulate Mr. Mordey and the Brush Company on this step, inasmuch as we believe the inductor type of alternator will ere long be the only type of alternator in use. It seems odd that English buyers have so long held aloof and not insisted upon machines of this type, when both on the Continent and in America they have come to be held in great esteem. Without hunting into the history of Patent Office specifications at home and abroad, it would be impossible to state who was really the first to attempt a practical machine of this type, but there is no doubt Mr. Mordey and Mr. Kingdon were amongst the first, if not absolutely the first, to realise the value of a machine having no moving complex parts. Although such was the case, the design languished here while it flourished elsewhere. That serves us with a text upon which much might be said, and all to the detriment of go-aheadness in this country. When we come to examine closely into the progress of electrical applications, we find that the impetus has generally come from abroad. Taking the Gramme and Siemens machines, or if it is preferred to go further back, the Alliance machines, these were designed outside this country, and only taken up here when we were compelled so to do. Our manufacturers may have improved the original machines put into their hands, but initiate they did not, and have not. The well-known Ferranti machines are derived from Continental ancestors at the instigation of Mr. Colson, of Leicester, and we should not be surprised to learn that the influence of that gentleman has had much to do in the development of the Mordey inductor alternator. At any rate, Mr. Colson's report of his last visit to the Continent is awaited with some impatience, and is expected to state pretty plainly his leanings towards this particular type of alternator. It must be remembered that electrical machines have to fulfil two conditions: one, and by no means an unimportant one, of mechanical stability, the other of electrical efficiency. Investigators in England seem to have gone "nap" on the latter, and paid too little attention to the former. The result has been many and varied troubles. We divulge no secrets, we speak of no particular machine, but central-station engineers know that troubles, too often of a mechanical nature, do arise, and hence will welcome a construction which is better mechanically, though it may be 5, or 1, or even 5 per cent. less efficient electrically. Efforts have often been made to account for our lagging behind in the race for improved machines and new developments, but no satisfactory solution has been put forward. It is the same with traction and power work: we follow, others lead. Had it not been for American enterprise and co-operation, little would have yet been done in traction work; but the Thomson-Houston agents have struggled hard, and in several cases succeeded in becoming pioneers in traction work. It may be that the real reason is to be found in a thickly-populated country already

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tolerably well provided with locomotion facilities, as contrasted with newly-settled territory not so well provided. But that reasoning cannot be made to account for delay in appreciating the good points of inductor alternators. Is it that in this case buyers are too much like sheep, only following when the bell-wether leads the way? At any rate, now the spell is broken, and it is not compulsory to go abroad for such machines, some progress will be made in their instalment. There is, however, one direction in which we may take the credit for being first, and that is consolatory. The results obtained by the use of Dowson generator gas are well known, but it may be news to some of our readers that Northwich, having obtained its order, has arranged to have its engines driven by Mond producer gas at the very low price of twopence per thousand cubic feet. The electrical unit should be cheap at Northwich.

THE PROGRESS OF THE MANCHESTER ELECTRICITY WORKS.

The following statement as to the rapid progress of the electricity works at Manchester will be of interest to our readers: These works were first opened for the supply of current in July, 1893, and by September of that year there were 82 consumers connected, with 8,000 lamps. The capacity of the plant first put down was sufficient to maintain 40,000 lamps simultaneously. By March, 1894, this number of lamps was reached, 40,000 lamps being connected in the premises of 416 consumers. The committee at once proceeded to put down additional plant capable of supplying 16,000 lamps, but by the following March (1895) the number of consumers had increased to 741, and the lamps to 66,914, so that in spite of the addition already made, the capacity of the plant was still too small to supply the demand. The committee therefore decided to make a very large extension, and ordered eight new engines and dynamos sufficient to supply an additional 64,000 lights, thus bringing the total capacity of the station up to 120,000 lamps. The demand, however, continued unabated, and by March, 1896, the number of consumers had swelled to 1,148 with a total of 103,002 lamps, and by March, 1897, when the erection of the new plant was completed, its capacity was already exceeded, the consumers numbering 1,581, and the lamps 143,398. Inasmuch as there was no sign of diminution in the rate of increase of consumers, it was imperative to take immediate steps to supply at least another 50,000 lamps during the winter of 1897-8. Seeing that the existing engine-room was now wholly filled with plant, and there was no time to build a new station, the committee, acting on the advice of their engineer, determined to remove six small engines and dynamos, since these were now too small to be of any practical use, and to replace them by two very much larger generators. The advantages of this course were many-fold, not the least being that it was possible to develop 5,000 h.p. by means of plant occupying no more space than the old, which only developed 600 h.p. As the first step in this extension, one generator capable of supplying 50,000 lamps has been ordered, and is now in course of construction. This new generator presents many points of interest. In the first place, it is an entirely new departure in this country, though generators of the same kind have been in very successful operation on the Continent and in America for very many years past. It is by far the largest continuous-current generator in Europe, and there is every reason to believe that it will be one of the finest examples of a combined engine and dynamo that has yet been constructed, either in Europe or America. Its efficiency, it is believed, will be extremely high, and considerable economy may be expected from its use.

Turning now to some figures, at the present time there are the equivalent of 145,962 lamps of 8 c.p. connected to the mains, and there are the equivalent of 12,840 awaiting connection. There are 1,615 consumers connected, and 36 waiting for a supply of current. As to the details of consuming devices, there are actually connected 121,736 incandescent lamps, 1,211 arc lamps, without reckoning those public lamps turned on by the Lord Mayor last week, and 135 motors aggregating about 235 h.p. It may be mentioned in connection with the work in hand, that there are 18 motors aggregating 110 h.p., and there is a prospect of a very large demand for motors in addition to these, although not actually applied for. During the year, between March, 1896, and March, 1897, there were added to the mains 40,132 lamps, or an average of 770 per week, and the rate of increase was remarkably steady throughout the year. The total output of current has increased very largely. In the first nine months the quantity sold was 439,379 units. The year ending March, 1895, this had increased to 1,168,382 units, and in March, 1896, to 1,748,244 units, while in March, 1897, the enormous amount of 2,508,588 units was reached, showing an increase of almost 50 per cent. over the previous year. The Manchester station is now the largest single station in this country, with one exception, the City of London Company.

The large increase in the number of consumers already referred to was due in large measure to the rapid extension of the mains. The original area of supply was bounded by Portland-street, Piccadilly, and Market-street, Deansgate, and Peter-street. Extensions were soon made to Whitworth-street, and the streets leading from it to Portland-street, also to Oldham-street, High-street, and Victoria-street. Then mains were put round Swan-street, Withy-grove, and Corporation-street. The next extension was a very large one, comprising Oxford-street, as far as High-street, and Cavendish-street and the whole of the Stretford-road within the city. Victoria-park was then added. At March, 1897, distributing mains were laid in about miles of street, of which 10½ miles were laid between March, 1896, and March, 1897, and in addition to these, 8½ miles of feeder were laid, of which nearly four miles had been laid during the year. The total length of single conductor amounted to no less than 167 miles. At the present time, further very large extensions are being rapidly pushed forward, notably along the Wilmslow-road to the city boundary at Fallowfield, along the Stockport-road, along Ryde-road and Clowes-street, along Oldham-road, and along Bury New-road and Cheetham Hill-road, and it is hoped that the supply of current will be available in a large portion of the districts named for next winter.

Street-Lighting.—Towards the end of last year the Electric Works Committee of the Manchester Corporation decided to make an experiment in street-lighting by means of arc lamps, and instructed their engineer, Mr. C. H. Wordingham, to advise them as to which portions of the city would be the most suitable for the experiment. Three open spaces were decided upon—viz., Albert-square, which bounds one side of the town hall; Piccadilly, which is a very fine wide open thoroughfare, on one side of which is the Royal Infirmary; and St. Ann's-square, which may be called the Manchester Regent-street. It was felt strongly by the engineer that from the beginning the electric lighting of the streets should be done on commercial principles, and therefore in his report he did not recommend making a large display of light, but rather the provision of a better illumination at about the same cost as the then existing gas. Accordingly, in Albert-square the illumination is about seven-fold, in Piccadilly three-fold, and in St. Ann's-square five-fold that afforded by the older system. In Albert-square 12 10-ampere Brockie-Pell lamps are fixed. They are so arranged that six can be extinguished at 11 p.m., and the remaining six left burning. They are supplied from the ordinary five-wire network, and the switches are fixed in the base of one of the pillars. Only two switches are used, and they are operated by the ordinary gas-lamp lighters. Although there is thus the utmost simplicity in working, the connections are somewhat complicated. When all lamps are alight eight burn in series on 400 volts, being connected to the two outer

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distributors, while the remaining four are connected between the middle conductor and one outer. When half the lamps are extinguished, the six left alight burn in series on 300 volts across one outer conductor and one of the intermediate conductors. The arrangement adopted is very economical in wiring, and secures efficient burning. The pillars are of very substantial design, and the lamps are fitted within canopies. In Piccadilly six Crompton-Pochin arc lamps are fixed; four are attached to overhanging arms, the object being to throw the light forward to the roadway, as the whole of the lighting is done from one side of the street. The remaining two lamps do not overhang, but are placed in crutches. These two lamps are each fixed in a refuge. They are so arranged that two lamps can be extinguished at 11 p.m. When all are burning the lamps are connected six in series on 300 volts, being connected to one outer conductor and one of the intermediate conductors. After the two are extinguished, the remainder burn on 200 volts between the middle conductor and one outer. In St. Ann's-square two Brockie-Pell lamps connected in the ordinary way to a 100-volt circuit are fixed. In all cases the lamps are guaranteed to burn 40 hours, and each is provided with an automatic cut-out.

In Albert-square the present annual cost of lighting by gas is approximately £162, the illumination given being approximately 2,380 c.p. The cost of electric lighting is estimated at £142, or, including interest on capital for lamps, mains, etc., and depreciation £166, while the illumination afforded will be the equivalent of about 15,000 c.p., or over six times as much as at present. In St. Ann's-square the present cost of lighting by gas is about £45 for an illumination of about 660 candles, while the estimated cost of the electric lighting is £25, or, including depreciation, etc., £30, the illumination being the equivalent of 3,000 candles, or nearly five times as much as at present. In Piccadilly the present cost of lighting by gas is approximately £174 per annum, and the illumination afforded is the equivalent of 2,730 candles, while the estimated cost of the electric lighting is £85, or, including interest and depreciation, £101, while the illumination is the equivalent of 9,000 candles, or considerably over three times as much as the gas.

On the 20th inst. the street-lighting was inaugurated, and the various groups of lamps were turned on by the Lord Mayor, and by Alderman Gibson (chairman of the Gas Committee), Alderman Higginbottom (chairman of the Electric Works Committee), and Councillor Phythian (deputy-chairman of the Electric Works Committee). They all started up without a hitch, and the effect was very satisfactory.

FORTHCOMING EVENTS.

The following are some of the announcements for the forthcoming week:

TO-DAY (FRIDAY).—Physical Society, Burlington House, 5 p.m.—Royal Institution (Prof. H. Moissan, directeur, Laboratoire de Chimie Minérale à l'Ecole Supérieure de Pharmacie, Membre de l'Académie des Sciences, Paris, who will lecture in French on "The Isolation of Fluorine," with experiments), 9 p.m.

TO-MORROW (SATURDAY) —Royal Institution (Mr. Fuller Maitland on Music), 3 p.m.

MONDAY, MAY 31.—London Chamber of Commerce (the Japanese Minister), at Skinners' Hall, Dowgate-hill, at 2.30 p.m.

TUESDAY, JUNE 1.—Royal Institution (Dr. Starling), 3 p.m.—Motorcarts start from the Crystal Palace to Birmingham (the *Engineer* competition).

WEDNESDAY, JUNE 2.—Annual dinner of the Institution of Marine Engineers.

THURSDAY, JUNE 3.—Royal Institution (Mr. Collins), 3 p.m.—Chemical Society meeting.

FRIDAY, JUNE 4.—Royal Institution (Mr. Preece on "Signalling Through Space Without Wires"), 9 p.m.—Also at Paris, meeting of the Ingenieurs Civils de France.

SATURDAY, JUNE 5.—Royal Institution (Mr. Maitland), 3 p.m.

Electric Illumination.—Although there are many electric signs for the Jubilee on order and in course of erection, we understand that in some districts the high price per unit charged by the supply companies for this special work is checking the demand.

THE MECHANICAL CONSTRUCTION OF ELECTRICAL MACHINERY.

BY F. M. WEYMOUTH.

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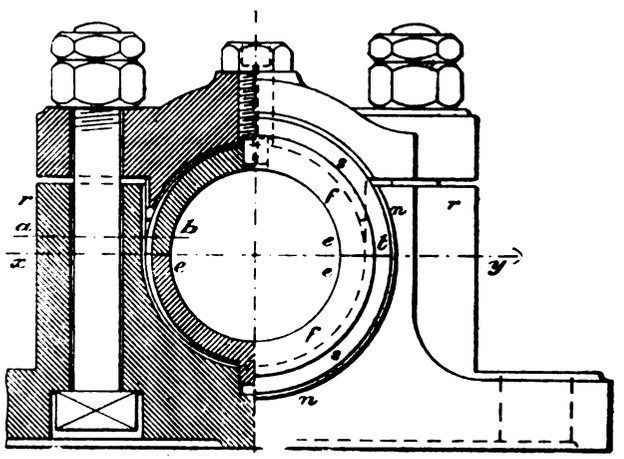
THE DYNAMO.

(Continued from page 648.)

Bearings (continued).—In Fig. 189 we indicated the main outline of a cap bearing; and we have elsewhere alluded to plummer blocks. These latter are split or cap bearings complete in themselves, not forming an inherent part in any machine, though they may be applied thereto. Thus, in the sketch of an oil-engine, Fig. 191, the lower half of the bearing was an inherent part of the machine, formed in the main frame, and so not movable apart from the engine. But, as we have already intimated, the bearings in a dynamo, contrariwise, are usually complete in themselves, and, both upper and lower halves, can bodily be separated from the machine; and they thus partake of the nature of plummer blocks. Inasmuch, therefore, as these latter will by the nature of the subject form our chief basis of comparison, it will be well to consider some of the principal "points" in their design.

FIG. 200.



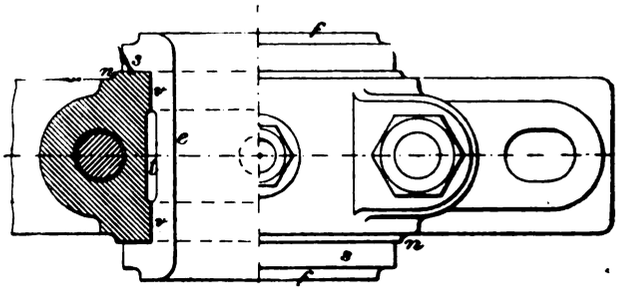


FIG. 201.

Fig. 200 herewith shows an elevation, part view, and part section, of a plummer block; and Fig. 201 is a plan, whereof one half is full view, and in the other half the cap is removed, and there is a section on *a b* through one jaw. Figs. 202 and 203 are details respectively of the cap and brasses. In the design of a bearing such as this, as in most mechanical design, there is a great deal of "touch and go," to use a popular phrase, more so than might perhaps be thought. A very little alteration in one direction will greatly affect the whole. On the other hand, its construction is based on sound mechanical principles. We may now regard this subject in some detail.

It will be observed that the plummer block consists essentially of a cast-iron base whose sides, or jaws, *r r*, are carried up well above the centre line *x y*. Across the top is the cast-iron cap; and included within are two "brasses," the junction between which latter comes on the centre line *x y*, as depicted. It is hence that the edge, or virtual section, of the lower brass appears in "view" in the plan,

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and is not cross-hatched in the sketch owing to the section not being an actual one.

The proportions here shown are mostly taken from Unwin's "Machine Design"; and the somewhat large diameter (in relation to dynamo shafting) of 5½in. has been assumed. Taking the formula therefore for the thickness of the brass at the bottom we find this = ·1 $d + \frac{1}{8}$ = ·1 × 5·5 + ·125 = ·675, that is, nearly $\frac{11}{16}$in.; and the thickness at the sides need be only about $\frac{3}{4}$ of $\frac{11}{16}$in., or a little over $\frac{1}{2}$in. It will be noted, that due to the odd $\frac{1}{8}$in. to be added being a constant quantity, the brasses for small shafts will be thicker in proportion to the diameter than those for large shafts.

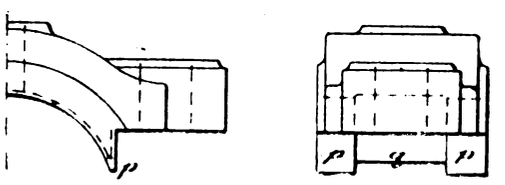

Fig. 202.

The diameter for the bolts is $\frac{1}{4}(d + \frac{1}{2})$, that is, 6 × ¼ = 1½in.; the thickness of the cap 6 × ⅓ = 2in.; and the height of $x\,y$ above the base line about 6 × 1·05 = say, 6¼in. We thus find the critical dimensions. It is now necessary to make the whole design as snug and compact as possible, so as to keep down the weight, and we may aim at a neat outside appearance. It is also desirable to minimise the distance between the bolt centres, and thus also to make the cap as short as possible in the same direction, so as to as completely as possible obviate all tendency of the cast iron to spring or bend across the top of the upper brass under the pressure of the nuts at its ends.

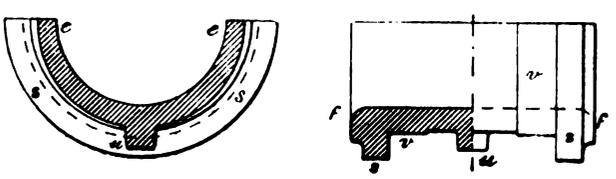

Fig. 203

It will now be noted that to the thickness of the brasses already given, circular facings, *v v*, are added, shown more clearly in Fig. 203. Corresponding facings are on the cast iron, and it is on these that the brasses are supported. On the lower brass a snug, *u*, is cast, which engages in a hole cored in the base as shown, so as to prevent it from rotating with the shaft. This snug will be merely filed to a fit. Coming between the circular facings, *v v*, it does not interfere with these latter being turned in the lathe.

In order to place the bolts as near each other as possible, each must be put as close to the inner edge of the upright jaw as allowable. On this point the rule in practice is that the bolt centre should never be nearer the edge of a casting than a distance equal to its own diameter. Hence the recess, *l*, between the facings being as shallow as feasible, say only ⅛in. deep, the centre of the bolt will be 1½in. back from this recess. We thus find the position of the bolts.

The cap may now be considered. It may be asked, Why is not the junction between the cap and the base made wholly on the horizontal centre line, *x y*? This brings us to the crucial part of the design. For by carrying the two lower jaws up well above the centre line, they are made to include two smaller jaws, *p p* (Fig. 202), projecting downwards from the cap. These latter are also provided with facings corresponding to those in the base and on the brasses, and are worked to an exact fit between the lower jaws. The under side of the cap, being bored with the base, fits the upper brass. Thus the cap, when bolted down, firmly holds the upper brass against any sideways movement.

Referring to Figs. 200 and 202, it will be observed that the recesses, *q q*, in the cap between the facings naturally come to an acute angle in the jaw at a higher level than the angle between the facings themselves. The sharp edges are removed: but the jaw is allowed to protrude downwards as much as feasible in the faced portions, as at *p p*, so as to well support the brass. Additional strength may be given the jaw by taking the facings through without the recesses. The jaws cannot be thickened without widening the whole bearing, involving a lengthening of the cap from bolt to bolt, all of which is undesirable, and without sufficient warrant.

We now return to the brasses once more. It will be noted that these have flanges, *s s*, which, fitting against facings, *n n*, on the base, prevent their moving endways in a direction parallel with the shaft; and it will particularly be observed that *both* brasses are thereby engaged with the base, the upper one being held at its corners, so to speak, where its flanges overlap the facing on the base, as shown at *t*. Hence, though the cap steadies the upper brass sideways, yet in the other direction, parallel with the shaft, the brass steadies the cap. But the main point here to be noted, is that, by this method of construction, all the parts are interlocked one with another; and no pressure in any direction from the shaft puts any load on the bolts other than pure tension. It is thus this locking together of the brasses and cap with the base that illustrates that sound principle of mechanical design to which we referred above: and an immediate advantage following this method that may be noted is that the end thrust of the collars of the shaft is borne by the upper brass equally with the lower. As regards the bolts for the cap, as these are not in shear, they may be simply black bolts, with cored clearance holes in the base and cap for their reception, and having square heads fitting loosely square recesses below to prevent their rotation with the nut.

In the final fitting and use of this bearing, the inner surfaces of the sides of the brasses, as at *e e*, are removed somewhat by scraping and filing so that they do not here touch the shaft: this reduces the tendency of the brass to seize on the shaft. Lubrication is accomplished by means of a drilled tap-bolt as shown, and as was described in connection with Fig. 192. In practice the upper brass may not actually be in contact with the lower brass on the line, *x y*, and caution is needed not to screw the nuts down so tight as to cause the cap and upper brass to jamb the journal. The nuts may, in fact, be merely set with the thumb and finger; and a lock nut is hence needed as shown. A lock nut is a second nut screwed hard against the principal nut; the latter is thus kept at any desired position on the threads, whether it also bears against any other body or not. On the question of lock nuts it may be remarked that Prof. Unwin points out in "Machine Design" that the small lock nut should be below the principal nut, and not above it, inasmuch as when both are tightened hard down, it is the upper one that takes most of the strain, relieving the threads of the lower one. Apart from the fact, however, that as we have intimated, in such a case as this the nuts are not hard down, a difficulty in actual practice is that spanners are usually too thick to work a thin lock nut with another nut overtopping it; and hence, unless thin spanners are specially provided, the thin lock nut is perforce placed uppermost. Of course, a more ready way out of this difficulty, if the bolt is sufficiently long, is to let both nuts be of full thickness, though this may not look so well.

Cases exist, however, wherewith it is desirable that the cap should be fastened down hard. A method thence in vogue is to leave gaps between the opposing edges of the two brasses, say from ⅛in. to ⅜in. in depth, according to the size of the bearing, and to insert in these gaps strips of brass termed "liners." The thickness of these latter is then so adjusted that when the upper brass is tightened down on to them, an easy working fit will be allowed the journal between the two brasses. When the brasses become worn so that the journal "knocks," the liners are filed thinner so as to let the brasses close again on to the journal to a proper working fit. This method, however, is not perhaps so applicable in the case of dynamos, wherewith it is essential that the axis of the shaft should not drop, and wear must be made good by new brasses or fresh white metal; though in times past bearings adjustable in height have been used permitting a dropped axis to be again raised by raising the whole bearing.

It will be observed that annular facings, *f f*, are shown in the illustrations on the brasses. The outer diameter of these will accord with that of the collar or shoulder on the shaft working against them. Otherwise, if there is any

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end pressure on the shaft calculated to cause appreciable wear on the brass cheek, the effect may be as shown at *w* (Fig. 204), where the collar has cut into the brass, which does not look well, while the friction on the outer periphery

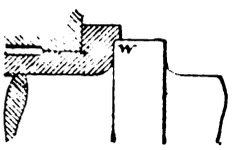


FIG. 204.

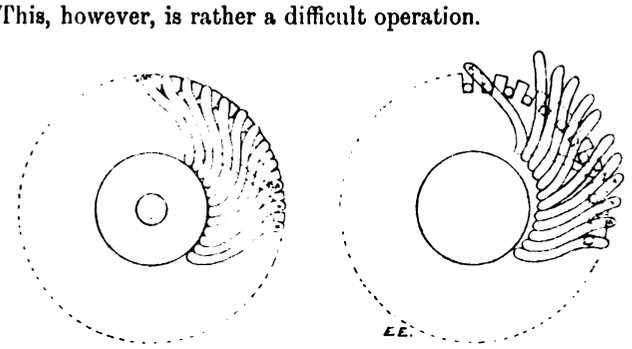
of the collar is an additional source of heating without any compensating advantage.

(*To be continued.*)

THE REPAIR OF SYMMETRICALLY-WOUND ARMATURES.*

Even when well acquainted with the winding diagram, it is not easy to remove a burnt-out coil from a symmetrically-wound armature unless one has had practical experience. It is a still more difficult matter to form a new coil and replace the damaged one. Therefore a few hints as to the method of doing this may prove acceptable.

The armature heads seem so symmetrical and the coils so tightly wedged in place that one hardly knows where to start or how to proceed. The hardest of all armatures of this class to repair is the original Eickemeyer winding, in which the coils pass symmetrically over the ends of the drum in spiral curves. The coils are often so stiff with varnish that even the experienced man is liable to damage a coil or two in removing a faulty one, and the green hand is almost certain to do so. The slotted armature, which is the only one to be considered in railway work, is in this winding wound with coils of the shape shown in Fig. 4. One side of this approximately rectangular coil is always free to be lifted out of this slot if the band wires are removed, as it rests in the top of a slot. But the other side is in the bottom of a slot, and is, of course, confined by the wire above it. The coils overlap each other much after the fashion of the shingles on a roof, and it is necessary to lift all the intervening wires between the two wires forming the sides of the coil before the latter can be removed. This, however, is rather a difficult operation.



FIGS. 1 AND 2.—Eickemeyer Armature Coils.

Consulting Fig. 1, which indicates the condition of affairs, the conductors X to A inclusive must be lifted clear from their slots before the coil of which X forms a side can be freed. It will also probably be necessary to partially lift the wires M and N, for the spiral connectors of these wires interfere with the spiral connector of A, as will be seen in the figure, and prevent the latter from being lifted clear from the slot to liberate Y. The position of Y is unknown at the start, though it is easy to find X. Count the total number of slots on the armature and divide by the number of pole-pieces. This will give the number of slots from X to A inclusive, and, of course, it will be easy knowing X to count forward to A. Having thus located A, unsolder the coil connections at the commutator between A and X and begin by prying up M or N, one or two conductors further on, as far as it will conveniently go by means of soft wood wedges. You will be only able to move a very little. Then pass to the next conductor, which can then be moved more, and so proceed till X is reached. It is probable that X can be lifted fully a hand's breadth from the core. If this has been sufficient to lift A clear of its slot the coil may be removed. If not, the operation of progressive lifting must be repeated till A is fully clear of its groove (see Fig. 2).

If the winding is of the wave type, the coil will not be entirely free even then. The lead that is soldered to one of the commutator lugs will be confined under its fellows, and these must be unsoldered till the lead of the coil to be removed is free. It will not be necessary to lift these additional coils from their slots. The process of inserting a new coil is a precise reversal of the process already described, and the observing operator having successfully removed a coil will have no difficulty in replacing it. The barrel winding, which is becoming very popular in railway work, is the only other winding of this type that the repair

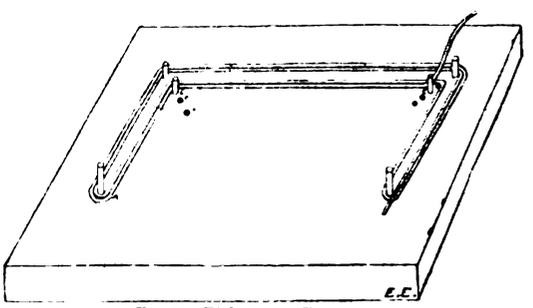


FIG. 3.—Eickemeyer Former.

man is likely to encounter in electric railway work. This winding is opened on an exactly similar plan, and the only difference is that it is a much easier job, as the coils are easily slipped in and out. In some few cases of windings T-shaped teeth are encountered, and in such cases the wire in the slot must be drawn out from the end and the spiral connector formed up afterwards. Oftentimes there is a soldered joint at the end of the slot, and if this is the case the repair is easier. This is often done in generator construction, but while it admits of easy repair it is an inferior design.

A few words as to the formation and preparation of the coils may not be amiss. With railway armatures the former are very simple and can be easily made by anyone. Nothing is needed with wire-bound coils but a hardwood board of suitable length, a drill, and a few round pins that will fit snugly into the holes that the drill makes. The Eickemeyer former, which is the most difficult, will be described first. Holes are drilled in the board as shown in Fig. 3, and the distance between these holes must be

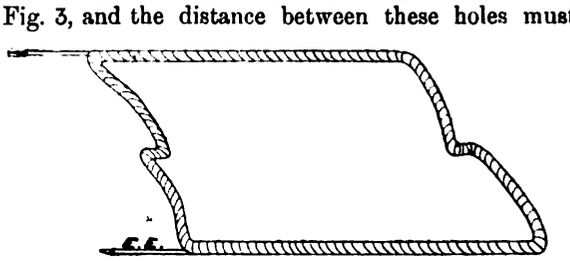


FIG. 4.—Eickemeyer Coil Completed.

obtained by suitable measurements of a sample of the coil to be formed. The distance apart of centres of the holes, D, E, and F, is equal to the thickness of the insulated wire used. A line drawn through the centre of these holes would have an angle of 45deg. with the lines connecting D and A and D and C. As the winding progresses, the pins in this row of holes are shifted inward, for on this side of the coil each successive turn comes on the inside of the rectangle, A, D, C, G. With the other half of the coil no such shifting is necessary as the successive turns come on the outer layers of the rectangle. After the coil is complete—and a few turns suffice—it is spread open, and assumes the well-known form of Fig. 4. Before spreading it is taped, and if a number of coils are to be made for stock it will be better to leave them unspread, for that can be as easily done by the winder, who will have to bend them in any event, and it is obvious that the less bending the better. Moreover,

* From the *American Electrician*.

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the coils pack better in storage just as they come from the former. When the winding is of the barrel form it is notably easier to handle. The former consists simply of two pins as in Fig. 5, and the coil can be bent to shape with simple angular bends as in Fig. 6, for all of its sides are straight. Nothing more than a good pair of pliers is necessary for this work. The proper distance apart of the pins can be ascertained by straightening out an old coil.

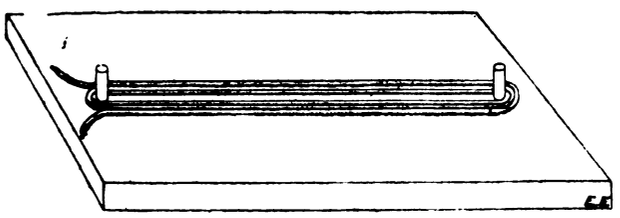

FIG. 5.—Barrel Winding Coil Former.

There are now on the market a number of drum-wound armatures on the barrel plan which use narrow ribbons of copper instead of wire, and such coils do not require any former at all. The coil is usually formed as in Fig. 7, and bent to shape with pliers as in Fig. 8. The bend of Fig. 7 is not an easy one to make, and requires a special machine. It can, however, be avoided, and the same end attained by

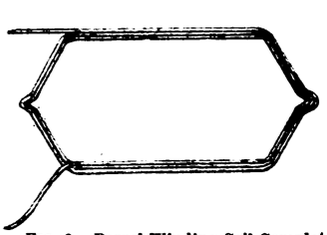

FIG. 6.—Barrel Winding Coil Completed.

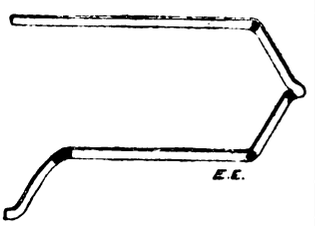

FIG. 8.—Ribbon Coil Completed.

bending straight copper ribbon as in Fig. 9. This does not make as neat a job, and the end of the coil is more bunchy, but there is always room for it, and if the bending is carefully done so as not to develop cracks it will answer just as well. If a number of ribbons are to be bent and packed together to form one large ribbon they had better be bent as in Fig. 10, as they will pack much more closely.

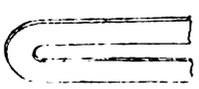

FIG. 7.—Forming Ribbon Coil—Machine Bend.

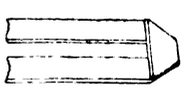

FIG. 9.—Forming Ribbon Coil—Second Method.

FIG. 10.—Forming Ribbon Coil—Third Method.

These coils are, of course, to be taped before slipping on the core, and for this purpose a tape that is sticky on one side only is best. If the coils are sticky on the outside, great difficulty will be found in adjusting them in place. If this special tape cannot be obtained, it is better to use white cotton tape and thoroughly shellac the completed coil.

INSTITUTION OF ELECTRICAL ENGINEERS, May 20.

Sir HENRY MANCE (president) in the chair.

After formal business the discussion on Mr. Trotter's paper was begun by

Mr. C. Bright, who said Mr. Trotter's paper was equally valuable to tramway and telegraphic engineers. Experiments that failed were not as a general rule the ones that were published, although their non-success conveyed valuable information. It was abundantly evident that the kicks of the siphon recorder in this case were not due to ordinary leakage, but to an inductive effect, probably on the two underground lines running from the cable hut to the station, and consequently it was hopeless to expect to do much by varying the earth. He was sorry to see that the plan, shown in Fig. 13A, of adding an artificial line, was not a success in practice. Theoretically it should have been perfect, but there was the practical difficulty of altering the adjustment at a point so far from the recording station. It was to be regretted that some alternative to the adoption of what was practically the metallic circuit principle was not found. From the cable company's point of view, no doubt, it did not matter, as it was to be presumed that the tramway people paid the bill. With the adoption of high-speed automatic working for cables, the question of induction effects for tramways would be of more importance than ever. Mr. Trotter spoke of condensers being used to get rid of earth currents. They were of use also to sharpen the signals and so give increased speed.

Mr. Preece said one reason why the Institution had so few papers of the kind was that the rivalry of competing companies had resulted in a policy of their discouraging the members of their staffs from contributing papers containing information on points of working to the technical Press or to the Institution. They had therefore not only to thank Mr. Trotter, but the South African Cable Company, that they had the paper. They suffered from disturbance of this kind in England, and the Post Office more than most people. He had spoken as to a recent experience with the City and South London Railway a few meetings ago. There had been also trouble at Liverpool and Leeds. All such difficulties were due to defect in the circuit, or some error of judgment in those who laid down the circuits. There was no difficulty in distinguishing between induction and leakage. In the particular instance described in the paper it was practically impossible for the tramway company to eliminate the cause of the disturbance. It was not a solitary instance, as Mr. Luke could tell them from experience at Madras.

Mr. Luke said that in the case of the cable landed at Madras disturbance was felt from the tramway. Various means were tried to obviate it, but nothing succeeded until a highly-insulated line was run from the station to the cable hut. The tramway company paid the cost, as they did also of the alterations necessary to prevent disturbance in the telephones. The earth-plate was carried out to sea half a mile on an insulated core, and a land line 15 miles along the coast was tried without success.

Mr. Gadsby also spoke as to the case of Madras. His experience ranged from 1894 to April, 1896. The cable was that of the Eastern and Australasian Telegraph Company from Penang. They (the tramway people) had determined that the trouble with the telephones was due to induction, but thought the difficulty with the cable was due to leakage. He believed the measures they adopted got over the difficulty, but had since heard that there had been further trouble. The tramway was an iron conduit one, with a single conductor, and two branches on the overhead system with return through the rails. [Mr. Gadsby showed a diagram of the Madras tramways, the cable and the telephone trunk lines. The main difference from the Cape Town case was that the cable went straight out to sea instead of running for several miles parallel to the coast and the tramway.] He had not been able to formulate an explanation on the basis of Mr. Trotter's experiments. Some pointed one way and some another. Instead of regarding the earth as of ample conductivity for their return, he thought they must accept the idea that a large discharged current might temporarily raise the potential of the surface above zero. This would give a condenser effect in the cable, which would affect the siphon recorder. He called attention to the fact that when the cable laid out in the bay had its end sealed, the disturbances did not cease.

Prof. Ayrton said the effect described by Mr. Gadsby was only another way of looking at leak. He did not think people realised the induction produced by tramways. In 1893 Prof. Rücker, Prof. Boys, and himself made a magnetic survey of the region of the City and South London line. Their instrument was a suspended magnet, and they took it about in a cab. It was in consequence of the results of this survey that the line proposed under Exhibition-road had not received parliamentary consent. It was found in South London that the instrument was affected, and they could tell with it what was happening on the railway 60ft. below the surface. The disturbances were not always strongest near the railway, which showed that the return current was wandering all about the earth, according to the position of gas or water pipes. Prof. Ayrton contended that by the law, if not as it was, then as it ought to be, the ground under the telegraph company's office at Cape Town should belong electrically to the company and not to the tramway, and that the ground under that building [the meeting was at the Society of Arts] should belong to its owners, and not be liable to electrical disturbance by, say, the District Railway. As it was, the telegraph company had to go five miles to sea to get an earth. No electric lighting company in this country used an uninsulated return. With railways such as contemplated, with a three minutes' service and an uninsulated return, to comply with the Board of Trade prescriptions, the conductor must be extremely heavy. It was a question of calculation to prove to the companies that they would gain by the use of an insulated return. The City and West-end Railway, the Brompton and Piccadilly-circus, and the District Deep-Level Express line had all been sufficiently convinced of that, and they had undertaken to insulate their return to the satisfaction of the Central Technical Institute. That was a great point, not only in the interests of science, but of the electric railway, because it was a little difficult to make people believe that anyone representing the interests of a scientific college was as anxious for the success of electric railways as for the experiments carried on by his students. The solution of all the problems was an insulated return, and it would prove the most beneficial in every way.

A short letter from **Prof. Forbes** was read by the **Secretary**. It consisted of a suggestion that Mr. Cuttriss, of New York, should be communicated with, in order to obtain details of similar disturbances, and their remedy, which occurred on the cable from Canso, in Newfoundland, which was landed at Coney Island.

Mr. Gadsby said the Madras telephones had an earth return. A diversion of the line overcame the difficulty, so the tramway leakage was not so great or so wide-reaching in its effects as was supposed.

The **President** said Mr. Trotter, being at Cape Town, could not reply. He had had something to do with the Madras tramways,

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and though Prof. Ayrton said tramways had no business to interfere with telegraphs, and though he (Sir Henry Mance) was a telegraph man himself, he thought that as the submarine telegraph had a monopoly of the ocean, it was too much to ask for a monopoly of the land as well. The cases of Madras and Cape Town differed as the relative positions of the cable and the tramways. The taking of the earth out to sea was recommended by Cromwell Varley 30 years ago. It was nothing unreasonable to ask a cable company to do it, and he (Sir Henry Mance) had done nothing else for many years. He did not think that it was always necessary to place the return wire underground in the costly way it was done at Madras, as an overhead wire with proper precautions was just as good. The splash in the diagrams given in Mr. Trotter's paper was undoubtedly due to induction, and was similar to what he had noticed in watching the recorder was produced by thunderstorms perhaps 50 miles away. It was necessary to consider several possibilities even when a distant earth was used, as the current which would affect their instruments was exceedingly small.

A paper by Mr. W. M. Mordey, "On Dynamoes," was then read.

MEETING, MAY 27.

At last night's meeting of the Institution the following were the candidates balloted for:

Associates.—Girindra Chandra Bose, 60, Great Western-road, Glasgow, N.B.; James Leonard Golding, Abercorn-street, Bulawayo; Lionel Edward Harvey, The Vicarage, Hounslow; John Douglas Knight, Ealing Electricity Works, Ealing, W.; Emile George Lind, 42, Charterhouse-square, E.C.

DISTURBANCE OF SUBMARINE CABLE WORKING BY ELECTRIC TRAMWAYS.

BY A. P. TROTTER, MEMBER.

(Concluded from page 662.)

On September 5 a telephone line to Salt River, a distance of 2¼ miles, and at an average distance of 200 yards from the railway (nowhere less than 100 yards) and about 350 yards from the tramway, was used for an earth. Besides

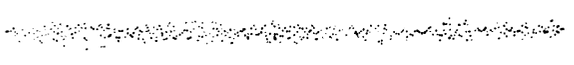

FIG. 10.—Durban Road Earth, August 17, 1896.

the usual tramway kicks, a continual vibration due to the railway and post office telegraph lines (especially the quadruplex), which run along the railway, was recorded on the tape, but not nearly so remarkable as in the case of the Durban-road earth already alluded to (Fig. 10). I regret that this experiment was not repeated with the condensers removed, in order that the effect of earth currents might be distinguished from induction. Another attempt was made on September 15 to neutralise the disturbances by means of an equal and opposite induction. Mr. Shaw, of the staff of the "Great Northern" cable ship, was present. The telephone line to Mowbray and the sheath of the cable and the syphon recorder were connected up through a rheostat so that resistance taken out of one earth could be added to the other (Fig. 11). It was expected that a point would be

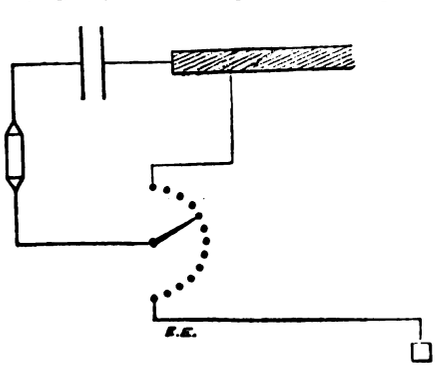

FIG. 11.

found at which the disturbances would be reduced to zero, and that beyond this they would be reversed, but neither reduction nor reversal could be obtained. On September 15 I made a report to the Postmaster-General upon the results of the experiments, and summarised the five courses which might be adopted. (1) Make a remote earth connection by means of a telegraph line—this has been so far unsuccessful; (2) neutralise—this has also been unsuccessful; (3) prevent all leakage—this is impracticable; (4) reduce abruptness of change of current—recommended if Nos. 1 and 2 fail; (5) a last resort, but a sure one: lay a few miles of new two-core cable across the bay.

Mr. N. Shaw continued to make experiments, at which I was not present. I understand they were not successful. On October 1 the tramway was opened to Sea Point (see map), and the increased traffic resulted in a marked increase in the number and in the amplitude of the disturbances. The operators had begun to read the signals in spite of the kicks, but after this date the signals were almost always illegible while the trams were running. In order to try a still more remote earth, a military telegraph line was run, under the superintendence of Captain O'Meara, along the shore of the bay to the point marked A on Fig. 1, and was terminated there with a copper plate in the sea. The result is shown in Fig. 12.

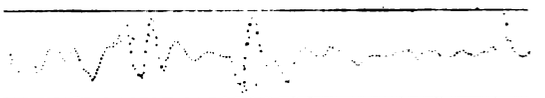

FIG. 12.—Earthed on Military Line beyond Salt River, October 1, 11.30.

On October 3 the disturbances appeared to be reduced, but on October 5—a public holiday in Cape Town—they were as bad as ever. It has been noticed that the amplitude of the kicks is much greater on some days than on others; but this variation has not been traced to the changes of weather, and may be due to nothing more than heavy traffic. Other experiments were made with a differential choking coil by the cable company's staff, and earths at the point A, and at Durban-road (12 miles from Cape Town along the railway), were tried, both separately and in shunt to the sheath, but without any promise of success. A sample of the slip taken at one of these experiments is shown in Fig. 13.

Early in October the cable was duplexed at the station, but no appreciable difference was noticed until, as I am informed, at the suggestion of Mr. H. A. C. Saunders on December 24 it was put on duplex connections with the artificial line at the cable house, as shown in Fig. 13A, from which date until January 14 the whole of the traffic was carried in a satisfactory manner during the interruption of the alternative route on the East Coast. On the restoration of the East Coast route the company discontinued this plan of working, as it was only a makeshift and very inconvenient. The cable was not actually

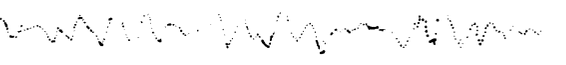

FIG. 13.—Earthed at Salt River, October 6.

under duplex conditions—that is, the company could not work duplex—the artificial line being only used as an adjustment to counterbalance the disturbance on the cable. The only remaining method was to lay a length of new cable. Three ways of employing such a cable present themselves. First, the old cable might be picked up and landed at a hut on the other side of the bay, and two cables or a two-core cable laid from that hut to Cape Town. Second, a two-core cable might be jointed to the old cable at some five or six knots distant from Cape Town, one core being spliced to the core of the old cable, and the other being connected to the sheath. The third way is simply to lay a cable over the old one, terminating in an earth-plate or joining the core to the sheath. No steps could be taken until the "Great Northern" arrived at Cape Town. The cable was laid under the superintendence of Mr. Harold W. Ansell on January 20, 1897. The end had been sealed. The sheath and core were connected to the instrument at the cable hut, and I am informed that kicks in all respects similar to those of the old cable were recorded. An attempt was made to neutralise or reverse the disturbances in the old cable by means of those in the new one, but without success. On January 22 an earth-

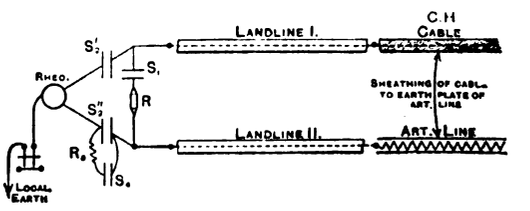

FIG. 13A.

plate was attached to the end of the new cable, and, to the great satisfaction of those who were present, a nearly continuous line was drawn by the syphon (Fig. 14). A few kicks of an amplitude of rather less than 1mm. were visible. Later in the day the earth-plate was removed and the core was soldered to the sheath, and the end was sealed to keep the sea-water from the soldered joint. This arrangement is shown in Fig. 14A. The length of the new cable is about five knots, and it was laid as nearly as possible over the old one. Since that date the traffic has been resumed, and no appreciable disturbances have been noticed.

At the first series of experiments Mr. T. Cassidy, Mr. H.

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Spetch, and one or more of the Cape Town staff of the cable company were present; together with Mr. W. B. Rommel, engineer of the Cape Town tramway companies; Mr. E. G. Jones, late electrical engineer of the Cape Town Corporation, and now resident engineer of the tramway companies; Mr. B. Bayly, metropolitan district engineer and surveyor of the Post Office; and myself. On the last occasion Mr. A. Worswick, engineer of the Port Elizabeth tramway, was present, Mr. Rommel being away. In the course of these experiments

FIG. 14

enough theories have been propounded, and cures proposed, to fill a volume. To non-cable electricians it is not easy to see why such disturbances should not be cancelled by means of an equal and opposite induction. There appears to be no difficulty in getting an opposite one, and it would seem that by shunts and resistances it could be made equal. The difficulty seems to have been that, while it was possible to produce differences of potential, there was no point within several miles as a *point d'appui* where the potential was fixed.

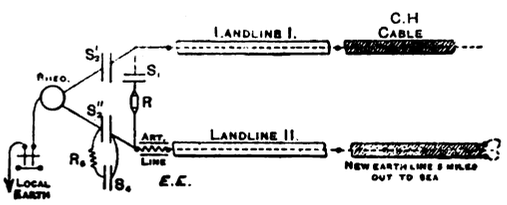

FIG 14A.

The distributed character of the induction is such that no useful effect could be produced by a small current shunted from the main current leaving the station. The sensitiveness of the syphon recorder to neighbouring telegraph currents introduced further difficulties when a good earth was sought. Many other very interesting investigations might have been made had time permitted, such as the distribution of the current which caused the induction, especially out at sea.

Surprise has been expressed in Cape Town that the tramway

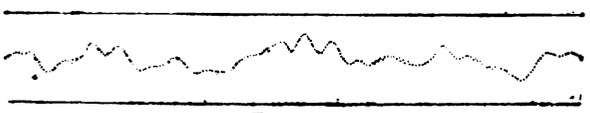

FIG 15.

companies should "allow so much current to run to waste into the sea that some of it gets into the submarine cable." A sufficient answer to this is that the current causing the disturbance is about a 20-millionth part of the average current generated at the works. But, seriously, the magnitude of the primary current which induces the secondary current in the cable is very difficult to estimate. The two or three amperes that pass through the earth-plates when about 200 amperes are being generated probably play only a small part. Although at the present date, owing to the increased traffic, the fall of volts on the rails from Sea Point to the works is rather serious, at the time of the first experiments when only five or six cars were running it was well under one volt; and nothing more could be asked from a tramway company using their rails as a return. At one time I thought that if the starting current could be switched on "by some efficient method of gradually varying resistance," say, in five steps of four amperes, succeeding each other at intervals of not less than one-fifth of a second, the five little kicks would be too small to interfere with the signals, and each would have time to die away before the next began. A worm-wheel on the controller would prevent the driver switching on too fast. But in mounting a hill a well-loaded car may take from 80 to 100 amperes, and to break this in four-ampere steps at intervals of a fifth of a second would occupy from 2 to 2¼ seconds. Since it is necessary that the reversing switch of a controller should be locked until all the current is cut off, such an arrangement would materially delay an emergency stop. If the current to be broken were always the same, it could be switched off from the motor to a resistance and then gradually reduced by the controller. But the varying current renders this impracticable. It is not worth while to discuss other details of methods of preventing the disturbances, since it would be always more satisfactory, and generally cheaper for a tramway company, to lay a short length of cable, as has been done at Cape Town.

The causes of the disturbances which have been experienced in this case are very different from those which affect telephones. The attention of the Joint Committee of the House of Lords and of the House of Commons which was appointed in 1893 to consider and report whether the grant of statutory powers to use electricity ought to be qualified by any prohibition or restriction as to earth return currents, or by any provisions as to leakage, induction, or similar matters, was confined to telephone and railway signal interferences. It is hardly necessary to remark that the rapidly fluctuating character of the current produced by the commutator of the motor, which is the chief cause of the trouble with telephones, would have no effect on a syphon recorder; nor would a strong continuous current, such as those which often get astray in Cape Town, dropping the indicators at the telephone exchange a dozen or two at a time, affect an instrument protected by a condenser. The sparking of the trolley at insulators is sometimes audible in a telephone, and the roar, as distinguished from the hum, is probably due to a dirty track. These are matters of small moment as far as a submarine cable is concerned. I have carefully listened for a click or other sudden sound in a telephone at the moment a hum begins or ends. The click, if any, at the beginning is very insignificant, and I have never heard any click whatever when the hum stops. Figs. 15, 16, and 17 are specimens of slip. Fig. 15 was recorded before the new cable was laid; the signals are unreadable owing to the tramway disturbances. Fig. 16 gives the words "Limited Cape Town Station," the recorder being earthed to the sheath of the old cable. The disturbances happened to be very slight. Fig. 17 gives the same words with the recorder earthed on the new cable.

In conclusion, I have to thank the Eastern and South African Telegraph Company for inviting me to take part in the experiments. I hope that this paper will be supplemented by an account of the experiments at which I was not present.

EXPERIMENTS UPON PROPELLER VENTILATING FANS, AND UPON THE ELECTRIC MOTOR DRIVING THEM.*

BY WILLIAM GEORGE WALKER.

(Concluded from page 654.)

These results are in accord with those obtained in the trials mentioned in the author's former paper in 1892, which were made in order to test the effect of the thickness of the blades of model screw-propellers 14in. diameter, rotating in a fixed position, and in air instead of in water. As then stated, "the screws were of two kinds: in one the transverse section of the blades was similar to that of an ordinary propeller, only much thicker in proportion; in the other kind the thickness was reduced to that of a thin plate, the other dimensions being identical. Screws of two, three, and six blades were tried at progressive revolutions ranging from 800 to 1,800 per minute, and it was found that the screws with the thicker blades were more efficient than those with the thinner blades." In his note to the British Association in 1893 (page 884) the author dealt with fans differing from one another only in the cross-section of their blades; and the results then obtained corroborate as far as they went the experiments now described. The amount of curvature of the blades for the best effect appears to be governed somewhat by the width of the blade and the nature of the feed. With a very wide blade working in a tube, its efficiency may be reduced by thickening it, in consequence of the feed becoming thereby contracted. In the majority of cases the angles of maximum efficiency have

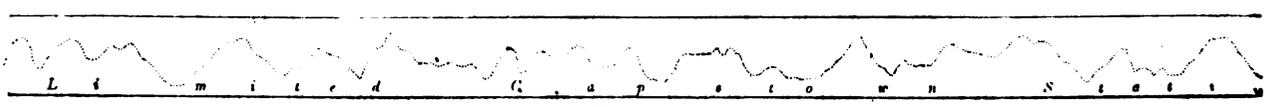

FIG. 16.

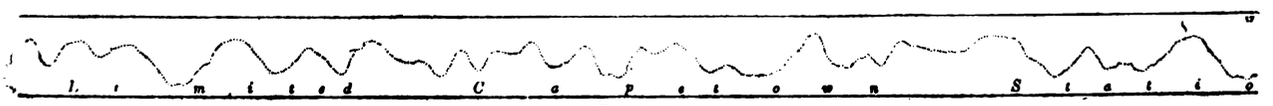

FIG. 17.

* Paper read before the Institution of Mechanical Engineers.

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been given in the tables. Other shapes were tried, and the general results were that the highest efficiency was obtained by making the blades as symmetrical and simple as possible.

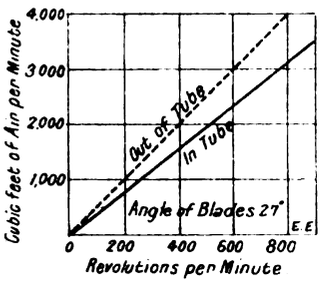
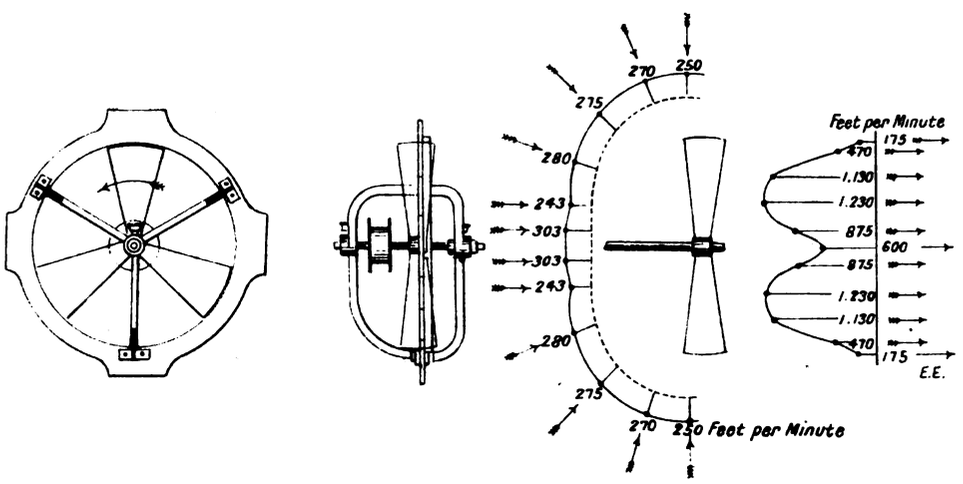


FIG. 36.—Revolutions and Air Discharge of Fan No. 9, both In and Out of Tube.

The experiments show the backs or non-propelling faces of the blades exercise an important influence on the working of the fan, and that a curved back is more efficient than a flat one.

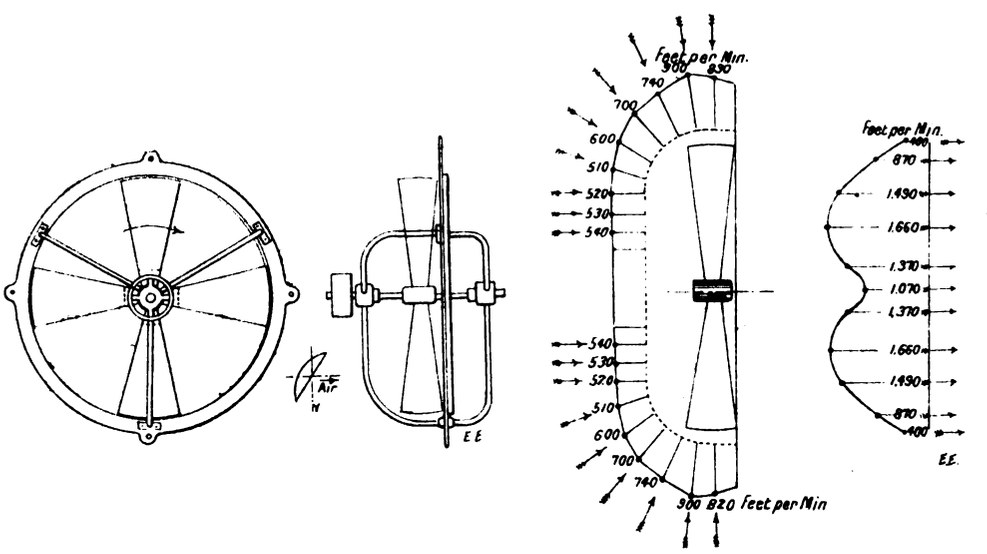
fan disc. It is therefore important that, where possible, the fan should be fixed with its circumference exposed, which is not always done in practice.

Velocity of Air on Entering and on Leaving Fans.—Some further experiments have recently been carried out by the author in order to ascertain the velocity of the air at different points on entering as well as on leaving the fan. They were made with two fans of 24in. and 48in. diameter. The 24in. fan, shown in Figs. 37 and 38, is a three-bladed fan with the blades set at an angle of 35deg. to the plane of rotation; it is a kind which has been designed and employed by the author for the ordinary ventilation of buildings, factories, and ships, and for drying. It was tested at 600 revolutions per minute, and was driven by a belt from a shunt-wound electric motor. Anemometer readings were taken at a distance of 18in. in front of the fan, as well as behind. In Fig. 39 is shown the velocity of air in feet per minute at the different points indicated. No delivery tube was employed, the fan being entirely open in front as well as behind. The air on the delivery side, at the distance of 18in. at which the readings were taken, had no tendency to spread beyond a radius equal to the outside



FIGS. 37 TO 39.—Test of 24in. Fan, showing Curves of Air Discharge.

Fans Feeding from Tips of Blades.—From all points behind the fan the air is sucked into the rarefied spaces left by the revolving blades; and is discharged in an axial direction in the shape of a cylindrical column of air having a spiral motion, the pitch of the spiral depending upon the angle at which the blades are set. Some of the fans were tried with the perimeter radius of the fan, the velocity being zero with the anemometer placed at a radius of 13in.—that is, 1in. greater radius than the radius of the fan. The maximum axial velocity on the delivery side at 18in. distance in front of the fan without delivery tube was 1,230ft. per minute at a radius of about 5in.; the minimum velocity was 175ft. per minute at 12in. radius.



FIGS. 40 TO 42.—Test of 48in. Fan, showing Curves of Air Discharge.

exposed by moving the delivery tube 4½in. forward, as shown dotted in Fig. 24, so as to increase the area of feed, the air being then drawn radially inwards from the tips of the blades, in addition to the axial feed through the spaces in the fan disc. The revolutions and air discharge of fan 9 have been plotted in Fig. 36, when the fan was tried in and out of the delivery tube. When out of the tube, the mechanical, volumetric, and pressure efficiencies were increased from 16·9 and 62·0 and 2·0 to 29·4 and 78·0 and 3·1 per cent. respectively. In the fans arranged to feed from the tips a much wider form of blade may be employed. It will be noticed that the general efficiency of the fans is increased by arranging them to feed from the tips in addition to the feed through the spaces in the

The velocity of the entering air was measured at points on the elliptical curve shown in Fig. 39, the axis of the anemometer being normal to the curve in all positions. The inward or radial velocity at the tips of the blades, at right angles to the fan spindle, was 250ft. per minute. The axial velocity, parallel to the fan spindle, was 303ft. per minute at a radius of 1¾in. The velocity of suction behind the fan depends on the distance of the anemometer from the fan disc. The stream of entering air converging towards the fan appeared to be rapidly accelerated in velocity as it approached the fan from all points behind. The 48in. fan, shown in Figs. 40 and 41, had four blades set at an angle of 32½deg. to the plane of rotation; it is designed specially for tea-drying in Ceylon and India. In order to reduce the

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TABLES 4 AND 5.—EXPERIMENTS ON VENTILATING FAN OF 23¾IN. DIAMETER, REVOLVING PARTLY INSIDE AIR-TUBE OF 24IN. BORE. CIRCULAR DISC FIXED DIRECTLY IN FRONT OF FAN BLADES, PARALLEL TO PLANE OF ROTATION, EXCEPT IN TRIALS MARKED "NONE." OUTER ORIFICE OF TUBE CONTRACTED TO 6—12—18 INCHES DIAMETER. SPEED, 800 REVOLUTIONS PER MINUTE.

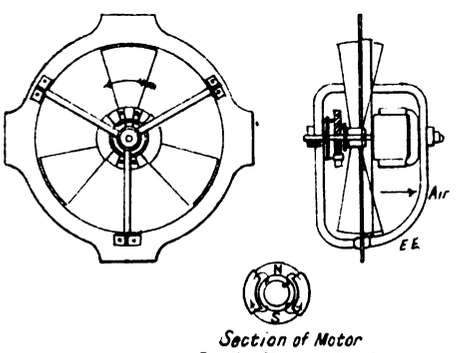
Fan Propelling Air.

Diameter of outlet.	Diameter of disc.	Mean velocity of air per min.	Air discharged per minute.	Volumetric efficiency.	Relative efficiency. Volumetric.	Relative efficiency. Mechanical.
In.	In.	Feet.	Cubic feet.	P. c.		
6	none	160	31	0·6	100	100
6	10	660	129	2·6	416	7,190
6	14	860	169	3·4	545	16,200
6	17	960	188	3·7	606	22,300
12	none	632	497	9·8	100	100
12	7	752	591	11·8	119	168
12	10	780	612	12·2	123	187
12	14	880	691	13 7	139	269
12	17	760	597	11·9	120	173
18	none	1,660	2,938	58·5	100	100
18	7	1,660	2,938	58·5	100	100
18	10	1,540	2,726	54·3	93	79
18	14	1,140	2,018	40·2	68	32

Fan Exhausting Air.

Diameter of inlet.	Diameter of disc.	Mean velocity of air per min.	Air exhausted per minute.	Volumetric efficiency.	Relative efficiency. Volumetric.	Relative efficiency. Mechanical.
In.	In.	Feet.	Cubic feet.	P. c.		
6	none	2,300	451	9·0	100	100
6	10	2 500	490	9·7	109	128
6	14	2 680	525	10 4	117	158
6	17	2,730	535	10·6	119	167
6	22	2,640	517	10·3	115	151
12	none	1,750	1,374	27·3	100	100
12	10	2,000	1,570	31·2	114	149
12	14	2,040	1,601	31·9	117	158
12	17	2,040	1,601	31·9	117	158
18	none	1,900	3,363	67·0	100	100
18	7	1,875	3,319	66·0	99	96
18	10	1,850	3,275	65·0	97	92
18	14	1,830	3,240	64·0	96	89

shipping charges it is made as light as possible; the arms carrying the fan spindle are of mild steel, 1in. diameter, screwed into cast-iron bosses and to a cast-iron ring. The blades are hollow, of plano-convex section, made of sheet steel 1-32in. thick, brazed together, and riveted upon the lugs of a cast-iron boss. Though so light, the blades are so rigid as to be practically incapable of vibration; consequently the fans are nearly silent at all speeds. In Fig. 42 is shown the velocity of the air at different points on entering and on leaving the fan, when driven at 350 revolutions per minute. No delivery tube was employed. Anemometer readings were taken at a distance of 3ft. in front of the fan, and at the points shown on the elliptical curve behind. The inward or radial velocity at the tips of the blades was 900ft. per minute, while the axial entering velocity at a radius of 10in. was only 540ft. per minute. The fan delivered 17,000 cubic feet of air per minute at 350 revolutions per minute, and about 34,000 cubic feet at 700 revolutions per minute.



FIGS. 43 TO 45.—Details of Fan combined with Electric Motor.

Fan Combined with Electric Motor.—In Figs. 43 and 44 is shown a fan combined with an electric motor specially designed for driving it. The field magnets are cylindrical, as shown in section in Fig. 45, and are made as small as possible in order to offer as little obstruction as possible to the passage of the air. In order to find the best position for the central electric motor, trials were made by fixing it both behind and in front of the fan, at different distances along the spindle. The position which offered the least obstruction to the air and gave the highest efficiency depended upon whether the fan was working with a contracted or a free orifice, and upon the amount of contraction; the best position was generally found to be at a little distance in front of the fan. There appears to be a central region immediately in front of the fan, where only a little stream of air is delivered, owing probably, in fans working with free discharge, to the centrifugal action on the front face of the blades, which is apparent near the centre.

Experiments with Contracted Outlet and Inlet.—These experiments were made with the three-bladed fan of 23¾in. diameter (Figs. 37 and 38), with blades set at an angle of 35deg. to the plane of rotation, driven at 800 revolutions per minute by belt from a shunt-wound motor. In Figs. 46 to 49 the fan is shown working partly in the 24in. delivery tube. The outer end of the tube was contracted by closing it successfully with plates containing central holes of 6in. and 12in. and 18in. diameter. The fan was tried both propelling and exhausting air, and its efficiency in either action was found to be much reduced by the contraction. One of the reasons that this kind of fan was unable to maintain static pressure in the air is probably the comparatively slow speed of the blades near the centre, in consequence of which the air tended to pass back again through the centre of the fan. The effect was therefore tried of fixing a circular disc in front of the fan on the delivery side, so as to prevent the air from returning through it; this had the effect of increasing the efficiency to a great extent when working against resistance, whereby a static pressure was obtained in the air delivered. Experiments were made with discs of different diameters, and it was found that the size of disc to give the best result depended upon the contraction of the delivery orifice, or upon the resistance offered to the passage of the air. Discs of 7in., 10in., 14in., 17in., and 22in. diameter were tried for the three contractions of the orifice. The trials showed that the more the air passage was baffled the larger became the disc required for maximum efficiency; with free discharge the presence of the disc only reduced the efficiency. The results are given in Tables 4 and 5. In Table 4 and Fig. 47 the fan was propelling air into the delivery tube, and the disc was placed in front of the fan in the delivery tube. In Table 5 and Fig. 49 the fan was exhausting air through the tube, and the disc was placed outside the tube but in front of the fan, which had been reversed upon its spindle. With the fan propelling air through the 6in. orifice, Table 4, only 31 cubic feet per minute were discharged when no disc was used; and with discs of 10in. and 14in. and 17in. diameter the discharge rose to 129 and 169 and 188 cubic feet respectively, the 17in. disc giving maximum efficiency. If the volumetric efficiency of the fan without the disc be taken as 100, then with the 17in. disc it becomes 606; while the mechanical efficiency is increased 223 times, from 100 up to 22,300. With the larger orifice of 12in. diameter the effect was not so great: the 14in. disc increased the volumetric efficiency 39 per cent., and the mechanical efficiency 169 per cent. With the still larger orifice of 18in. diameter, no difference was noticed when the 7in. disc was added, and the larger discs reduce the efficiency. Somewhat similar effects, but of less magnitude, were obtained when exhausting air instead of propelling. With the 6in. orifice in Table 5 the 14in. and 17in. discs increased the volumetric efficiency 17 and 19 per cent., and the mechanical 58 and 67 per cent. The fan was also tried with the disc on the back or inlet side, and also with the central part of the blades filled up to the same extent, but the result of either plan was that the efficiency was reduced. The disc was also tried at various distances in front of the fan, and the best position was found to be when touching the blades; it then allows the fan to feed near the centre at the back, and the air in entering the fan takes a radial direction due to centrifugal action, and then passes through over the disc. In Fig. 50 is shown the probable direction of the currents of air when the fan is propelling through a contracted orifice without a disc, showing that most of the air propelled by the tips takes a short circuit and enters the fan again at the centre, being thus only circulated in the fan. In view of the fact that this kind of fan is being employed in many cases with a contracted orifice, as in Fig. 49—as when drawing air through a material to be dried, like wool, or through tortuous flues, as in refrigerating apparatus—the adoption of the central disc becomes important, inasmuch as the efficiency of the fan can thereby be increased to such a great extent.

Forced and Induced Draught.—It is interesting to notice that with a contracted orifice the efficiency of the fan is higher in exhausting than in propelling. Referring to the experi-

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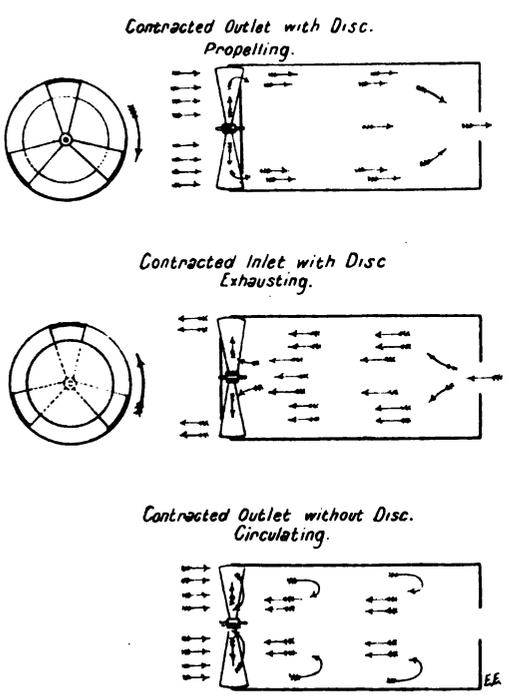
ments without circular discs in Tables 4 and 5, while 31 cubic feet of air per minute were propelled through the 6in. orifice at 800 revolutions per minute, the delivery was increased to 451 cubic feet when exhausting, the other conditions being identical; the volumetric efficiency was increased 15 times. With the 12in. orifice 497 cubic feet of air per minute were discharged by propulsion, and 1,374 when exhausting, the volumetric efficiency being increased nearly three times. With still less contraction the difference was not so great, the volumetric efficiency with the 18in. orifice being only increased from 58½ per cent. when propelling to 67 per cent. when exhausting. It thus appears that the freedom of the discharge or outlet side of the fan is of greater importance than the freedom of the suction or inlet side. As far as they go, and under the conditions under which they were made, the experiments seem to present an argument in favour of induced draught over forced.

Negative Slip, Effect of Thickness of Blades.—It is interesting to notice the great effect of the thickness of the blades, caused by fixing the curved surface to the backs of the blades. Comparing fans 1 and 2 in Table 1, the air discharge was increased from 2,128 cubic feet per minute in fan 1 to 2,888 cubic feet in fan 2 at 30 revolutions less per minute, merely by making the blades thicker. This is a substantial reason for the "apparent negative slip," which is sometimes noticed in a screw-propeller, when the pitch is calculated from the front face, without taking into account the round back whereby the virtual pitch is increased; and negative slip has generally been noticed in those propellers that have thick blades and round backs. Without entering into any theoretical views as



FIGS. 46 TO 50.—Diagrams showing the Effects of Contracted Outlets and Inlets.

to the action of the blades, which is a complicated question affected by many conditions, it may be said that, having regard to the stream-line principle, the section of the blades should be as ship-shape as possible, and that rotary motion of the air should be as small as possible. The two losses in an air-propeller are rotary motion imparted to the air, and skin friction of the blades; and the problem is to make the sum of these two losses as small as possible, and at the same time the delivery of air as large as possible. The loss due to the skin friction of the blades is comparatively small, as was ascertained by rotating the flat thin blades when their plane was set to coincide with the plane of rotation. The author's thanks are due to his assistant, Mr. S. G. Lovell, for his help in carrying out these experiments.

Note.—For convenience in making the calculations the fans have been taken at 24in. diameter, the same as the bore of the tube. This slight difference from the exact dimensions affects the results to an extremely small extent only.

ISLINGTON.

The electricity accounts of the Vestry of St. Mary, Islington, have just been issued, from which it appears that the total expenditure up to December 31, 1896, amounted to £102,101. 14s. 9d. We give herewith the revenue account and the general balance-sheet.

REVENUE ACCOUNT.

Expenditure.				£	s.	d.
Coal and other fuel	£1,860	0	8			
Oil, waste, water, and engine-room stores	569	15	9			
Wages at generating station	1,450	18	2			
Repairs and maintenance of boilers and machinery, £209. 17s. 11d.; buildings, £16. 19s. 10d.; instruments, £6. 9s. 7d.	233	7	4			
				4,114	1	11
Wages of linesmen, fitters, and labourers	38	4	4			
Repairs and maintenance of mains and indicators, etc.	19	17	0			
				58	1	4
Wages	100	10	0			
Repairs and maintenance	24	13	4			
				125	3	4
Poor and parochial rates and taxes				372	10	0
Printing and stationery	178	5	7			
Stamp duties and stamps	20	0	0			
Rent of telephone, etc.	48	17	6			
Insurance	167	1	3			
Legal expenses	44	9	10			
General establishment charges	111	17	3			
Salaries of electrical engineer and staff	574	9	8			
				1,145	1	1
Repairs, rates, and taxes (Burnard-place property)				143	4	10
				5,958	2	6
Balance—gross profit carried to net revenue account				1,614	15	6
				£7,572	18	0

Income.				£	s.	d.
Sale of current—public lamps, 137,516·4 units at 5d.				2,864	18	6
Private lighting, 117,406·5 units at 7d.	£3,424	7	0			
,, 10,464 ,, 6d.	261	12	0			
,, 14,991 ,, 5d.	312	6	3			
,, 17,423 ,, 4d.	290	11	0			
,, 24 ,, 3½d.	0	7	0			
				4 289	3	3
Rent of meters and other apparatus on customers' premises, service lines, etc				101	9	10
				7,255	11	7
Miscellaneous fees				40	16	5
Rents (Burnard-place property)				276	10	0
				£7,572	18	0

BALANCE-SHEET.

Liabilities.	£	s.	d.
Capital account—London County Council, Mortgage No. 1	8 858	14	1
London County Council, Mortgage No. 2	50,364	1	7
,, ,, ,, 3	5,109	13	6
,, ,, ,, 4	24,000	0	0
	88,332	9	2
Advance from bankers	12,951	4	9
Redemption of debt—amount redeemed to date	817	10	10
	102,101	4	9
Revenue account—sundry creditors: on open accounts, £593. 16s. 7d.; interest on loans, £771. 18s.	1 365	14	7
Cash account—balance overdrawn	5,653	11	2
	£109,120	10	6

Assets.	£	s.	d.
Capital account—amount expended	102,101	4	9
Revenue account—sundry debtors: on open accounts, £32. 16s. 11d.; for current supplied, £3,582. 13s.	3,615	9	11
Stores on hand—coal, £40. 12s. 6d.; oil, waste, etc., £146 16s. 6d.	187	9	0
Suspense account—for insurance premium paid in advance	48	0	0
Deficiency at Dec. 31, 1895, brought forward, £1,331. 19s.; deficiency for year as per net revenue account, £1,836. 7s. 10d.	3,168	6	10
	7,019	5	9
	£109,120	10	6

LEGAL INTELLIGENCE.

THETFORD ELECTRIC LIGHTING COMPANY.

The matter of the winding-up of the above company came before the Court of Appeal on Monday.

Mr. Stokes, on behalf of a client who, he said, was the holder of nearly one-half of the capital of the company—viz., 175 out of

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368 shares—asked the Master of the Rolls and Lords Justices Smith and Chitty to reverse the order of a Divisional Court, which had dismissed an application to have the company wound up compulsorily, and under the supervision of the Court, instead of voluntarily. Following an application to the judge of the Ipswich County Court to order a winding-up, which his client thought inevitable, though he was of opinion the creditors would be paid in full, the company held a meeting, and the chairman (it was the plaintiff's case) counted the votes wrongly, and not in accordance with the provisions of the company's articles. There was consequently a voluntary winding-up intended; but the plaintiff preferred that it should be done under supervision, and that he might have the opportunity of investigating charges which he had to make.

The **Master of the Rolls**, however, said he could see nothing in the case, as now stated to induce the Court to interfere with the decision appealed against, and taking it out of the ordinary course.

The **Lords Justices** agreeing, the appeal was dismissed.

DISPUTED ORDER OF ELECTRIC LAMPS.

In the Westminster County Court, on Tuesday, his Honour Judge Lumley Smith, Q.C., had before him the case of Goodwin *v.* Douglas in which the plaintiff, an electrical engineer, sought to recover the sum of £2. 8s. in respect of two dozen 16 c.p. lamps alleged to have been supplied to the order of the defendant, who carries on business at Bond-street.

The **Defendant** appeared, and said the goods were certainly sent to his place, but he denied ever having ordered them, or having given authority for the order. Moreover, the lamps were totally useless to him, as they were not suitable for his business.

His **Honour** said, in any event, the defendant had kept the lamps for three months, and now he must pay for them. Judgment would be for the plaintiff for the amount claimed.

CLAIM FOR ELECTRIC WORK.

In the Westminster County Court, on Thursday, his Honour Judge Lumley Smith, Q.C., had before him the case of Reed *v.* Jacobs, in which the plaintiff sought to recover the sum of £8. 14s. 6d. for work done to the order of the defendant.

The defence was that the charges for the work, which was done at the defendant's private residence, was altogether excessive, and could have been done for £1. 10s.

In cross-examination the **Plaintiff** admitted that the work was done in March, 1894, and no account was sent in until September, 1896.

His **Honour** gave judgment for the plaintiff for the sum of £1. 10s., which had been paid into court by the defendant.

COMPANIES' MEETINGS AND REPORTS.

READING ELECTRIC SUPPLY COMPANY, LIMITED.

Directors: Henry Collins (chairman), Frederick William Albury, F.R.I.B.A., Lewis William George Butler, Joseph Charles Fidler, George May. Engineer: F. F. Yeatman, M.I.E.E. Secretary: Ernest Francis, A.C.A.

From the report of the directors for the year ended December 31, 1896, it appears that the expenditure on capital account after deducting the amount realised during the year from the sale of the freehold land and buildings forming the late island station and a portion of the plant, etc, therein, amounted on December 31, 1896, to £35,212. 16s. 8d. During the year 1,312 additional ordinary shares of £5 each have been subscribed for in full and allotted, making a total share allotment to December 31, 1896, of 4,706 out of the first issue of 5,000 shares, and a total subscribed share capital of £23 530. As the result of much deliberation, the directors, in order to provide the requisite funds for carrying out extensions of mains and other works, decided to issue registered debentures of £100 each to the nominal value of £10,000, with power to increase, if necessary, to £25,000, carrying interest at 4 per cent. repayable on January 1, 1900, at par; and in December last a communication was addressed to each shareholder giving full particulars of the proposed issue and stating that in the first instance the debentures would be offered to the shareholders, and in proceeding to allotment regard would be had to the amount of the holding in shares of the respective applicants, so that every applicant would be entitled to an allotment of a debenture of £100 in respect of every £200 of his holding in shares before any other or further allotment was made In response to such communication the whole of the debenture issue of £10,000 was subscribed for by shareholders of the Company, but this subscription, with the exception of £275 application money, was not received on December 31, 1896. The total revenue for the year ended December 31, 1896, was £2,133. 10s 9d.; and the expenditure connected with the generation and distribution of electricity, management expenses, and a sum of £310. 15s. 9d. written off the buildings and plant at the central station and the mains for depreciation amounted to £2,094. 16s. 6d.—leaving a balance on the year's working of £38. 14s. 3d., which was carried to the credit of net revenue account. This balance, however, together with the credit balance of £18. 8s. 9d. on December 31, 1895, and the sum of £13. 4s. received during the year for interest on the investment in Corporation stock, amounting together to £70. 7s., was insufficient to meet the charge for interest on the Company's overdraft at the bank, and the net revenue account accordingly closed with a debit balance of £76. 6s. 4d. As already mentioned, the freehold land and building forming the late island station, together with a portion of the plant, machinery, etc., therein were sold during the past year, the remainder of the plant, etc., having been transferred to the central station. The increased demand for current has necessitated an addition to the existing plant, and the directors have, after due consideration, decided to purchase a new 200 kilowatt steam alternator, which it is hoped will be supplied and in use before the close of the present year. The directors have had under their serious consideration the question of giving a continuous supply of current from the central station, and propose to give such a supply in the ensuing autumn. In accordance with the intimation given in the report submitted to the last ordinary general meeting, additional mains have during the year been laid in portions of the residential districts on the east of Reading, and the Board have decided to extend the mains during this summer to portions of the residential district on the west of Reading. The directors have quoted terms for supplying the whole of the municipal buildings with current, which have been accepted by the Town Council, and a contract giving effect to the arrangement will shortly be entered into. It is with much satisfaction that the directors submit the following table, showing the rate at which the Company's business has progressed:

	Number of consumers.	Number of lamps wired.
December, 1894	38	2 150
December, 1895	83	4,300
December, 1896	154	8,700

and since December 31, 1896, the number of lamps added and applied for is 2,712.

REVENUE ACCOUNT YEAR ENDING DEC. 31, 1896.

Dr.				£	s.	d.
Coal or other fuel, including dues, carriage, unloading, storing, and all expenses of placing the same on the works	£612	13	11			
Oil, waste, water, and engine-room stores	74	1	4			
Proportions of salaries of engineers, superintendents, and officers, as certified by the managing engineer (generation of electricity)	60	15	10			
Wages and gratuities at generating stations	417	7	2			
Repairs and maintenance—buildings, £4. 0s. 5d.; engines, boilers, £59. 9s. 3d.	63	9	8			
				1,228	7	11
Proportion of salaries of superintendents and officers, as certified by managing engineer (distribution of electricity)	30	7	10			
Wages and gratuities to linesmen, fitters, labourers	36	19	4			
Repairs, maintenance, and renewals of apparatus at distributing stations	26	11	11			
				93	19	1
Rents payable	120	10	10			
Rates and taxes	66	12	2			
				187	3	0
Salaries of managing engineer, secretary, accountants, clerks, messengers, etc. (management expenses)	66	13	4			
Stationery and printing	54	6	6			
General establishment charges	54	15	3			
Auditors of Company	37	2	0			
Auditor appointed under the provisions of the order	15	1	9			
				227	18	10
Law expenses				6	16	0
Depreciation in respect of buildings	99	5	0			
Depreciation in respect of plant, machinery, etc.	211	10	9			
				310	15	9
Insurances, etc.				39	15	11
Total expenditure				2,094	16	6
Balance carried to net revenue				38	14	3
				£2,133	10	9

Cr.	£	s.	d.
Sale of current per meter at 6d. per B.T.U.	2,056	10	2
Rental of meters and other apparatus on consumers' premises, £76. 12s. 9d.; sale and repairs of lamps, arc or incandescent	77	0	7
	£2,133	10	9

GENERAL BALANCE SHEET.

Dr. Liabilities.	£	s.	d.
Capital account—amount received	34,805	0	0
Sundry tradesmen and others, due on construction of plant and machinery, fuel, stores, etc., to Dec. 31, 1896	3,036	8	9
Sundry creditors on open accounts	430	6	11
Depreciation fund account	390	13	3
	£38,662	8	11

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Cr. Assets.	£	s.	d.
Capital account—amount expended for works	35,212	16	8
Stores on hand at Dec. 31, 1896—coal, £140. 18s. 3d.; oils, waste, etc., £19. 16s. 10d.; general, £259. 10s. 7d.	420	5	8
Preliminary expenses.....	1,280	4	1
Sundry debtors for current supplied to Dec. 31, 1896	1,132	8	1
Other debtors	40	8	1
Investment in 3½ per cent. Reading Corporation stock	500	0	0
Net revenue account—balance at debit thereof	76	6	4
	£38,662	8	11

HASTINGS ELECTRIC LIGHT COMPANY.

On Tuesday afternoon, at the Queen's Hotel, Hastings, Mr. F. A. Langham presided over an ordinary general meeting of this Company.

In the report it was stated that the accounts indicated an increase in income of nearly £1,000 for lighting. Demand for the light was continuing, but the Company were unable to obtain an increase of capital, either to the extent or at the rate of interest they desired, to meet the demand. The balance against the Company had been reduced from £667. 8s. 9d. to £166. 2s. 2d.

The **Chairman**, in moving the adoption of the report and balance-sheet, referred to the determination of the Corporation to take over the public lighting, but he did not know whether they would be in a position to take it over by June 30, or whether they would desire the Company to continue the contract until their installation works were in readiness. There was no reason why the Company could not go on with it till September 30, and it would pay them very well.

Mr. A. Bray seconded the motion, which was carried.

At an extraordinary meeting held subsequently for the purpose of considering the proposed sale of the undertaking to the Corporation, the **Chairman** related the negotiations which had taken place and the offer to sell the concern for £58,000. He would not have advocated the proposal if they were in a position to raise money at 3 or 4 per cent., but seeing that there must be a constant demand for additional capital which they could only raise at 5 and 6 per cent., he thought it would be wise if the Corporation would give them enough to put their money back into their pockets, to sell. It would be handing over what would prove a great benefit to the ratepayers. The Corporation had said that they should not be required to pay for the purchase until March 31 next, and that the Company should carry on the business till that time, and they undertook that whatever was spent on capital, by the sanction of their engineer, would be repaid. He concluded by moving a resolution authorising the directors to enter into a provisional contract for the sale of the undertaking for £58,000, and to carry the same into effect in the manner and at the time they thought proper.

Mr. H. M. Baker seconded, and after remarks of approval the motion was carried.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Cologne.—Tenders will be received by the Municipal Authorities on September 3 for the working of about 12½ miles of electric tramway at Cologne. Particulars are obtainable for 3 marks (3s). Application to die Registratur B.

Butzbach (Germany)—Tenders will be received on June 1 for an electric lighting system for the city. Particulars for three marks (3s.) on application to the Burgomaster (Grossh. Bürgomeister Joutz) at Butzbach.

Ghent.—The city of Ghent has put out for competition the electric tramway service. Particulars are obtainable on application to le secretariat de la ville de Ghent, Belgium, and tenders must be in by July 2.

Morecambe.—The Urban District Council want tenders for a chimney shaft (129ft.), engine and boiler houses for the electric light generating station. Plans and specifications can be obtained from the Surveyor, at the offices of the Urban District Council, and tenders must be in by June 7.

Southampton.—The Corporation invite tenders for the supply and erection of water-tube boilers, mechanical stokers, coal conveyor, pumps, steam and water mains, water tank, water purifier, fuel economiser, and ironwork. Tenders to be in by June 16. For full particulars, see advertisement.

Santiago de Chile.—The Chilian Government Telegraphic Department will receive tenders on June 19, at Santiago, for the supply of galvanised iron wire, insulators, Morse instruments, paper for same, etc. Particulars (a summary only, and in Spanish) can be consulted at the Musée Commerciale, Brussels ; otherwise application is to Santiago.

Leeds.—The Corporation are prepared to receive tenders for the erection of a battery station in connection with the tramways at Kirkstall. Plans and specification may be seen and bills of quantities obtained on payment of a deposit of £2. 2s. (which will be returned on receipt of a bona fide tender) at the City Engineer's Office, Municipal Buildings, Leeds.

Rio de Janeiro.—The Secretary of State for Foreign Affairs has received a despatch from H.M. Consul-General at Rio de Janeiro enclosing a translation of an official notice setting forth the conditions under which tenders are invited for the telephonic service of that city and its suburbs. The tenders are to be presented by June 30, and the conditions may be inspected at the Commercial Department of the Foreign Office any day between 11 and 6.

Bray (Ireland).—The Township Commissioners require tenders for supplying, during ensuing 12 months, carbons, cables, house wires, switches, fuses, incandescent lamps, holders, casings, insulating materials, etc., and sundry articles more particularly specified in schedule, which will be forwarded, together with form of tender, on application to Mr. P. Macdonnell town clerk, Town Hall, Bray. Tenders to be delivered to the Town Clerk, properly sealed, and endorsed "Tender for ——," by 10 a.m. on June 7.

Huddersfield.—The Electric Lighting Committee of the Corporation are prepared to receive tenders for the supply and erection of two steam-boilers at the electric supply station, St. Andrew's-road, Huddersfield. Specifications may be obtained on application to Mr. A. B. Mountain, borough electrical engineer, St. Andrew's-road, Huddersfield. Sealed tenders, endorsed "Tender for Boilers," must be delivered, free of charge, addressed in the handwriting of the tenderer or his agent, to the Town Clerk, Town Hall, Huddersfield, not later than June 1, 1897.

Bedford.—The Urban Sanitary Authority are prepared to receive tenders for the supply and erection at the sewage pumping works of two alternating-current motors coupled direct to two vertical spindle centrifugal pumps, and the necessary cast-iron piping, valves, etc., for fixing and connecting the same. Specification and plan may be obtained from Mr. T. S. Porter, town clerk, at the Town Hall, on receipt of an application enclosing a deposit of £2, which will be returned on receipt of a bona fide tender. Sealed tenders, marked "Motors," must be delivered at the Town Clerk's Office not later than Tuesday, June 8.

Glasgow.—The Caledonian Railway Company require tenders for the supply of telegraph and electric appliances for 12 months from August 1. Specifications and forms of tender and any other necessary information may be obtained from Mr. Jas. Lorrimer stores superintendent, Caledonian Railway, Charles-street, St. Rollox, Glasgow. Patterns may be inspected from 9 a.m. till 5 p.m., at the company's stores, Charles-street, St. Rollox (Saturdays, 9 a.m. till 1 p.m.). Tenders, endorsed "Tender for Stores," to be lodged with Mr. J. Blackburn, secretary, 302, Buchanan-street, Glasgow, by June 7.

Belfast.—The Electric Committee are prepared to receive tenders for the supply and erection of the following plant: Section B 5—switchboard, instruments, and connections ; Section B 6—motor-generator and boosters. Specifications and conditions of contract may be obtained on application to Mr. Victor A. H. McCowen, Corporation electrical engineer, on payment of £1. 1s. per copy for each section, which sum will be refunded on the return of the specification with a bona fide tender. Sealed tenders, endorsed "Tender for ——," must be lodged in the office of Sir Samuel Black, town clerk, not later than noon on Thursday, June 3, 1897.

York.—The North-Eastern Railway Company require tenders for the following articles, in such quantities as they may require, during six months ending December 31, 1897, delivered carriage paid at the company's telegraph stores at York : (1) telegraph apparatus ; (2) telegraph wires and line stores. Payment for each month's delivery will be made at the end of three clear months, or in cash, less 2½ per cent. discount. Forms of tender may be obtained on application to Mr. Graves, Telegraph Department, York ; and tenders must be sent to Mr. C. N. Wilkinson, secretary, sealed and marked "Tender for Telegraph Stores," by noon on June 7.

Sunderland.—The Corporation require tenders for the supply of high-speed three-crank steam dynamo. Specification and schedule of quantities can be obtained from Mr. J. F. C. Snell, borough electrical engineer, Dunning-street, on payment of a deposit of £2. 2s., which will be returned on receipt of a bona fide tender. The persons or firms whose tenders are accepted will be expected to pay the rate of wages to the workmen engaged in carrying out the work which is payable by the particular trade affected by the contract in the district where the work is executed. Sealed tenders, addressed to the Chairman of the Highways Committee, Town Hall, Sunderland, must be sent to Mr. Fras. M. Bowey, town clerk, Town Hall, Sunderland, by 26th inst. not later than 12 noon. Tenders to be endorsed "Tender for Steam Dynamo."

Wakefield.—The Guardians invite tenders for the following work at the new infirmary : (1) electric lighting plant, combined steam-engine and dynamo, belt-driven dynamo, motor-dynamo, motor, switchboard, storage cells, etc.; (2) complete system of wiring for the electric light, also bells and telephones ; (3) vertical steam-engine, feed-water heater, tank, pumps, and pipe work, etc. Contractors wishing to tender for any of above sections must forward to Messrs. Shepherd and Watney, engineers, 71, Albion-street, Leeds, a deposit of £1. 1s. for such section, which will be returned on receipt of a bona fide tender. Specifications will then be forwarded to such applicants on or about May 13. Tenders must be delivered to Mr. H. Beaumont, clerk, Union Offices, Tetley House, Wakefield, in sealed envelopes, endorsed "Section No. 1, etc.," by noon on June 2.

RESULTS OF TENDERS.

Cardiff.—The Corporation have accepted the tender of the Park Coal Company, Salisbury-road, Cardiff, for the supply of about

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2,000 tons of washed pea-nut coal for the electricity works during 12 months ending June 30, 1898, at 7s. 9d. per ton.

Perim (China).—For the works contained in building telegraph station for shipment to Perim, for the Eastern Telegraph Company (Mr. C. Isaacs, Winchester House, Old Broad-street, engineer), the tender of Mr. Hawkins, Ashford, Middlesex (£690), was accepted.

Blackburn—For erection of chimney at electricity works, Jubilee-street, for the Corporation (Mr. E. M. Lacey, 10, Delahay-street, S.W., engineer), the following tenders were received :

R. B. Hilton and Son	£1,545	0	0
J. Hilton	1 445	14	9
Myles and Warner	1,294	0	0
J. Cronshaw	1,150	0	0
W. J. W. Cronshaw, 28, Montague-street, Blackburn (accepted)	950	0	0

BUSINESS NOTES.

Ramsgate.—Owing to the resolution of May 6 last at the Town Council meeting having been rescinded, the whole question of electric tramways is open for consideration again.

Morley.—The Corporation electricity works in Fountain-street are making good progress, and there is every prospect that the supply of electricity will commence on October 1 next.

Colliery Machinery.—A model of a working coal mine has been opened under the nave of the Crystal Palace. An electric coal-cutter can be seen in operation, and there is an electric drill.

Electric Welding.—The members of the East London Foremen Engineers' Association paid a visit last week to the works of the Electric Welding Company, and witnessed various experiments.

Calendar.—We have received a very handsome calendar from the Chloride Electrical Storage Syndicate, Limited, which departs from the usual custom of such things, and runs from May to May.

Monaco.—An electric tramway has been projected for the Principality, and has been definitely declared "of public utility" by a Royal ordinance. The work has been entrusted to M. Henri Crovetto.

Western and Brazilian Telegraph Company.—Receipts for the past week ending May 21, after deducting 17 per cent. payable to the London Platino-Brazilian Telegraph Company, Limited, were £2,162.

Blackheath.—The Board of Trade are about to approve the Blackheath and Greenwich District electric lighting provisional order, no further suggestions being forthcoming from the Lewisham District Board.

Hornsey.—The Urban District Council have declined to entertain for the present a proposal from Messrs. Edmundson's, Limited, of 19, Great George-street, Westminster, in respect of the electric lighting of the district.

Rawtenstall.—The surveyor has handed in his report to the Town Council on the visit of himself and Alderman Schofield to the Whitechapel destructor and the Shoreditch destructor and electric lighting station.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended May 23 amounted to £1,386, as compared with £1,178 in the corresponding week of the previous year, being an increase of £200.

Folkestone.—The Town Council at their last meeting approved the draft of the proposed deed of transfer of the Folkestone Corporation electric lighting provisional order to the Folkestone Electricity Supply Company, Limited.

Bristol Tramways and Carriage Company, Limited.—The traffic returns for the week ended May 22 were £2 483. 19s. 1d., compared with £2,183. 16s. 2d. for the corresponding period of last year, being an increase of £300. 2s. 11d.

Torquay.—The electric lighting works are already in hand. Extensive preparations are being made at the coal stores adjoining the Bath Saloons for the reception of the dynamos, boilers, and other plant, and about 30 tons of cables have arrived.

Brazilian Submarine Telegraph Company, Limited.—The directors have declared an interim dividend of 3s. per share, or at the rate of 6 per cent. per annum, free of income tax, for the quarter ended March 31, 1897, and payable on June 19.

Rowley Regis.—The District Council having discussed the proposal of the British Electric Traction Company to construct light railways within the district of the Council, have decided to await the result of a public meeting to be held at an early date.

Train-Lighting in Switzerland.—The Swiss railways are adopting electric light in their trains to a great extent. According to the *Schweizerische Bauzeitung*, 535 passenger carriages in Switzerland are now lighted electrically, and the number is continually increasing.

Swansea.—The Corporation Tramways Bill has been before the Select Committee of the House of Lords, and on the second day's proceedings the Chairman announced that the preamble of the Bill was not proved. This result has been received in Swansea with deep regret.

New Transatlantic Cable.—The new Transatlantic cable, which is to be laid between Brest and New York during the coming summer, will be 3,250 nautical miles long, and the total weight with its envelope is estimated at 11,000 tons. Four large ships are to be employed,

Thornton Motor Company, Limited.—This Company has been registered with a capital of £1,000, in £1 shares, to enter into a certain agreement and to carry on the business of motor car and carriage builders, cycle and cycle accessory manufacturers, engineers, machinists, etc.

City and South London Railway.—The returns for the week ended May 23 were £958 compared with £893 for the corresponding period of last year, being an increase of £65. The total receipts for the half-year 1897 were £21,461, compared with £19,693 last year, being an increase of £1,768.

Salford.—The annual report of the Finance Committee shows a loss on the electric lighting account during the year of £3,876, which is £1,252 more than the loss sustained during the previous year. The Electric Lighting Committee confidently look forward next year to the loss being decreased.

Jubilee Celebrations.—Messrs. Rose and Bird, Limited, Stamford-street, S.E., are making a speciality of lamps of 100 c.p., consuming 1 to 1¼ watts, in ordinary sized bulbs and fitted with either B. C. or E. S. caps, price 1s. 3d. each net to the trade only. Special quotations for large quantities.

French Improved Electric Glow Lamp Syndicate, Limited.—This Company has been registered, with a capital of £2,500 in £1 shares, to adopt an agreement with the Improved Electric Glow Lamp Company, Limited, and to carry on the business of electrical engineers, manufacturers, and contractors in France and her colonies.

Paris.—The sub-committee appointed to examine the tenders for the construction of the Metropolitan Railway in Paris has handed in its report, and it is stated that the work will be proceeded with forthwith. The motive power will be electrical, and it is estimated that 7,000 tons of copper wire will be required for its installation.

Bath.—The Local Government Board have, upon the representation of Mr. J. F. Meehan, written, stating that they consider further enquiry into the application of the Town Council to borrow £6,860 for purposes of electric lighting desirable. The Board intimate that the enquiry will take place as soon as the other engagements of the inspectors will permit.

Motor-Car Speeds.—At Leamington County Police Court on Wednesday, Alphonse Deniot, a Frenchman, late of Coventry, was fined £16. 4s. 6d., including costs, for driving a motor car at Leek Wootton on two occasions at a greater speed than 11 miles an hour, contrary to the Warwickshire County Council regulations. Defendant, it was alleged, drove at 30 miles per hour.

Newmarket.—The Urban District Council have accepted the offer of Messrs. Edmundsons, Limited, for the purchase of the Council's provisional order for electric lighting on the understanding that the sum payable by the Council to make up the profits of the company to 5 per cent. in the event of re-purchase should be computed on the average income of the company during their term of working.

Electricity on Table Mountain.—To increase their water supply, the Cape Town authorities have formed a reservoir on the summit of Table Mountain capable of holding 225,000,000 gallons. The engineers have arranged to make the water in descending to the level of the existing Molteno reservoir turn a set of turbines and generate electricity to work the tramcars and light the city.

Electric Lighting in West Sussex.—The Duke of Norfolk is having the whole of Arundel Castle lighted by electricity, and the new convalescent home at Littlehampton is similarly lighted. Messrs. Constable's brewery has, during the past week, been fitted up for a supply from machinery on the premises, and it is very probable that there will be an extension to the Bridge Hotel adjoining.

Glasgow.—The Electric Lighting Committee reported at the Corporation meeting that Mr. Richard Miller had offered to purchase from the Corporation the 106 Brush arc lamps at present burning in the street circuits, and which are to be replaced by new lamps, at the price of £3. 10s. each, less 2½ per cent, delivery to be given by the end of July next at latest. The offer was accepted.

Edinburgh.—At the Town Council meeting the Electric Light Committee recommended that the salary of the resident electrical engineer be increased from £400 to £500 per annum, and that the salary of the superintendent of mains be increased from £200 to £240 per annum. They also recommended the extension of the electric lighting mains to Newington and Murrayfield, at a probable cost of £1,900. This was agreed to.

Leeds.—In order to make room for the standards along the centre of the tramway track in Boar-lane to support the electric wires, it will be necessary to move the lines of rails 15in. farther apart, and the Telephone Company and the electric lighting company have intimated that they desire to lay cables on each side of the track. The City Council have decided to take this opportunity of laying the roadway with wood pavement.

Fleetwood.—The special committee *re* electric light reported at the Urban District Council meeting that they had instructed the clerk to communicate with the promoters of the Blackpool and Fleetwood Electric Tramroads Company with reference to the terms and conditions upon which the provisions of the Blackpool and Fleetwood Tramroad Act, 1896, Section 67, may be brought into effect, for the supply of electrical energy in this district.

The District Railway "Deep Level" Scheme.—The Select Committee of the House of Commons appointed to consider the Metropolitan District Railway Bill have reported to the House their sanction to the proposed "deep level" railway from Earl's Court Station to the Mansion House. The additional capital

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sanctioned for this line is £1,200,000, and £500,000 for electrical works, which will enable the company to work the existing railway, as well as the new railway, by electricity.

Madeira.—An English company has obtained a concession for 40 years from the Municipality of Madeira to supply electric power for that town. The necessary plant for the installation is of English manufacture, and has been admitted under special arrangement free of duty. The contractors also are English, and they hope to have the works completed early in the summer, when the present means of illumination—which is by petroleum lamps—will be superseded by one which will be more in keeping with modern requirements.

Bilston.—A suggestion has been thrown out that to commemorate the Diamond Jubilee year the town should be lighted by electricity, and to this end that the District Council should take the necessary steps to obtain a provisional order from the Local Government Board. It is estimated that the plant would cost £25,000. This amount, borrowed at 3 per cent., would cost the ratepayers £750 per annum for the specified term of years in repayment of principal and interest. Against this the Council already pay £1,200 per year for gas.

Hospital Lighting.—Upon the recommendation of the Works Committee the Metropolitan Asylums Board at their last meeting, agreed that the plans and specification prepared by Mr. Tiltman, architect, for lighting the Grove Hospital by means of electricity be generally approved, and that tenders for the works be invited by advertisement; and that the plans and specification prepared by Mr. Tiltman, architect, for the supply and fixing of the cooking apparatus at the Grove Hospital be generally approved, and that tenders for the same be invited by advertisement.

Lincoln.—By invitation of Mr. Thos. Bell, the managing director of Robey and Co., the members of the Corporation and the Corporation officials inspected an electric light installation at the Globe Works last Friday afternoon. The installation consisted of a compound high-speed vertical engine with flywheel alternator, which the firm has just completed for Hong Kong. The visitors were also shown a horizontal slow-speed engine of 250 h.p., being the fourth of equal construction supplied by the firm for the municipal lighting of the city of Bilbao, Spain.

London Lighting Extensions.—The London County Council have had for sanction notices of extensions of mains in Redcliffe-square and Manson-place by the House-to-House Company; in Union-street, Pepper-street, Orange-street, Quilp-street, etc., by the London Electric Supply Corporation; from Knightsbridge-road, through Knightsbridge-green to Brompton-road, by the Kensington and Knightsbridge Company; in Windmill-street and across Charlotte-street from Tottenham Court-road, by the Vestry of St. Pancras, besides notices from the Hampstead Vestry.

Electricity Applied to Railways.—The directors of the New York, New Haven, and Hartford Railway Company, in conjunction with the directors of the New York and New England Railroad Company, have been making an important experiment in electricity. A train moved and controlled by electricity developed at a central power-house was run from Berlin to Hartford on a regular schedule between two trains drawn by steam locomotives in the ordinary way. The electrically-equipped train did not in any way interfere with the passage of the train drawn by locomotives.

A Motorcar Accident.—Proceedings were taken in Hove Police Court a few days ago against Charles Fredk. Monk, Beaconsfield-road, Brighton, for causing injury to an elderly man named Welch, a flower-seller, by failing to give notice of the approach of the motorcar that defendant was driving. The car was going at 10 miles an hour, and Welch, being knocked down, had five of his ribs broken, besides other injuries. The defence raised was that Welch had contributed to the accident by turning in the road. The Bench convicted the defendant, and fined him the full penalty, £5 and costs.

Cheltenham.—An enquiry has been held by the Light Railway Commissioners into the application made by Mr. Nevins for an order under the Light Railway Act authorising him to construct and maintain a line from Cheltenham to Winchcombe. Mr. Banks (instructed by Messrs. Lumley and Co.) appeared on behalf of the promoter, and explained that the sanction of the Commissioners was not asked that day to the whole of the original scheme, but merely to an instalment of it, the intention of Mr. Nevins, however, being to apply for an order for the completion of the scheme at the earliest possible moment.

Maidstone.—The Electric Lighting Committee reported at the Urban District Council meeting that the 12 months for which the electric lighting question was adjourned had now expired. The committee recommended that the matter be now considered by the whole Council in committee. Mr. Morling moved the adoption of the report, which was seconded by Mr. Lawrence, and carried. Mr. Barker gave notice that he would move at the next meeting that the Council carry out the order itself. He altered the date of his motion till a month that day, as it was thought it would forestall the decision of the committee.

Liverpool Electric Trams.—Some time ago the Liverpool Corporation sent Sir Arthur Forwood to America to enquire into the different systems of tramway traction in use in the United States. Sir Arthur has returned, and reported that, in his judgment, the electric system is the only suitable one, and he also recommended that Mr. F. S. Pearson, the consulting engineer to the City of Birmingham Tramways Company, should be consulted. The Liverpool Corporation have accordingly appointed Mr. Pearson their consulting engineer, and Mr. Pearson has gone to Liverpool in order to advise the Corporation on the matter.

The Turin Exhibition.—For the occasion of the National Exhibition which will be held in Turin, Italy, in the summer of 1898, to celebrate the fiftieth anniversary of the proclamation of the Italian Constitution, the special department of electricity is soliciting exhibits from all countries. The electrical section will be divided into 11 classes, including all of the applications of electricity in the arts, historical exhibits, etc. The large amount of unemployed hydraulic power in Italy is said to afford a considerable field for enterprising electrical engineers. Communications and applications for space should be addressed to Angelo Alasia, 3, Via San Maria, Turin, Italy.

The Birmingham Trams.—The Public Works Committee have the following paragraph relating to this matter in their report to the next meeting of the City Council: "Your committee report that, although they have given every attention to these matters, and have been in constant communication with the City of Birmingham Tramways Company thereon, they have not at present been able to come to a satisfactory arrangement with the company. They hope, however, to be able to report fully thereon in a short time. In the meantime they consider it undesirable in the public interest that the matter should be publicly discussed, and they ask the indulgence of the Council in this respect."

Montreal.—A. J. Corriveau, who was the chief promoter of the system of electric railways which now covers the Island of Montreal, is interested in a scheme to build an electric railway from St. Lambert or Longueuil, opposite Montreal, to points in Eastern Quebec not touched by the trunk line railway, as far as Sherbrooke, with crossing powers over the bridges, ultimately connecting with the railway systems at Newport, Vt. The company also propose to put electric launches on the River Richelieu, to run from St. John's to points on Lake Champlain. The whole system will cover something like 150 miles, and the power is to be supplied by the Chambly Rapids Water and Power Company.

St. Luke's, E C.—The Board of Churchwardens and Overseers have reported to the Vestry that they had received the report of Messrs. Eve and Son, valuers, upon the investigations, etc., made by them as to the values for rating purposes of the property of the electric light company, and the telephone wires in the parish. It was resolved (1) that the valuation of the electric light company's property be accepted, and that the assessment be placed in the next provisional valuation list at £580 gross value and £387 ratable value; (2) that the clerk communicate with Messrs. Eve and Son with reference to the assessment of the telephone wires, and state that in the meantime consideration thereof be deferred. This was agreed to.

Halifax.—The Tramways Committee reported at the Town Council meeting that they had arranged the service as follows: five minutes between Church-street and the Post Office, 10 minutes between the Post Office and King Cross. The committee had further decided that the system of side poles and brackets, with a double line of overhead wires on the tramway routes, should be adopted; also that the borough engineer be instructed to prepare specifications and forms of tender for the supplying and laying of rails, paving work, erection of sheds at the Highroad Well depôt, and for erecting poles, brackets, and overhead wires, and for the supply of cars and motors. The minutes were adopted.

Chester.—At the Town Council meeting the Electric Light Committee asked authority to have distributing and arc cables laid, and to provide for arc lighting in Northgate-street to the junction of the Liverpool and Parkgate roads, and in Boughton, from City-road to the fountain at the junction of the Tarvin and Whitchurch roads. The Mayor, in moving the recommendation, said the committee thought these were very important thoroughfares, and should be lighted as far as the points indicated. Possibly it might encourage those who dwelt in neighbourhoods abutting upon these thoroughfares to take the light from the Corporation, and they only hoped it might do so. Mr. John Jones, Boughton, seconded, and the motion was carried.

The Blackwall Tunnel.—To provide for the electric lighting of the tunnel there is a large generating station on the Poplar side of the river, where there are three Lancashire boilers supplying steam to five compound steam dynamos of the latest type. Three of these dynamos are of 120 h.p., and the other two of 60 h.p. They supply not only light, but power to six motors driving pumps and lifts and the tools in the well-equipped workshop attached to the generating station. Mr. T. P. Gunyon, the Council's chief electrical engineer, has designed the whole electric system, and he has arranged for lamps of larger candle-power at the entrances than in the interior, so that the transition from broad daylight to the artificial illumination of the tunnel may be less trying to horses and drivers on entering.

British India Rubber and Exploration Company, Limited. This Company has been formed, with a share capital of £200,000 in £1 shares and an issue of £100,000 6 per cent. first mortgage debentures, to acquire, carry on, and further develop the great rubber-growing territory of Appaboomah, situate about 35 miles north of Cape Coast Castle, West Africa, and within British jurisdiction. This territory, having an area of some 500 square miles, or about 320,000 acres, is held for a period of 99 years from December 31, 1895, with the right of renewal for successive periods of 99 years on giving three months' notice in writing. The purchase price to be paid has been fixed by the vendor at £250,000, payable in shares or debentures or cash, or partly in either of them, at the option of the directors. Subscriptions are now invited for the whole of the ordinary shares and the debentures.

Accident on the Isle of Man Electric Railway.—A young gentleman named Platt met with a serious accident at Douglas

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last week. In company with a friend, he had been playing on the Howstrake Golf Links, and on leaving they signalled an electric car coming along from Laxey to stop, but the driver signalled back to signify it was a through car and could not stop. Platt succeeded in safely springing on to the side step, holding on to the iron grip. Swinging round to look where his friend was, his body projected so much beyond the car that his head came in contact with the pole between the lines which supported the arms carrying the out and in track wires. He was knocked off the car, which was stopped, and it was found that he was unconscious, with his face badly cut. He was conveyed to the Bay View Hotel. Medical aid was summoned. In about an hour Platt recovered consciousness, and the doctor was able to state that he was out of danger.

Toronto.—A Toronto syndicate, which has been securing options on the stock of the Street Railway Company and other lines, of Hamilton, Ontario, has laid before the City Council a proposition looking to the control of the electric railways in that city. It is proposed that a company, to be known as the Hamilton Franchise Company, shall be formed to acquire from the syndicate the property upon which it has options, including the Hamilton and Dundas Railway. The syndicate will accept its pay half in stock of the company and half in bonds. The interest on these bonds is to be first charged on revenue of the company, then at 6 per cent. dividend on stock, after which the city is to receive all the balance of the net revenue up to 20,000dol., when the stockholders may receive another 1 per cent., and the city all the remainder. The city is to relinquish its mileage and percentage on the Street Railway earnings, which now amount to about 14,000dol. annually. The city will have the right to appoint certain directors in the new company. It is probable considerable discussion will take place before the deal goes through.

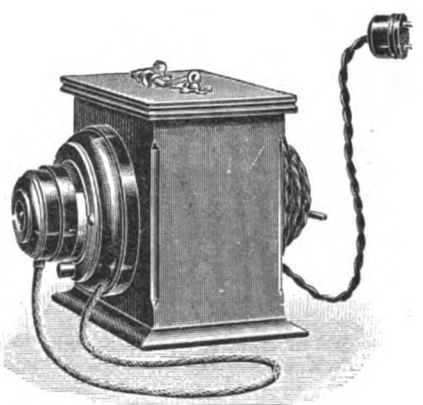
Calcutta Electric Supply Corporation.—The Calcutta Electric Supply Corporation, Limitod, has a capital of £100,000, in £5 shares, of which 6,500 have been subscribed at par, the balance being now offered. The prospectus states that the Company has been formed to take up and work a license granted to Messrs. Kilburn and Co. as agents for this Company, by the Government of Bengal for the supply of electrical energy for lighting and power in Calcutta. The license is for 21 years from December 29 last, the municipality being authorised to purchase the undertaking on the expiration of the license on the basis of its value as a going concern. If not purchased, the Government of Bengal have promised to renew the license for a further like period upon the same terms. A considerable demand for electric current is expected in Calcutta, as it has hitherto been adopted only in a few instances, owing to the cost of separate installations. A contract has been entered into to erect and equip a generating and distributing station, with plant complete, estimated to be sufficient to meet an initial demand for supplying 60,000 8 c.p. lamps for £65,000, in which is included the initial expense incurred in obtaining the license.

Llandudno.—It was resolved at the Urban District Council meeting that Mr. T. T. Marks be appointed chairman of the Electric Lighting Committee for the ensuing year. Mr. Marks explained the position with regard to the electric lighting scheme and the provision of a refuse destructor, and submitted a long report from Mr. Preece, the engineer, setting forth the cost of the scheme to be £25,000, and the necessity of urgency in concluding the preliminary arrangements if the scheme was to be ready by the season of 1898. He moved that, in order to forward matters, the committee be empowered to act. Mr. Thorp seconded. Mr. J O. Thomas thought it would be preferable to have special meetings of the Council in such an important matter, involving a large outlay. Mr. T. W. Griffith objected to giving a committee power to spend £30,000, or perhaps £35,000, without consulting the Council. He did not think that was a constitutional way of carrying on business. Mr. Bevan suggested that the committee have power to act provided they do not exceed the £25,000 estimate. Mr. Marks was willing to make greater concession than that. He amended the resolution, that the committee have power to act up to the point of accepting tenders. This was agreed to.

Epsom.—Some discussion took place at the Urban District Council meeting on the question of giving instructions for preparing specifications for the installation of the electric light. Mr. Langlands thought they only applied for a provisional order to keep other people out. Mr. Beams was of opinion that the sooner the electric light was adopted for Epsom, the better for all of them. Mr. Jay said he would want to be convinced that they would have certain value for their money, as he felt alarmed at the way the rates were going up with these innovations. He learnt from some other districts, where this system of lighting was in force, that they were sorry they had taken it up, and he wished to know what the expenses were going to be. Mr. Langlands said in the first instance they decided upon the spending of 25 guineas for advice, and now the expenses were running into hundreds. The Chairman said they must obtain a specification, or otherwise their labour would be thrown away. He thought a good many people would be pleased to see Epsom lighted by electricity, as they were all aware of their unsatisfactory relations with the gas company, who had drivon them to apply for the provisional order. Having gone so far, he thought they must proceed to the next step. Mr. Chuter said the gas company actually drove them to do what they had done. Mr. Langlands: You hold this provisional order over the heads of the gas company. On the motion of Mr. Northey, the clerk was directed to ascertain the cost of preparing the specification.

The Dublin Trams.—An adjourned special meeting of the Municipal Council has been held for the purpose of considering the report of the committee of the whole house in reference to the agreement to be entered into between the Corporation and the Dublin United Tramways Company, granting the company liberty to extend their existing lines, to construct new lines of tramways, and to use electrical traction within the city. Mr. R. S. Tresilian, assistant secretary, and Mr. George Collins, of Messrs. Casey and Clay, solicitors to the tramway company, were in attendance. Alderman Sir Robert Sexton moved the adoption of the report, and said it had been the subject of long discussion and a good deal of controversy, and had been thoroughly threshed out in a very large committee. The principal thing in the agreement between the Corporation and the tramway company was that the company had a lease of 40 years of the lines made and now contemplated. They agreed to pay the Corporation in respect of existing lines and lines to be constructed £500 per year per street electrically equipped, the minimum payment to be £10,000 per annum. The company were also under certain restrictions as to the way in which the lines were to be constructed and lay down. The payment by the company amounted to about 6*d*. in the pound on the rating. Mr. Jones seconded the report, and it was unanimously adopted. The Dublin United Tramways (Electric Powers) Bill and the Dublin Electric Tramway (New Lines) Bill have been before the Select Committee of the House of Lords.

Sick-Room Telephone.—The accompanying illustration represents a small telephone manufactured by the General Electric Company, Limited. The idea is to establish communication



between the sick-room and the outside world, and in cases of infectious illness there is no doubt that this instrument, which is sold at 45s., would be of considerable benefit.

Birmingham.—Another meeting of the Public Works Committee has been held this week, at which the conference between the committee and their advisers and the representatives of the City of Birmingham Tramways Company was continued. The committee sat for nearly four hours. The chief difficulty arose in connection with the requirement on the part of the committee that if electric conductors were employed they should be placed in an underground conduit, and should not take the form of overhead wires. The company represented that it would be absolutely impossible in the 21 years' lease to recoup the heavy capital which this form of traction would involve. The conduit system such as the committee required would involve an outlay of £12 000 per mile, and it was further pointed out that no other corporation in the kingdom had laid down or demanded such a system. It was also pointed out that what the company did in the city they would be required to do by the suburban districts outside. The company's estimate of cost was regarded by the committee as excessive; and they also intimated that the relations of the company to the outside districts was not a matter of which the Corporation could take cognisance. At first the company had asked that they should be conceded a term of 42 years, but this having been most absolutely refused the company proposed that 30 years should be granted. The majority of the members of the committee, while not unwilling to make some concession, regarded 30 years as too long. Alternatives were suggested bearing upon the question of an easier rental, and, although it was found impossible to arrive at a settlement, the hope of some compromise was not abandoned, but a further adjournment was made until next week, with the understanding that in the interval the engineers and surveyors on both sides should endeavour to arrive at an agreement upon the exact facts concerning the cost of construction. At the same time some legal points will also be discussed between the town clerk and the solicitors to the company.

PROVISIONAL PATENTS, 1897.

MAY 17.

12126. Improvements in arc lamps. Willis Nelson Stewart, Fred Beanland, and John William Perkin, 30, Park-row, Leeds.

12128. Improvements in apparatus for working railway points and signals by electric power. Francis William Webb and Arthur Moore Thompson, Holly Bank, Crewe.

12210. Improved electrical traction apparatus. Raoul Demeuse, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

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12134. Improvements in the hanging of electroliers and other electrical fittings. Ernest Alexander Claremont and Frederick Henry Royce, Cooke-street, Hulme, Manchester. (Complete specification.)

12204. A new or improved method of retransmitting telegraphic messages and apparatus for use in connection with the said method and for other purposes. John Rymer-Jones, Norfolk House, Norfolk-street, London.

12211. Improvements relating to electric traction Felix Frederic Martial Antoine Nave, 45, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, November 17, 1896, being date of application in France.)

MAY 18.

12237. Automatic electric signal for railways. George Frederick Gascoyne, 7, Shakespeare-street, Nottingham.

12251. Improvements in electric indicators. Frederick Jones, 64, Grant-road, Clapham Junction, London.

12327. A new or improved device for use in connection with storage batteries Georg Walter, 70, Chancery-lane, London. (Complete specification.)

12329. A new or improved arc enclosing device for electric arc lamps. Samuel Edgar Fedden, James Wheatley Prior, and Robert Middlemass, Norfolk House, Norfolk-street, London.

12336. Improvement in electric arc lights. Daniel Asa Shesler, 40, Chancery-lane, London.

MAY 19.

12423. Improvements in electric bell pushes and the like. John George Dixon, 70, Palace-chambers, Westminster, London.

12431. Improvements in pipes or conduits for conveying sewage or for containing electric conductors or for analogous purposes. William Gosling, 47, Lincoln's-inn-fields, London.

12435. Improvements in electric conducting cords and means for connecting them to walls and other supports. Mór Károly Perci and Frigyes Schacherer, 46, Lincoln's-inn-fields, London.

MAY 20.

12443. Improvements in electric accumulators. Alexis Werner and Paul de Kilduchevsky, 49, Bernard-street, London.

12455. Improvements in and relating to prepayment devices for use with telephones. Siegfried Silberberg, 70, Market-street, Manchester. (Complete specification.)

12469. An improved method of arranging the coils of a set of electrical resistances and means for manipulating the same. John Horace Reeves, 2, John-street, Bristol.

12473. The electromagnetic propulsion machine. William Thomas Pember, 25, Toronto-street, Toronto.

12530. Improvements in dynamo-electric machines. William Morris Mordey, 46, Lincoln's-inn-fields, London.

12531. Improvements in electric switches. Gerald William Partridge, 46, Lincoln's-inn-fields, London.

12544. Improvements in the process and apparatus for the electrolysis of alkaline solutions and the like. Henri Pierre Marie Brunel, 40, Chancery-lane, London.

12549. Improvements in plates for accumulators. Wilhelm Majert, 18, Southampton-buildings, Chancery-lane, London. (Complete specification.)

MAY 21.

12589. Improvements in automatic circuit-closing devices for galvanic batteries. John Duvall Holmes and Webster Lafayette Heath, 89, Chancery-lane, London.

12639. Improvements in means for regulating the voltage of dynamos. La Société Générale des Industries Economiques, 46, Lincoln's-inn-fields, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, March 20, 1897, being date of application in France.) (Complete specification.)

12642. Improvements in contact fingers for electric controllers. Eugene Chilton Parham, 45, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103 November 18, 1896, being date of application in the United States.) (Complete specification.)

12643. An improved system of conductors for electric railways. Eduard Lachmann, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

MAY 22.

12675 Improvements in galvanic batteries. Robert Krayn and Carl Koenig, 70, Market-street, Manchester. (Complete specification.

12692. Automatic steering apparatus for toy or other sailing, steam, electric, and other motor-driven boats. Edwin Yarrington Mackenzie, 60, Queen Victoria-street, London.

12714. An improved insulating and carrying frame for accumulator electrodes. Friedrich Wilhelm Schneider, 18, Buckingham-street, Strand, London. (Complete specification.)

12726. Improvements in telegraph apparatus applicable for ships and other like apparatus. Peter Douglas and Harry John Beswick, 6, Lord-street, Liverpool.

12721. Improvements in the construction and regulation of arc lamps. Henry Leitner, 37, Chancery-lane, London.

SPECIFICATIONS PUBLISHED.

1896.

6423. Electric switches. Dingle and Urquhart.

8973. Electrical organs. Strand and Stockton.

9806. Apparatus or devices for starting and arresting electromotors employed in driving wire-drawing or other similar machines. Pieper.

9843. Electric current meters. Wilson.

9975. Conduits for electrical conductors. Bathurst.

10069. Method of and apparatus for electrically controlling or adjusting the position of rudders, guns, signals, and the like. Pfatischer.

10272. Dynamo-electric machines. Harrison.

11858. Portable electrically-driven pumps. Merryweather.

12637. Electric motors and transformers. Cooley.

13200. Charging of accumulators. Strömberg.

13271. Electric switches. Verity.

13644. Electrical accumulators. Greengrass and Docking.

13847. Electro-mechanically operated gas-lighters and the like. Armstrong and Orling.

14397. Electric arc lamps. Andersen.

14464. Telegraphy. Essick.

15162. Electric meters. Siemens Bros. and Co., Limited. (Siemens and Halske.)

16852. Electrolysis. Poore.

23282. Method of and arrangements for illumination by means of incandescent electric lamps. Champion.

25904. Regulating polyphase circuits. The British Thomson-Houston Company, Limited. (Armstrong.)

1897.

964. Reflectors for electric lamps and supports for the same. Anderson and Waterman.

4198. Electric motors and dynamo-electric machines. Lake. (Sperry.)

4934. Electric arc lamps. Deleavau and Brérat.

6868. Electric arc lamps. Adams.

7462. Current supply and conduits for electric traction. Sayer.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	9¼-9¾
Brush Company, Ordinary	5	1½-1¾
—— Non. Cum., 6 per cent. Pref.	2	1⅝-1¾
—— 4½ per cent. Debenture Stock	100	104-108
—— 4½ per cent. 2nd Debenture Stock	100	96-99
Callender's Cable Company, Debentures	100	110-115
Central London Railway, Ordinary	10	9¾-10¼
——	6	5¾-6¼
Charing Cross and Strand	5	13-14
Chelsea Electricity Company	5	10½-10¾
—— 4½ per cent. Debentures	100	112-116
City of London, Ordinary	10	23½-24½
—— 6 per cent. Cumulative Pref.	10	17-18
—— 5 per cent. Debenture Stock	100	131-136
City and South London Railway, Consolidated Ordinary	100	58-60
—— 4 per cent. Debenture Stock	100	137-139
—— 5 per cent. Pref. Shares	10	15½-16
County of London and Brush Provincial Co., Ordinary	10	12½-12¾
—— 6 per cent. Cum. Pref.	10	15-15½
—— 4½ per cent. 2nd Debenture Stock	10	14¾-15¼
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	1¾-2¼
—— 5 per cent. Debentures	—	90-95
Edison and Swan United Ordinary	3	1¾-2¼
—— 5 per cent. Debentures	5	3-4
—— 4½ per cent. Debentures	100	105-110
Electric Construction, Limited	2	1¾-1¾
—— 7 per cent. Cumulative Pref.	2	2¼-2¾
Elmore's Copper Depositing	1	¾-1
Elmore's Wire Company	2	1-1¼
W. T. Henley's Telegraph Works, Ordinary	10	18-19
—— 7 per cent. Preference	10	18½-19½
—— 4½ per cent. Debentures	100	106-113
House-to-House Company, Ordinary	5	9¼-9¾
—— 7 per cent. Preference	5	9¾-10¼
India Rubber and Gutta Percha Works	10	20½-21½
—— 4½ per cent. Debentures	100	104-107
Kensington and Knightsbridge Ordinary	5	12-12½
—— 6 per cent. Pref.	5	8-8½
London Electric Supply	5	1¾-2¼
Metropolitan Electric Supply	10	17-18
—— 4½ per cent. First Mortgage Debenture Stock	100	120-124
National Telephone, Ordinary	5	6¼-6½
—— 6 per cent. Cum. First Pref.	10	15-17
—— 6 per cent. Cum. Second Pref.	10	15-17
—— 5 per cent. Non. Cum. Third Pref.	5	6-6½
—— 3½ per cent. Deb. Stock	100	105-109
Notting Hill Company	10	15-16
Oriental, Limited, £1 shares	1	1¼-2
—— £5 Shares	5	8½-9
—— £4½ shares	4½	7½-8
Oriental Telephone and Electric Company	1	¾-1
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	102-104
St. James's and Pall Mall, Ordinary	5	15½-16½
—— 7 per cent. Pref.	5	10-11
Telegraph Construction and Maintenance	12	34-37
—— 5 per cent. Bonds	100	103-106
Waterloo and City Railway, Ordinary	8	10¾-11¼
Westminster Electric Supply, Ordinary	5	15½-16¼
Yorkshire House-to-House	5	8¼-8¾

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NOTES.

The Institution Secretaryship.—Mr. Walter G. McMillan, F.I.C., F.C.S., lecturer on metallurgy at Mason College, Birmingham, has been elected to fill the appointment of secretary and librarian of the Institution of Electrical Engineers on the retirement of Mr. F. H. Webb, and he will enter on his duties in the latter part of the year.

The New Magnetic Observatory.—In the House of Commons on Friday last, replying to Lord Hugh Cecil, the First Commissioner of Works (Mr. Akers Douglas) said a site had been selected for the new magnetic observatory at Greenwich. Her Majesty the Queen had been pleased to signify her consent to the handing over of the Ranger's Lodge at Greenwich to the Commissioners of Woods and Forests, to form part of the hereditary land revenues of the Crown. A portion of Greenwich Park will at the same time be thrown into the park for the use of the public.

Anglo-French Telegraph Rates.—The Liverpool Chamber of Commerce has had under consideration some strong representations which the British Chamber of Commerce in Paris has been making to both the French and English Governments that the rate charged on Anglo-French telegrams was too high, and should be reduced from 2d. to 1d. per word. The Liverpool Chamber has written to the Postmaster-General strongly urging the reduction sought by the Paris Chamber, and pointing out that, as the result would probably be an increase in traffic, it would doubtless repay itself. In this connection it was pointed out that telegrams to France were often delayed and not promptly delivered to the recipients, and it was resolved to solicit again the co-operation of the Paris Chamber in the matter.

A Tramway Incident.—According to the *Detroit Evening News*, the extraordinary spectacle of a fountain of water springing from the top of an electric tramway pole has been witnessed in that city. It naturally drew a crowd who looked on with amazement. When a gang of men were set to work to discover the occasion of the phenomenon, in the course of time they came to a water-pipe, which ran beneath the pole. This had been eaten through with electrolysis, and the water burst through, entered the hollow iron trolley pole, and having nowhere else to go, came out at the top. Electrolysis trouble is usually ascribable to insufficient rail return. It is believed that such a pretty demonstration of the necessity of looking out also for bad work or accident in the insulation of the trolley line is unique.

City and Guilds of London Institute.—At the Imperial Institute on the 27th ult. Viscount Cross opened an exhibition of work done by scholars. The work consisted principally of examination tests, done at the examinations held by the institute for certificates to be granted to artisans, students, and others. There were represented mechanical engineering, carpentry and joinery, cabinet-making, practical plumbing, cotton-weaving, needlework, etc. There was practically nothing connected with electrical engineering, and how it is that this was so may perhaps be explained by a paragraph from the report of the work of the examinations department, which was distributed at the opening ceremony. Under the heading of electric lighting and power, this report says, "The conclusion seems inevitable that in many cases the teachers who are conducting the classes are not engineers at all, but possess only a book knowledge of electrical work." But that is a matter which was commented on at the time, and need not be further revived.

A Canal Congress.—The congress of the German and Austro-Hungarian Association for the Promotion of Inland Navigation has been held in Vienna, and was brought to a close last week. In the course of the proceedings several matters of high importance for the commercial future of the Central European States were discussed. Austro-Hungarian party politics are varied and curious in many ways, and an interesting feature of the congress was the protest raised against the hindrances to the development of inland navigation due to the opposition of the Agrarian party. Among other matters discussed, the question of utilising the water power in the projected Moldau-Danube Canal to generate electricity for traction and other purposes was considered. The Biwa-Kioto Canal in Japan was referred to as the most striking instance of this description. There the power generated is used not only for traction on the canal itself, but for lighting various towns along its banks and for driving the machinery in a number of large and small factories.

The Marconi Telegraph.—Mr. Preece is to lecture to-night on the Marconi telegraph. It is understood that he has succeeded in signalling with it right across the Bristol Channel between Weston-super-Mare and Penarth—say, 10 or 11 miles of sea. Some little while ago *L'Avvenire*, of Bologna, in congratulating that city that "the greatest discovery of the end of the century" should be joined to the name of a Bolognese, goes on to remark on the fact that Mr. Marconi is little more than 24; and that he finds himself in London is due to the fact that his invention was not properly appreciated in his own country, although it has received the applause and encouragement of English experts, and the English Government has offered the inventor a very considerable sum for his discovery. *L'Avvenire* further claims that this is really something quite beyond a "mere application of the results of Hertz." There is a reference to the interview published by the *Strand Magazine*, which is, however, hardly reassuring as to our contemporary's precise knowledge of this part of the subject.

Contact Electricity.—When Lord Kelvin a fortnight ago discoursed on contact electricity of metals, it appears that he intended to spring nothing less than a new theory of the nature of electricity on his audience at the Royal Institution. Finding, however, that he had exceeded the accustomed hour by not far short of five-and-twenty minutes, he refrained, but he has since published an outline of the theory (without the mathematics) in *Nature*. It is a molecular theory, with, however, some affinities to the single-fluid one, and has the peculiarity that it is positive electricity and not negative electricity, which is supposed to have no real existence (Lord Kelvin, however, calls them resinous and vitreous). The atoms of electricity, "electrons," which appear to be assumed to be small compared with those of ordinary matter, are attracted to the latter and each other according to definite laws, the precise effect of which will require some amount of working out before one can be quite certain of what would happen. In the case of the electrolysis of copper sulphate, for example, which is given as an illustration, it would seem to be held that the copper being metal goes off alone on its own account to the cathode, while the atoms of (negative) electricity, which are left behind with the rest of the molecule, bundle it off to the anode.

"Dynamoes."—There seems to be a general conviction among electrical engineers that Mr. Mordey's way of spelling dynamos is completely wrong. Some of them, however, when driven into a corner are not so ready to give a good reason for the faith that is in them. That is

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not a pleasant position for members of a profession which is entirely governed by science and reason. Of course there is neither science, reason, nor good engineering in English spelling—custom alone is judge there. And the rule of custom—which is not in the grammars—appears to be that though for legitimate words ending in "o" the proper plural termination is "oes," when a word is formed, so to say, anyhow by cutting a compound word in halves and throwing away the latter half, it is treated as a mere abbreviation would be, and gets an "s" only. Consequently dynamos, which when they were young and little used to be called dynamo-electric machines, come into the same class as magnetos and pianos (pianofortes), not to mention chromos, photos, electros, and a host of other semi-slang expressions which no one who has any care for his speech permits himself to use at all. There is undoubtedly a tendency to omit the "e" in all cases of foreign-looking or unfamiliar words. One might easily be uncertain for a moment as to the proper plural of "fiasco," for instance. The underlying feeling is probably the same in every case—namely, that there is something quasi-improper in their being inflected at all, and therefore that they cannot follow the general rule.

The Apostoloff Telephone Syndicate. — The Apostoloff Automatic Telephone Parent Syndicate, Limited, is going to do or try to do a rather peculiar thing to-day. The Apostoloff automatic telephone has been described and illustrated in our columns. Its merits, possible defects, and commercial practicability, or the reverse, are not the subject of this note. From the merely mechanical point of view it is decidedly a pretty device. The Parent Apostoloff Syndicate is going to retire in favour of a new company, to which it will sell its rights for a very considerable sum, which, however, will be taken in fully-paid shares. The new company is to be formed with a capital of £100,000 in 5s. shares. "It is decided to allow the existing shareholders only" to subscribe at par for the £10,000 working capital said to be necessary for the company. There is nothing altogether unusual in this. But the novelty is that besides this the Board are going at the meeting to-day to put up an additional number of the shares for auction in small parcels, and knock them down for the highest premium offered. The shareholders should know best what the Apostoloff Automatic Parent Syndicate has been doing, and it will be interesting to see what they will bid, and what the outside public of possible buyers will think of it all. As the component elements of the old company take their payment in shares in the new one, they will hold about three-quarters of the authorised capital of the new company to start with. The whole process seems a peculiar way of getting in new capital, and for those that are curious in such matters will repay thinking out.

Iron and Steel Institute.—The autumn meeting of the Iron and Steel Institute of Great Britain will be held at Cardiff from August 3 to 6, inclusive, in the house of the South Wales Institute of Engineers. The proceedings will comprise the reading and discussion of papers and visits to works of interest, besides several social gatherings, the second and third items being distinctly prominent in the programme. On August 3 there will be visits to the Bute Docks, the Cardiff-Dowlais Works, and other establishments in the vicinity. On August 4 the Penarth Docks and works on the Taff Vale Railway will be inspected. On the following day a visit will be paid to the Dowlais and Cyfarthfa Steelworks, and on August 6 there will be a whole day excursion to points of interest in the neighbourhood. On the evening of August 3 the Mayor of Cardiff will hold a reception at the Free Art Library, Art Gallery, and Museum building. On August 4 the members and the ladies accompanying them will be invited to a ball by the Marquis and Marchioness of Bute. On August 5 the local committee will give a Welsh concert at the Park Hall. The members will be invited to luncheon by the Monmouthshire and South Wales Coalowners' Association on August 3, and by the president of the Cardiff Chambers of Commerce, Lord Windsor, on August 4. On the same day the members will also be invited to dinner by the directors of the Taff Vale Railway Company. The chairman of the local reception committee in Cardiff is Sir William T. Lewis, and the honorary secretary is Mr. T. Hurry Riches, M.I.C.E., of the Taff Vale Railway, Cardiff.

The Higher Voltage.—In the House of Commons last Tuesday, Mr. H. M. Stanley asked a question which had been put down in the name of Mr. Burdett-Coutts. It was addressed to the President of the Board of Trade, and enquired whether the notice recently issued by the Kensington and Knightsbridge Electric Lighting Company to their consumers, intimating their intention to increase the voltage of the current supplied from 100 to 200, and calling upon the consumers to adapt their fittings at their own expense to comply with the altered voltage, was issued with the sanction of the Board of Trade, and whether compliance with such notice was legally binding on the consumers. Mr. Ritchie, in reply, said that he had not seen the notice referred to, but the sanction of the Board of Trade to any such notice was not required. Any change of standard pressure by the company was subject to the approval of the County Council, and not of the Board of Trade, and no provision was made for a reference to the Board of Trade, except on appeal by the company against any decision of the County Council. No change was allowable in the pressure of the supply to any premises which on March 4, 1896, the date of the Board of Trade regulations, were supplied with energy by the company, except with the consent of the consumer. Subsequently Mr. Tully brought in a Bill to amend the Electric Lighting Acts, which was read a first time. The purport of the Bill is not known to the writer, but it must be a very little one, and have few enemies, if much more is to be heard of it this session. So far as the change over to the higher voltage is concerned, speaking generally, very considerable tact has been displayed by the municipal electrical engineers that have had to effect it in obtaining the co-operation of their customers. Experience seems to show that if it is gone about in the right way, though it cannot be said that it is a matter of no trouble, it can at least be done without any friction.

Lightning.—Thunderstorms and their incidents have been one of the features of the week. Churches have been struck, and cattle killed. At Heywood, on Tuesday, the steeple of the church at the cemetery was struck and demolished and the building partially unroofed; two grave-diggers were slightly injured. In Yorkshire there was another illustration of the fact that the human subject can take the electric shock, whether low tension, high tension, extra high, or positively tempestuous, with much greater impunity than many of the lower animals. At Leven Grange, a youth named Riley was struck while at work rolling a field with a couple of horses. Both animals were killed by the lightning, and the boy injured and thrown to the earth. He was found lying in the field with a portion of his clothing ripped off, so it is beyond question that he took his share of the discharge. The lightning also upset the signalling instruments on the Lancashire and Yorkshire Railway, and a number of signals were completely disconnected. A telegraph wire was burned in two, and communication stopped with Bolton. At

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Bedford the lightning tried conclusions with the gas. A house there in Tavistock-street was struck and a gas-pipe underneath the drawing-room floor was cut in two. (Thus it is set down in the pages of a provincial contemporary. The present writer was not there to see.) The room was soon in flames, but assistance was close at hand, and the fire was checked after considerable damage had been done. It is not proposed at present to call attention to this unforeseen danger which accompanies installations of the gas light, or to insist that in the public interest it is necessary that in all house-piping work the provision of 'suitable lightning arresters" should be made compulsory on the gas company. But perhaps the most curious thing was to see the fire engines called out to put out a tree in Kensington Gardens. The lightning set fire to the top of a large tree there which, notwithstanding the rain, blazed furiously. When the brigade arrived it was found that some strangers had got a private hydrant to work, and by this means the tree was put out.

Bacteria and Rontgen Rays.—That the Crookes tube would turn out an effective instrument for the slaughter of bacteria seemed, in spite of what was reported from France, exceedingly unlikely. It appears, however, now that the question whether the Röntgen radiations exert any influence on bacterial life has been definitely settled in the negative, at least so far as concerns the tubercle and diphtheria bacilli. Conclusive evidence on at least this part of the subject has been arrived at by Dr. J. Brunton Blaikie, president of the Edinburgh Royal Medical Society. His experiments, published in the current number of the *Scottish Medical and Surgical Journal*, were as follows: Portions of glycerine agar having been placed in small boxes of aluminium, which is more transparent to the rays than glass is, they were sterilised and inoculated with streak cultures of the tubercle bacillus. At the same time four healthy guinea pigs were inoculated with twice the minimum lethal dose of diphtheria toxin, and the remainder of the diphtheria toxin was placed in another aluminium box. Three of the boxes containing tubercle cultures, two of the guinea pigs, and the box with the toxin, were placed under the full influence of the rays generated by a 4in. spark coil and a good focus Crookes tube. Guinea pigs also were inoculated and subjected to the action of the rays. In the results the guinea pigs subjected to the rays lived actually a shorter time than others not so treated, and that the toxin through which the rays passed did not lose its lethal properties. All the guinea pigs showed the ordinary signs of death from diphtheria toxin, the only difference among them being that the hair of those through which the rays had passed could be pulled out with unusual ease. The cultivations of tubercle bacillus all grew in the ordinary manner, so that they were evidently not affected by the rays. There is, of course, always the possibility of the radiations acting not as a bactericide, but as a stimulant to the affected tissues. This, however, could not apply to diphtheria, and it seems hardly likely in the case of the alleged beneficial effects produced in cases of phthisis. When there is any action at all, it appears to be confined to the under skin and to be the reverse of beneficial.

Motorcarts.—During the past week the *Engineer* competition motorcarts ought to have been careering across the Midlands to Birmingham and back. A representative of the *Evening News* professes to have seen a motorcart frightened by the thunderstorm and bolting in the Edgware-road on Sunday—but that is out in the matter of date, and for other reasons. Considering that a total sum of 1,100 guineas was offered by the *Engineer* and distributed in prizes, ranging in amount from 350 to 150 guineas, so as to encourage different classes of vehicles to be entered, and the contest was thrown open to the world, it can hardly be said that the result is up to expectation. As a matter of fact, entries have come in from only five different makers, who are altogether represented by exactly seven vehicles. These comprise a tandem tricycle and a four-seat dogcart, constructed by Messrs. Roots and Venables, Westminster Bridge-road, both of which derive their motive power from common lamp oil, instead of benzoline; a light, three-wheel victoria, and a phaeton, carrying four persons, built by the Electric Construction Company, Wolverhampton, and driven by electricity; a motor steam parcel-van, entered by the Liquid Fuel Engineering Company, East Cowes; a traveller's carriage, with accommodation in the rear for parcels, made by the Yeovil Motor Car and Cycle Company, using petroleum; and a phaeton for two persons, designed by Mr. Holroyd Smith, of Westminster, in which the power is obtained from benzoline. A representative of the judges was to accompany each car, and three routes outwards and four routes homewards had been mapped for the competitors. Though the actual decision was not to be announced until after the return of the motorcarts, it is believed that the judges intimated that the exhibits did not show sufficient merit to justify them in awarding any one of the large prizes offered, so it may be considered that the race is off altogether. The Electric Construction and the Liquid Fuel motorcarts, however, are to have a "highly commended." It is very evident that we are at present in the cold-fit stage of the motorcart excitement, but, all the same, it is a matter of much regret that there has been so poor a response to our contemporary's spirited effort to induce engineers to devote attention to a branch of work in which this country has some little leeway to make up.

The Institution.—The final meeting of the Electrical Engineers fully kept up the recently acquired habit of late hours. If everyone had spoken on Mr. Mordey's paper who was prepared to do so, we should not have gone home till the morning. Some of them, like Prof. Perry, were not called on; others, like Prof. Ayrton, recognised that it was too late. Much of the discussion was done on the blackboard, which, it is presumed, will hardly facilitate the reports. Prof. Silvanus Thompson and Mr. Raworth exalted Mr. Mordey and all his works. On the other hand, Mr. Esson pulled him all to pieces, even to the uttermost molecule, and then, which was more unkind, insisted that he must be constructed anew of entirely fresh materials. But it is to be said that the new Mr. Mordey appears to be much more satisfactory to Mr. Esson than the old one, and, moreover, is warranted for seven years certain. The speech of the evening was that of Mr. Sayers. The answer to it was practically, "The machine does work." Mr. Crompton again undertook the task of moderating the enthusiasms of the rising generation. As a few weeks ago he did not think the type of steam-engine in use was going to be radically altered by a recurrence of the fashion for cut-off governing, so now he was confident that the manufacture of dynamos would not be revolutionised by a new winding of the armature. Mr. Blathy, of Budapest, could not be persuaded to speak. Apparently he distrusted his English. From what he did say, he seemed to have no need to do this whatever. But perhaps he was afraid of Prof. Jamieson, who is such an expert that he can detect traces, not merely of the Scottish speech, but even the Aberdeen variety of it remaining after a score of years in England. We English should never have noticed anything. Apart from these trivialities, as was anticipated last week, Mr. Mordey's proposals were

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not the only ones brought forward for discussion. And perhaps the general impression that the whole debate would leave on anyone who has not been reared in a dynamo shop is that there are quite a quantity of other ways, besides Mr. Mordey's, which promise to give most of the things he wants, but that when the makers try to apply them to large machines, something unexpected comes up which renders them by no means so easy to carry out as they seem. Altogether, this, the last, discussion was probably the most interesting of a rather uneventful session. One thing more may be noted. The first duty of a president is obviously to preside. Sir Henry Mance thinks so, for he has not missed a single meeting, and has generally, when time permitted, had something to say.

Lord Kelvin's Speech.—Lord Kelvin is not a frequent speaker in the House of Lords. It is one of the advantages of the Upper Chamber that one is not expected to speak there for the sake of speaking or to please constituents. But last Friday, when the occasion and need for speech came, he lent valuable support to Earl Stanhope's motion in reference to the charging of heavy succession duties on works of art or scientific instruments, which not only bring no income, but which, as they will never be sold, have no sale value. Lord Kelvin said that, as an ex-president of the Royal Society, he desired to point out the great importance of the motion of Earl Stanhope so far as scientific collections were concerned. It might have an exceedingly injurious effect upon scientific investigation in this country if the heavy death duties were charged upon apparatus for scientific research or upon natural history collections, the property of private owners. Very large sums of money had been spent on private observatories. Members of the House knew well something of what had been done in that way. A large part of the astronomical investigation in the United Kingdom had been performed by amateur astronomers, if he might use the word of those who stood at the very head of scientific men in knowledge and skill in scientific investigation. A large amount of money had been spent upon private observatories, on great telescopes, and on other instruments of research which would be subject to exceedingly heavy death duties, and the heirs of the proprietors might find it impossible to keep them. The result might be that it would be necessary to sell them; foreign purchasers might get them, and those valuable tools for scientific work might be sent out of England and leave this country so much the poorer in respect of scientific work. The same might also be said of natural history collections. Such collections were of unique value. A man might spend his whole life in the work of making such collections and leave something that was of priceless value in reality, and which would be estimated at a very high money figure if the expense involved in creating the collection was to be taken into account. It would be most disastrous that such natural history collections or apparatus for scientific investigation should be subjected to the severe death duties that were charged on those to whom was left property which they could use, and which might be sources of income and revenue to the inheritors, when that which was inherited could only be of use through the inheritor devoting himself, as the creator of the collection had devoted himself, to the public good and for the advancement of science. He thought it would be exceedingly bad and in every way undesirable that a duty anything more than merely nominal should be charged in such cases. Few, except those who have a dislike of the science which they do not understand, will contend that Lord Kelvin has not made out his case. An objection to the endowment of research at the expense of the taxpayer is always arguable, but there ought to be no dispute as to the impropriety of taxing and penalising it.

Physical Society.—Neither of the papers at the Physical Society last week had any bearing on electrical matters, and therefore, though both of them were decidedly interesting in themselves, they hardly require a separate report. The first was by Dr. Albert A. Gray, M.D., on "The Perception of the Difference of Phase by the Two Ears." The investigation related to certain acoustical results obtained some years ago by Dr. S. P. Thompson, which may be summarised as follows: (*a*) When two simple tones in opposite phases are conveyed separately, through tubes or otherwise, to the two ears, the sensation of sound appears localised at the back of the head. (*b*) If the respective tones from two forks mistuned to give "beats" are conducted separately to the two ears, they still produce the sensation of beats; and, to the observer, this sensation also seems localised at the back of the head. The "beats" are distinct, but there are no true silences, at any rate so long as attention is fixed on the note. (*c*) Although "beats" are heard under these circumstances, no beat-tones are discernible by the binaural method. The author explained the phenomena on the assumption that there is a physiological connection between the nerves of both ears. The whole subject is a very difficult one. From the point of view of the instrument maker, neither the eye nor the ear are by any means perfect. The second paper, which was by Mr. J. Rose-Innes, at least did not require one to be a physiologist to understand it. It was on "The Isothermals of Isopentane." The author took advantage of the recent experimental work of Ramsay and Young, upon the thermal properties of isopentane, to test a formula giving the relation of pressure to temperature for gases generally over a considerable range of volume. From the linear equation, $p = bT - a$, for the pressure at constant volume, where a and b are functions of the volume, no formula could be found to give close agreement with observed results. More definite results were obtained by examining a quantity depending upon a and b together; such a quantity is the temperature at which, for each volume, the substance behaves as a perfect gas. It is shown by tables that this is nearly a constant for volumes from 350 to about 8. Below 8 it diminishes very rapidly with the volume. The next meeting is on June 11, when there are four papers down for reading. They are: (1) "The Effect of Sea-Water on Induction Telegraphy," by Mr. C. S. Whitehead; (2) "A New Definition of Focal Length, and an Instrument for its Determination," by Mr. Thomas H. Blakesley; (3) "On the Decomposition of Silver Salts under Pressure," by Dr. J. E. Myers and Dr. F. Braun; and (4) "On a New Way of Determining Hysteresis in Straight Strips," by Dr. Fleming, F.R.S. Even if this last is not reached, number one would be enough to render the meeting an interesting one.

South Kensington.—If the authorities who have control of such matters cannot be induced to finish the South Kensington Museum on its own merits, it is possible that from the mere fire insurance point of view the danger of losing it altogether may induce them to do something. The select committee appointed to enquire into and report upon the administration and cost of the museums of the Science and Art Department have presented their first report. They begin by simply reporting "progress," but "they consider it to be their duty to make an immediate report to the House of Commons on the peril of destruction by fire to which the priceless collections at the South Kensington Museum are exposed." There are 13 paragraphs,

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but a few words may be given as a sample of the sort of things the committee say: "There are a number of old buildings, built of wood and lath-and-plaster, and in some instances covered with tarred felt, in close proximity to the modern permanent buildings which contain the bulk of the collections; and the danger has been aggravated by the erection of large temporary buildings constructed of fir framing"; and, again, the galleries, "constructed mainly of unsuitable timber, are especially open to fire damage, from the fact of having wood lanterns, skylights, and open side-lights. The walls are boarded and canvassed, with a space behind." "The private residences of the officers of the department in the immediate vicinity of the galleries are a further source of danger." There are 81 open fireplaces. "These premises cannot be watched day and night by the police and attendants as the other buildings are, and a domestic accident, such as might happen in any London house, might at any moment be the beginning of a conflagration." Again, "the entrance to the southern galleries on the west side of the Exhibition-road is a highly dangerous structure. It is timber-framed and weather-boarded, and roofed with tarred felt." Or, "the southern galleries themselves would fall an easy prey to fire," and "dangerous as these galleries are in themselves, they are exposed to still greater risk from the flimsy temporary buildings which adjoin them." Really, as materials for a bonfire, this would seem to be all very nice, but as a place of safe deposit for things of which many are very valuable and some are absolutely not to be replaced, it would be rather ludicrous if it were not so serious. The report goes on to declare that the fact that the buildings in which the collections at South Kensington are placed have enjoyed so long a comparative immunity from fire is due to the care and vigilance of the police, the skill and care of the various attendants and mechanics employed about the premises, and the unremitting watchfulness of the officials. That the principal structural alterations necessary for the protection of the collections from fire have not been made, appears to be due to the fact that the completion of the permanent buildings of the South Kensington Museum has always been in the contemplation of successive Governments as the true remedy for the danger of destruction from fire which hangs over the collections so long as they have to be partly housed in the present temporary structures. The committee conclude by saying that they regard it as their immediate duty to lay before the House of Commons by means of an interim report their very strong opinion, that permanent buildings for the adequate accommodation of the collections at the South Kensington Museum should be proceeded with without delay. They are of opinion that it will be a source of grave discredit to the country if the settlement of this matter, which has been the subject of consideration by Government for many years, and of endless correspondence between the departments concerned, is any longer delayed. Meantime, there has been some talk of an intention to disperse much of the contents of the museum into separate museums in different parts of London. That would be a very great mistake indeed.

Fluorine.—Mr. Moissan exhibited the isolation of fluorine at the Royal Institution last Friday. He spoke, of course, in French, but he is a speaker of great distinction, and did not forget that among his large audience there were those to whom chemistry in French might be somewhat less familiar than in English. Mr. Moissan began with a *résumé* of the history of hydrofluoric acid, and the part it played in conjunction with the other halogen acids in dissipating the superstition that an acid must have oxygen in its composition. Coming, then, to the element itself, he spoke of the long series of efforts made by the chemists to isolate it. These might be divided into electrolytic and non-electrolytic. All the latter it successfully resisted. It was thought, for instance, that when fluorine, which will combine with almost everything in the world except oxygen, was got in combination with phosphorus, it was trapped. It seemed only necessary to attack the compound with oxygen. Not at all; it would rather give up its dislike for the company of oxygen and form an oxyfluoride than stand alone, and in general it successfully resisted all attempts to get it out of any binary combination by promptly forming a ternary one. The failure of all electrolytic methods to isolate it by electrolysis from aqueous HFl or any solution was a foregone conclusion, from the fact that it immediately acted on the water. Mr. Moissan then described his own attempts. At first he had tried to obtain it by the electrolysis of the arsenic compound, and actually got little bubbles of gas, but only to see them dissolve again in the liquid which contained free arsenic. So he was driven to use HFl reduced to a liquid form by a freezing mixture. It would appear that it is the latter which is responsible for the success of Mr. Moissan's process, since at a low temperature it seems that fluorine loses much of the violent affinity which makes it impossible to hold it in any vessel or to make a tight joint. The actual temperature worked at was about – 23 C., and the apparatus exhibited was exceedingly compact. The electrolysis was done in a platinum U-tube, with, it is understood, an iridium-platinum anode. The liquid HFl is rendered conducting by a small quantity of added KFl, and it is one of the conditions of success that the acid and salt should not only be anhydrous, but absolutely pure, a mere trace of impurity absorbed in the preparation being enough to act as a carrier and set up action on the metal. The gas was given off from a long platinum tube, and Mr. Moissan showed, by placing various substances under the outlet of this, how it combined violently with them. As with chlorine, it appears that light will assist in starting a combination. In quantity, Mr. Moissan stated that the isolated gas is yellow in colour (the small quantity given off was only visible by its effects). He also exhibited the apparatus by which he had shown that its density corresponded with what it should be theoretically. Lastly, the question of whether the isolation of fluorine would be of any practical use was referred to. Allowed to act on water, it formed ozone. That it could only at present be prepared with great difficulty, merely meant that it was at the same stage as sodium was in the time of Davy. It further appears that, with the help of Prof. Dewar's apparatus, Mr. Moissan has since succeeded in liquefying the gaseous fluorine. At low temperatures it loses its affinity for silicon, so it is possible to work in glass and see what one is doing. From a communication made by Mr. Moissan to the Paris Académie, when a current of fluorine gas is passed into a tube in the midst of liquid oxygen in tranquil ebullition at a temperature of – 183deg. C., liquefaction does not occur. But when the temperature is diminished some degrees by exhausting the gas above the liquid oxygen, the liquefaction of the fluorine begins, and a clear yellow and extremely mobile liquid is obtained, which resumes the gaseous state as soon as the temperature rises. The liquid fluorine has lost the chemical activity characteristic of fluorine in a state of gas, and no longer attacks glass, silicon, sulphur, or phosphorus, but still attacks hydro-carbons, and, it is believed, hydrogen. Further results are anticipated shortly by Prof. Dewar and Mr. Moissan. It may be expected, however, that fluorine will give them some further trouble before they get it solid.

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THE ELECTRIC PLANT AT THE HOTEL CECIL.

We gave a brief *résumé* of the electric lighting arrangements at the Hotel Cecil when it was opened a year ago. The description was then limited by the difficulty of obtaining information when all connected with the hotel were so busy getting ready for the opening ceremonies. Through the courtesy of Mr. W. R. Beckton, the engineer-in-chief at the hotel, we are now able to give fuller information and drawings of the arrangements. We have also been furnished with particulars of the costs of production for various months, which form most interesting reading.

As regards the hotel itself, it is too late to give details of architecture, etc., but we are able to show our readers four characteristic views of rooms in the hotel which illustrate the methods of lighting. The first two (Figs. 1 and 2) show the details of the Indian dining-room. The fact that the decorations are modelled on those of the Emperor Akbar's palace at Futteypore-sikri will not add much to our readers' knowledge. It remains to be said that the walls and pillars are covered in Doulton's majolica ware, and that the scheme of colouring is peacock-blue and yellow. The single pendants add to the beauty of the room. There are also provided a number of floor plugs for table lamps. One drawing-room on the ground floor is shown in Fig. 3, which necessarily illustrates one corner only. The scheme of decoration is carried out in white and gold, with a coloured frieze, which is hand-painted. The remaining view (Fig. 4) shows a room in one of the series of suites in the hotel. From it some idea of the accommodation provided by the nation for our Colonial guests for June 22 can be obtained.

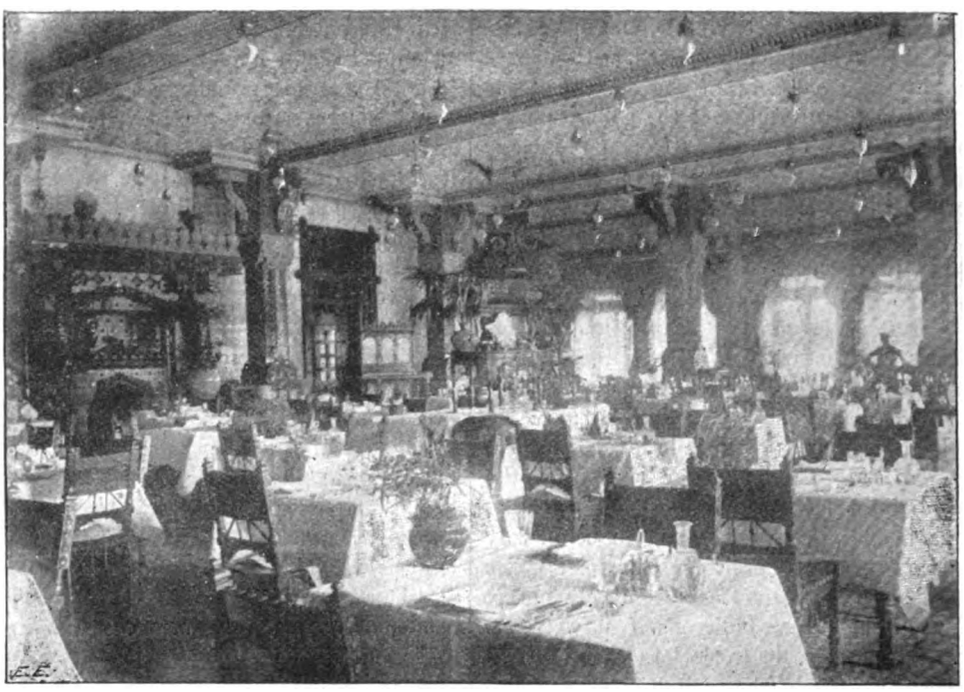

FIG. 1.—General View of the Indian Dining Room in the Hotel Cecil.

The generating plant is placed in the basement under the main courtyard, and is arranged as shown in Fig. 5. The boilers now in use are five in number, and are of the "Economic" type, manufactured by Messrs. Davey, Paxman, and Co., of Colchester. Four of these are each 14ft. long and 7ft. 6in. diameter, and are each guaranteed to evaporate 5,000lb. of water per hour from 65deg. F. The other

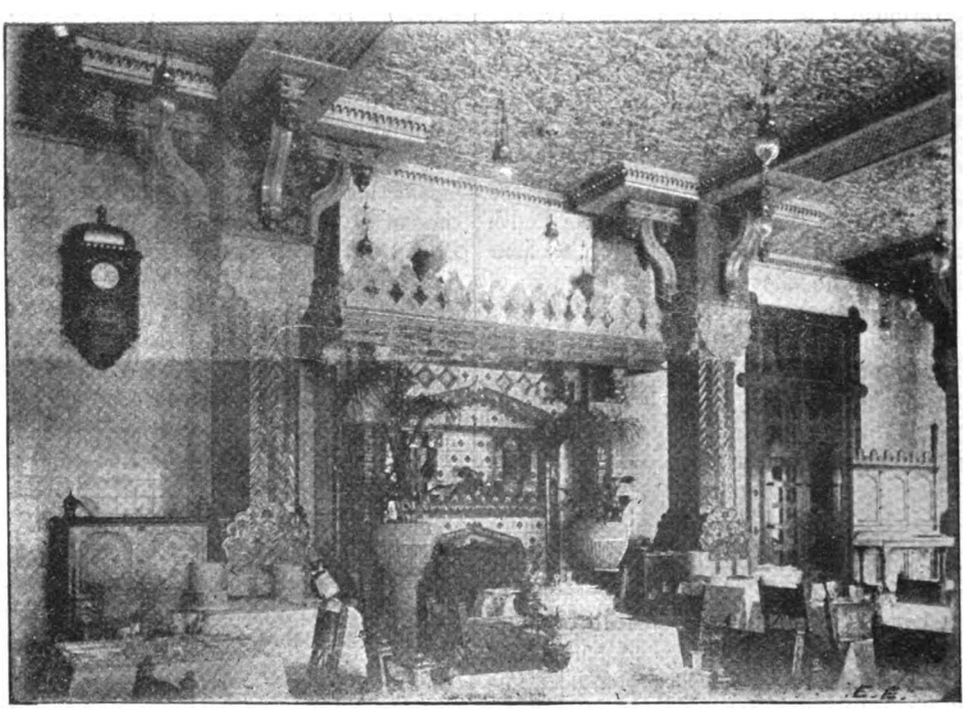

FIG. 2.—View of the Fire-place in the Indian Dining Room.

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boiler is 14ft. 6in. long and 8ft. diameter. It is supposed to deliver 5,500ft. per hour. Mr. J. Weatherby, the electrical engineer-in-charge of the plant under Mr. Beckton, informs us that once on an emergency some 10,800lb. per hour were evaporated for a two hours' run by one of the smaller boilers.

Fig. 6 shows an elevation of one of the boilers and the arrangement of flues, while Fig. 7 shows the front elevation of the range of boilers. The boiler fittings are all of Hopkinson's own make, and consist of two patent water-gauges, a marine-type safety-valve, blow-off cocks, stop-valve, etc. All the boilers are fitted with the "Meldrum" system of forced-draught furnaces. This apparatus is so well known as to require no detailed description. In this case the steam-jet blowers are fitted with continuations at their front ends, which reach to the floor-level, and by

FIG. 3.—A Corner of a Drawing-room in the Hotel Cecil.

FIG. 4.—A Room in a Privat Suite in the Hotel Cecil.

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means of openings in the foot-plates in front of the boilers they draw the air which is supplied to the fires along a trench, and from points distant from the boilers, by which means no noise from issuing steam is perceptible. The power of the chimney shaft was found to be insufficient to produce unassisted the large amount of draught required for this powerful range of multitubular boilers, but the application of the "Meldrum" system enables splendid fires to be kept going and an ample supply of steam to be obtained, as will be gathered from the above evaporation. The complete command of sufficient draught is also of the greatest value in those cases of sudden demand for light which so frequently arise in the atmosphere of the Metropolis.

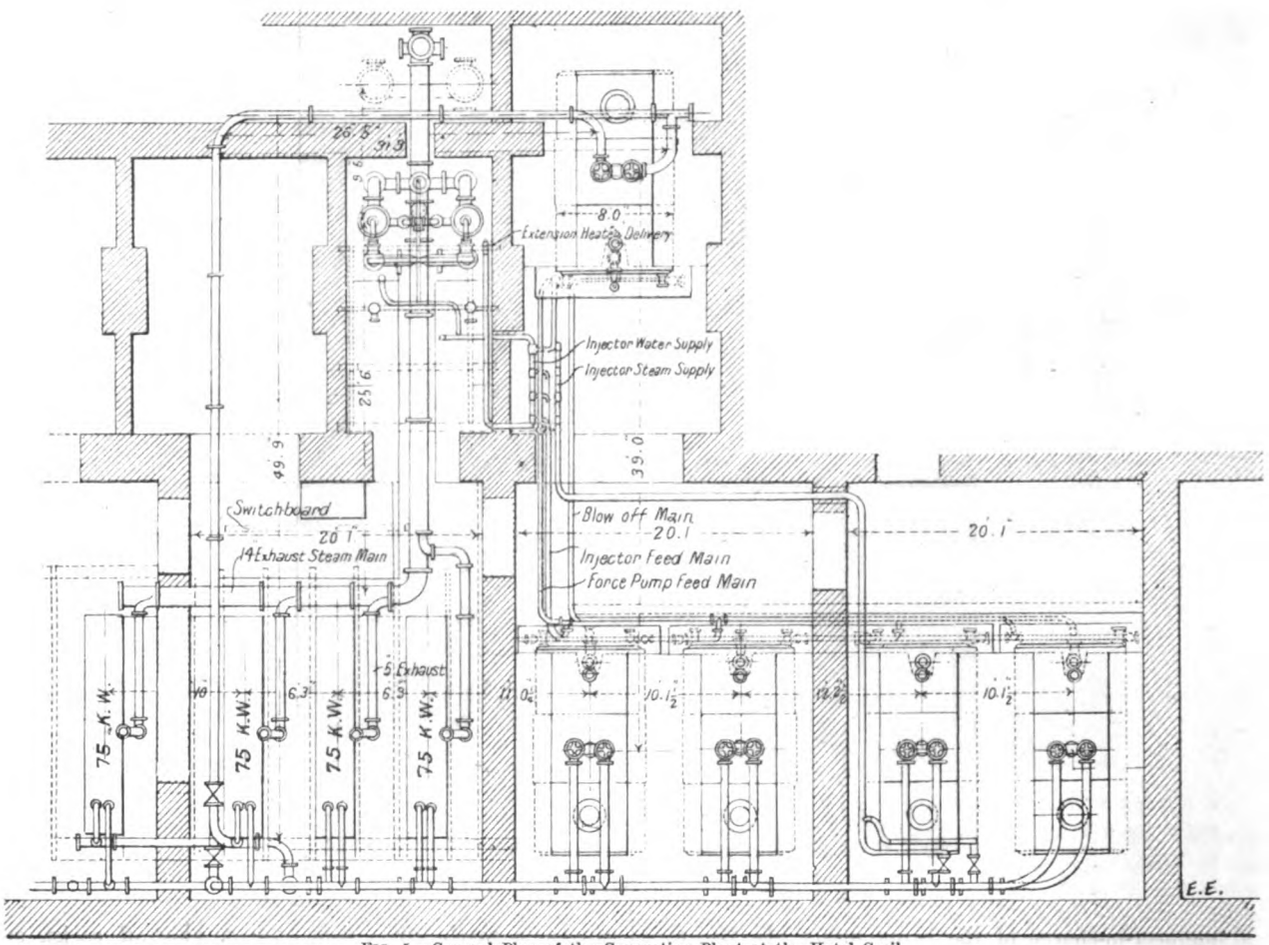

FIG. 5.—General Plan of the Generating Plant at the Hotel Cecil.

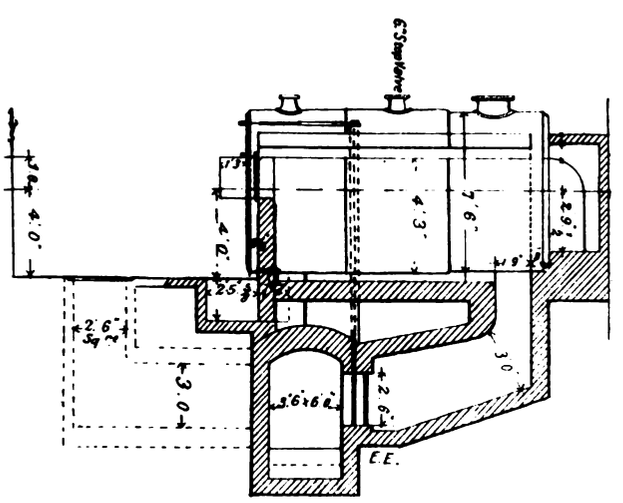

FIG. 6.—Section of the Boiler Seating showing the Flues.

Perhaps one of the most novel features in this boiler plant is the use of a superheating apparatus which really does superheat. In most other installations the superheat does not get to the stop-valve of the engine. The superheaters were supplied by Messrs. Babcock, Wilcox, and Co., and are placed in the combustion chambers at the end of the flues, as shown in Fig. 8. The apparatus consist of a series of U-tubes of drawn steel 1in. diameter. There are some 56 of these tubes in each apparatus, having a total heating surface of 80 square feet. The ends of these tubes are fixed by the usual tube-expanding device into two boxes, one of which receives steam from the boiler. The other is connected to the main steam-pipes. The superheater is thus not subjected to the immediate action of the fire, as the furnace gases must first pass through the front part of the boiler, which comprises a considerable heating surface.

The following figures give an idea of the extent to which the superheating is effective with each of the turbines at work. The trials were made on consecutive days, and were of eight hours' duration. The figures are averages of the series of readings taken :

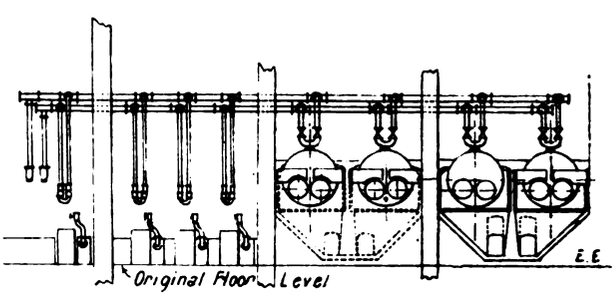

FIG. 7.—Front Elevation of the Battery of Boilers.

No. of turbine.	Output in kw.	Total length of steam-pipe used.	Steam pressure.	Temperature at superheater.	Temperature at a stop-valve.
1	76	41ft. 9in.	135	560	540
2	76	49ft. 11in.	133	555	524
3	76	59ft. 3in.	135	560	505
4	75	69ft. 3in.	135	560	490

The temperature of dry steam at the above pressure is about 356deg. F., so that nearly 200deg. superheat was obtained at the turbines.

The steam-pipes are duplicated on the ring system. They are 6in. diameter, and of lap-welded steel. The question

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of packing is always of great moment where superheating is used. In this case, Taylor metallic packing, filled in with red lead, is used, and it has given great satisfaction. The first joints were made with asbestos, which was found to be quite useless at the high temperatures used. The whole of the boilers and feed-heaters are lagged with Cape asbestos mattresses, which can easily be removed in case inspection

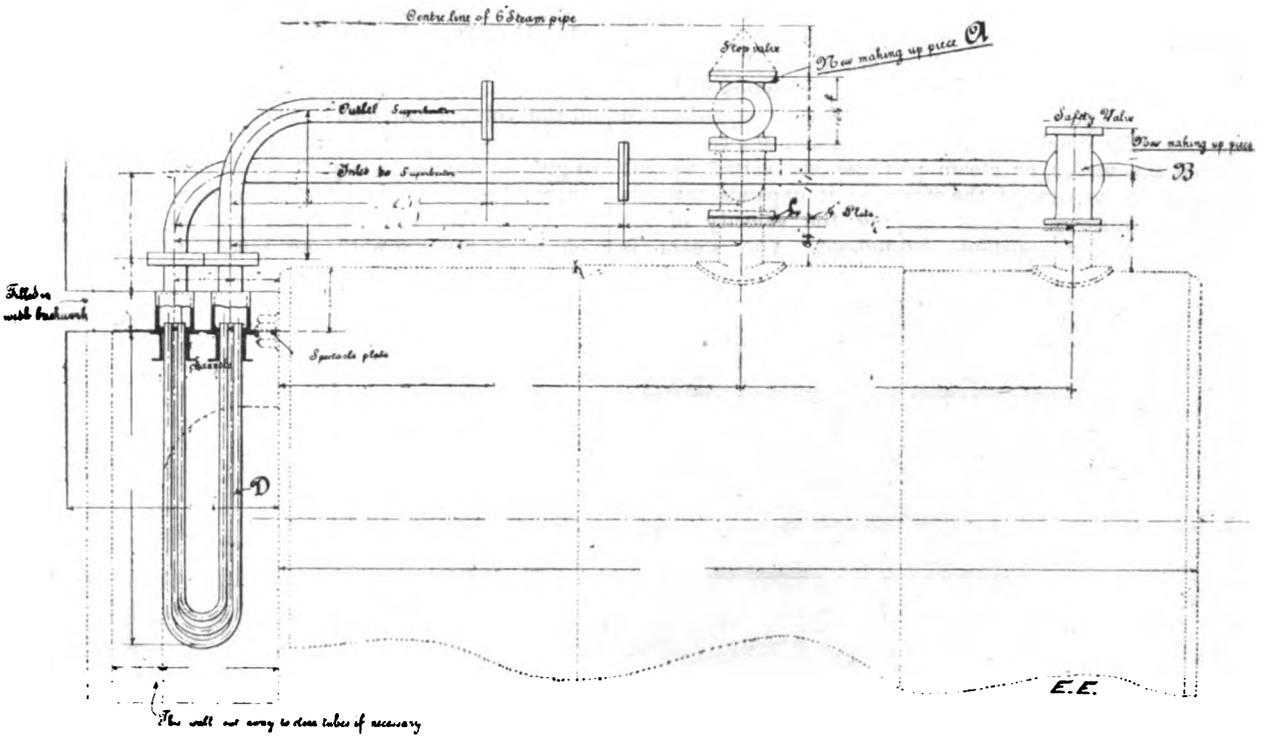

FIG. 8.—Details of the Babcock-Wilcox Superheaters.

is needed. Most of the steam-pipes are lagged with the same material, as some sections covered with magnesium compound have shown that this latter substance cannot stand the high temperature employed. The exhaust-pipes are also lagged, so as to keep down as far as possible the temperature in the engine and boiler rooms. The exhaust steam is led through four exhaust-steam heaters of the Brown-Berryman type. The feeding apparatus consists of two Worthington pumps—one capable of supplying 20

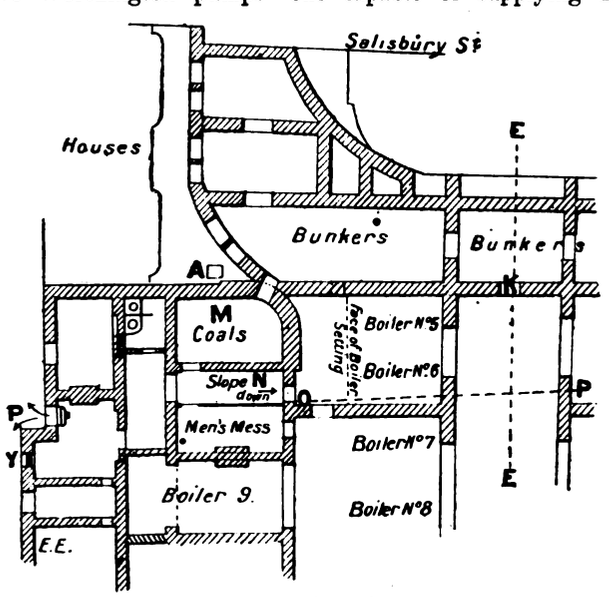

FIG. 9.—Plan of the Coal Stores.

gallons per minute against 1351b. pressure, and the other capable of supplying 80 gallons. The third pump is electrically driven by an Electric Construction Company's motor. It consists of a three-throw Hayward Tyler and Co.'s pump, and chain gearing is used to reduce the speed to the required limit. The illustration, Fig. 8A, shows an elevation of this part of the station. The duplicate feed by means of injectors deserves special mention. Four Holden and Brookes injectors are used. The three smaller ones are each capable of delivering 500 gallons per hour, and are worked in parallel. To enable this to be done, they are arranged to supply into a common foot-pipe, with check valves to each connection. An ingenious silencer has been devised by Mr. Weatherby, and fitted to these injectors with marked success. It consists of an equilibrium non-return valve on the overflow side, which prevents air passing into the injector when at work, while at the same time free egress for steam or water is allowed.

The coaling arrangements were described in our previous article, but we are now able to illustrate Mr. Beckton's arrangement in Figs. 9 and 10. The coal-vans can be drawn up at the end of the lower road immediately under the opening, K. There an hydraulic lift takes the coal up to the main bunkers, where it is stored till wanted. This

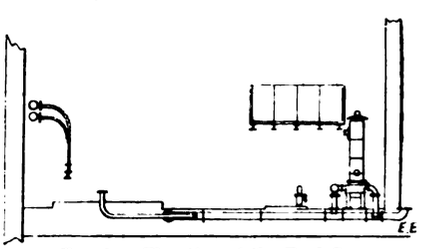

FIG. 8A.—Elevation of the Feed Gear.

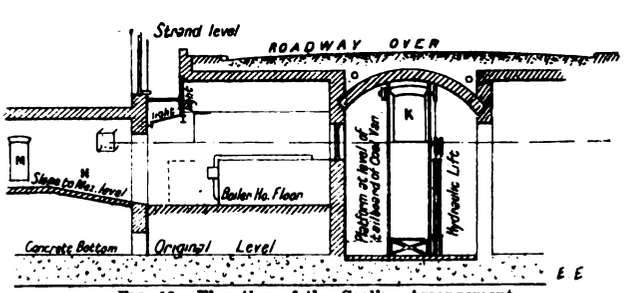

FIG. 10.—Elevation of the Coaling Arrangement.

coal is then shot down into the bunker room, M, whence it can be wheeled down an incline to the firing floors. It is, however, found convenient to use the main bunker more as a store, and a certain amount of coal is each day wheeled direct from the cart to the firing floor.

The generating plant consists of four Parsons steam-turbines coupled direct to direct-current dynamos. The nominal output of each set is 75 kilowatts—*i.e.*, 710 amperes at 105 volts when running at a speed of about 4,000 revo-

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lutions per minute. The steam-turbines are of the parallel-flow type, the steam passing through 35 rows of blades. The moving blades are fitted round the outer circumference of what may be termed a "stepped barrel," comprising a series of three barrels of different diameters, rigidly keyed to the turbine shaft. On the inner periphery of the turbine case are fitted corresponding fixed or stationary blades, between which the moving blades revolve. The barrels at the admission end (Fig. 11) are simply "dummies," for the purpose of balancing them. In the figure it will be seen that there are three diameters of barrel, and that those of corresponding diameters are connected by passages in the casting in order to equalise the pressure. The diameter of the barrels and the clearances between the blades, or steam passages, are varied to suit the increasing volume of the steam as it expands towards the low-pressure end, thus keeping the velocity of the steam practically constant throughout. The steam is admitted through a double-beat valve, and enters the turbine case all round the spindle, thence flowing in each direction towards the ends of the cylinder, the impact of the steam on the moving blades causing the barrel, and consequently the turbine shaft, to rotate. The main bearings are of a special construction, adapted to ensure easy running at high speeds and to damp out vibration. The turbine shaft rotates in a phosphor-bronze sleeve, outside of which are slipped three concentric steel tubes fitting loosely over one another. The outermost tube is a loose fit in the casting which forms the seat of the bearing. Oil is continuously and freely fed to the bearing from a recess above, under a head of some 6in., and drains into a chamber below, from which it is automatically pumped back to the cistern. In this way the small clearance between each tube or sleeve and the one outside of it is kept charged with a film of oil, with the effect that while the shaft retains a necessary small amount of freedom to adjust itself by lateral displacement, the viscosity of the films acts as a powerful damper to prevent oscillation from being set up. The working of the bearing is perfectly satisfactory, and the damping action is so great that the shaft may even be put considerably out of balance without causing the vibration to become excessive or making the bearings run hot.

The centrifugal governor is driven by worm gearing, giving a great reduction in speed, but this governor is used chiefly as a stand-by. The electric governor, also seen in the illustration, varies the quantity of steam admitted by means of the levers attached to the core of the shunt solenoid. Thus the turbine is regulated to give constant E.M.F. at the terminals; and unless there are great variations in steam pressure, there is no need of hand regulation on the voltage supplied. The admission of steam is not continuous, but is controlled by the lower lever and a relay to give an impulse every 21 revolutions. The quantity of steam admitted is then further regulated by the electrical governor. We published last week a curve of the steam consumed per kilowatt-hour output of a similar turbine, and the table of costs at the Hotel Cecil given below confirms the fact that the machines are economical.

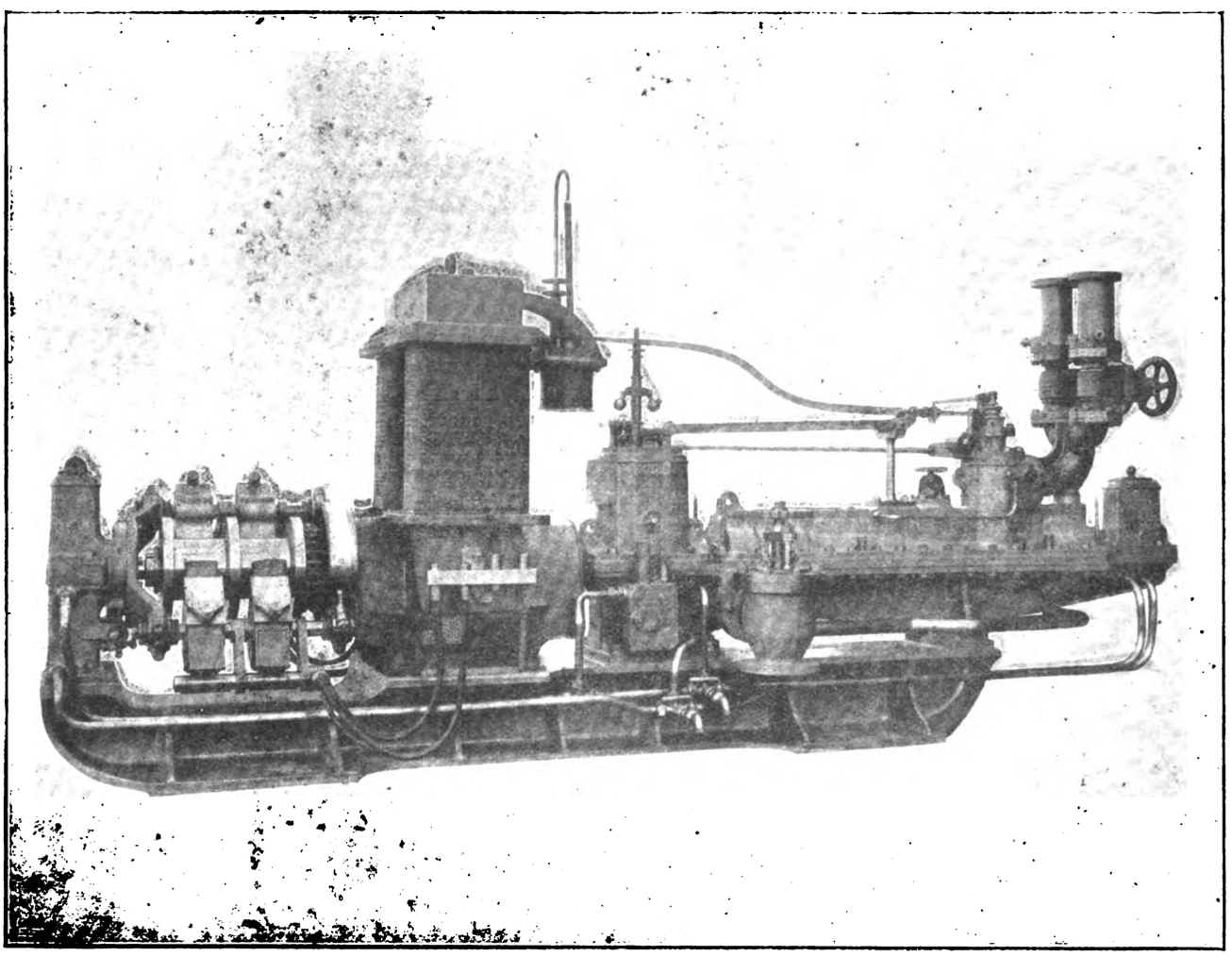

Fig. 11.—View of the 75-kw. Parsons Steam Turbine and Dynamo.

The switchboard was supplied by Messrs. Verity and Co., and is of most substantial design. For some reason or other the work has been carried out on the two-wire system at 105 volts, so that most massive switches and connections have had to be provided. Three panels of the switchboard are shown in Fig. 12, while Fig. 13 is an end elevation of the same. The diagram of a typical panel is shown in Fig. 14. It will be seen that provision is made for taking supply from the Charing Cross and Strand Electric Light Company should necessity arise, and that the change-over switches (Fig. 15) are for throwing the load over. The design of the switch is good, and by an ingenious device in the bottom contact the short-circuit of the Kelvin meters which register the current taken by each circuit is broken by the act of throwing over. When working, the sum of these meter readings gives the units actually generated by the hotel plant, while the supply company's meter gives the current taken from their mains. The main switch is shown

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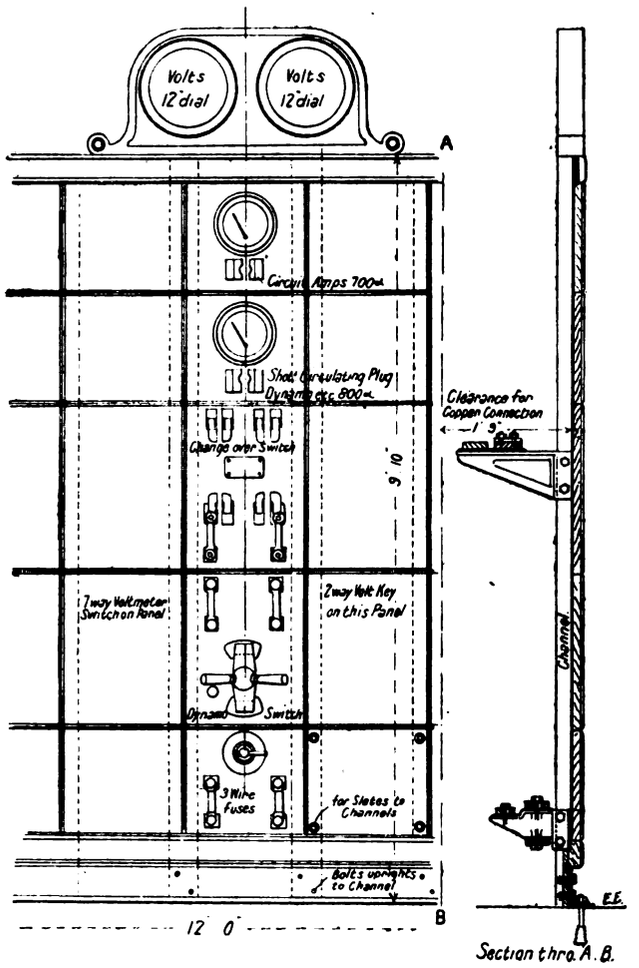
in detail in Fig. 16. There are seven panels in the switchboard, all arranged on the general lines of the one shown.



FIGS. 12 AND 13.—View of Switchboard.

Only four of these have at present been fitted with dynamo main switches, but there are seven feeders to the hotel. The supply from the Charing Cross Company is on the three-wire system, so that the feeders are coupled on

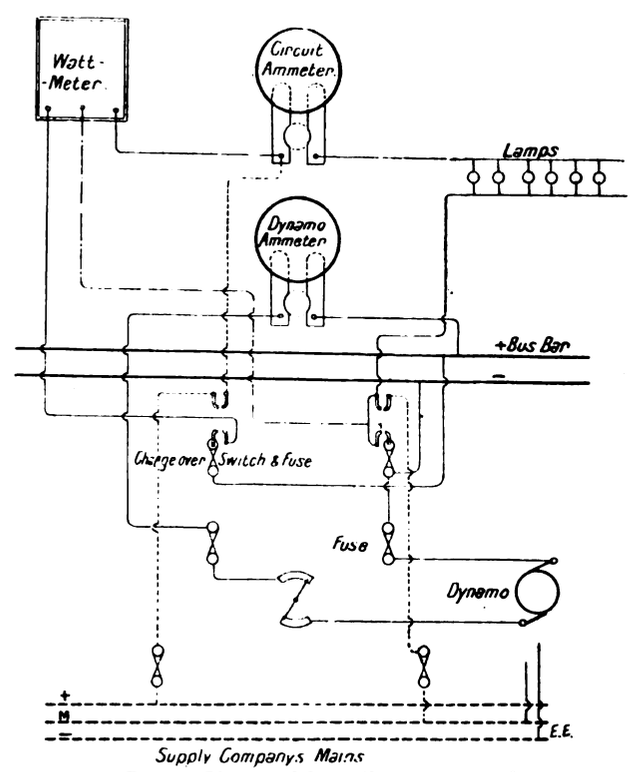


FIG. 14.—Diagram of Connections on one panel.

alternately to each side of the system when taking current from the company's mains.

The load on the station is not confined to the lamps used for illumination, but a large number of electric fans are employed to ventilate various rooms. Also the laundry machinery is driven electrically. For this purpose a Castle motor, supplied by Messrs. J. H. Holmes and Co., is employed (Figs. 17 and 18). Mr. Beckton's device for securing

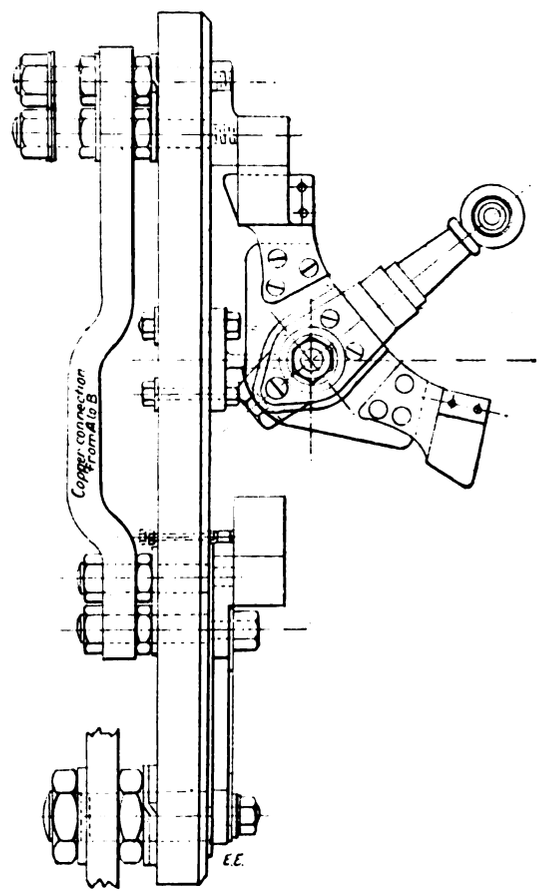


FIG. 15.—View of the Change-Over Switch.

the slide frame of the motor to the concrete floor is a very ingenious one. This load for power, together with the

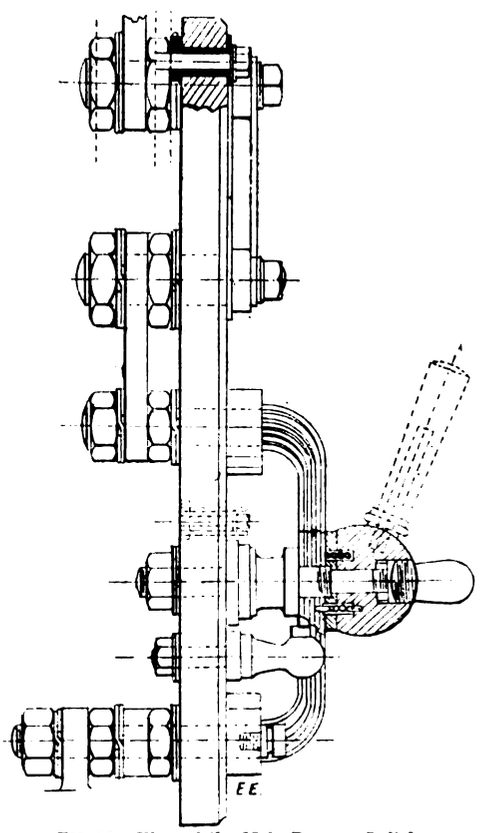


FIG. 16.—View of the Main Dynamo Switch.

fact that certain corridors have to be lighted throughout the whole 24 hours, gives the very respectable minimum load of about 280 amperes. The load curves we are

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HOTEL CECIL ELECTRIC LIGHTING STATION.—ANALYSIS OF COST.

—	Pence per unit.								Total cost.	Units consumed—		
	Coal.	Water.	Oil, waste.	Men's wages.	Super-vision.	Repairs, maintenance	Works cost.	Interest and deprociation.		By own plant.	By Charing Cross Co.	Total.
September...	·96	·08	·04	·47	·22	Nil.	1·77	1·0	2·77	29,961	8,000	37,961
October	·94	·06	·08	·37	·13	Nil.	1·58	·57	2·15	52 200	3,946	56,146
November ...	·94	·07	·09	·41	·13	Nil.	1·64	·56	2 20	53,200	1,760	54,960
December ...	·78	·06	·08	·49	·16	Nil.	1·54	·66	2·20	44,921	15,226	60,147
February ...	·771	·053	·088	·317	·109	·158	1·456	·476	1 932	63,000	2,108	65,108
March..... ..	·776	·053	·046	·326	·118	·096	1·415	·447	1·862	67,000	Nil.	67,000
April	·712	·059	·053	·357	·135	·136	1·452	·511	1·963	58,000	46	58,046

No figures are available for January, owing to official test of plant.

able to reproduce. Fig. 19 shows what may be considered a typical week in May. The great difference between the days is caused by a variation of the number of the public rooms used, and by the nature of the functions being held in them. It will be noticed that all the curves

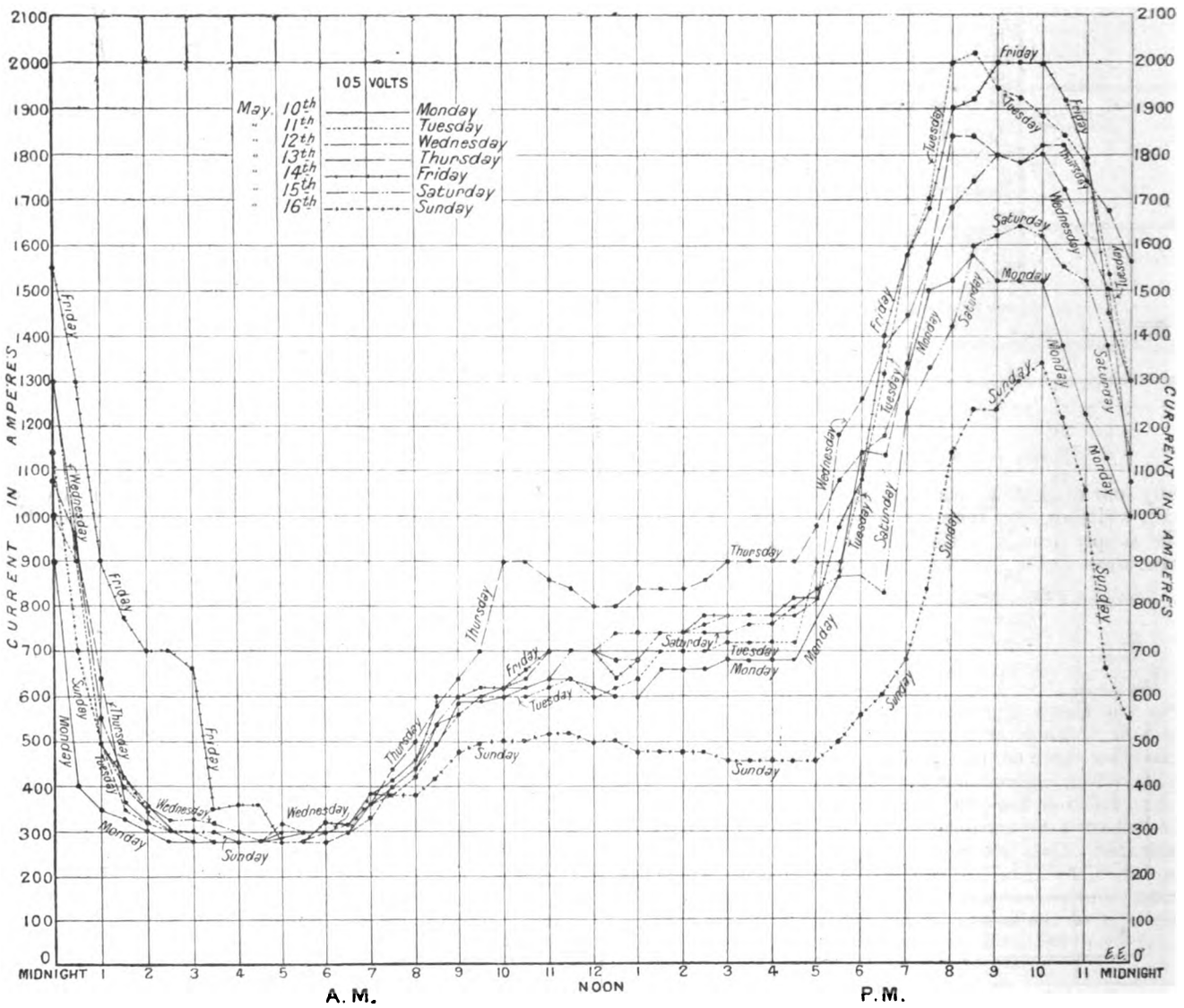

FIG. 19.—Seven Typical Load Curves from the Hotel Cecil.

show that the 280-ampere minimum limit is about constant, and this is a great advantage. This current represents about half load for one of the sets, so that this load is the least for which a turbine has to be run. The figures of cost in the table herewith are supplemented by the numbers of units used per month. From these and the load curve the load factor can be calculated. In this case we mean by the load factor the percentage which the energy actually supplied is of the total energy which would be supplied if the maximum observed load was taken for the whole time. Working this out, we get that about 361,000 units have been taken by the hotel during six months, and that 920,000 units would have been used if the full load had been regularly required. Hence the load factor is 39·5 per cent. Similar figures for comparison will be of interest. Thus at the General Post Office the load factor is about 39 per cent., that of Madame Tussaud and Son's installation 25·8 per cent., while Messrs. Bainbridge and Co.'s shop in Newcastle has a load factor of 12·7 per cent., and that of Sir David Salomons's house at Tunbridge Wells 7·1 per cent. These figures are taken from Mr. Kapp's paper on the cost of electric supply in private installations, read before the Society of Arts. From his figures it was concluded that the cost of supply per unit depended largely on the load factor.

Coming now to the table of costs, it must be remembered that the electric light boilers have also to supply the laundries with steam. As there is no means of ascertaining the quantity of steam taken, the equivalent cost of coal for laundry purposes cannot be exactly calculated. Hence a regular deduction from the total coal burnt has to be made when calculating the cost of fuel for the electric supply. We may say in this respect that the amount deducted is not large, and that we think that Mr. Beckton's figures for cost of coal per unit err on the high side, if anything. The coal used cost over £1 per ton, and hence the fuel

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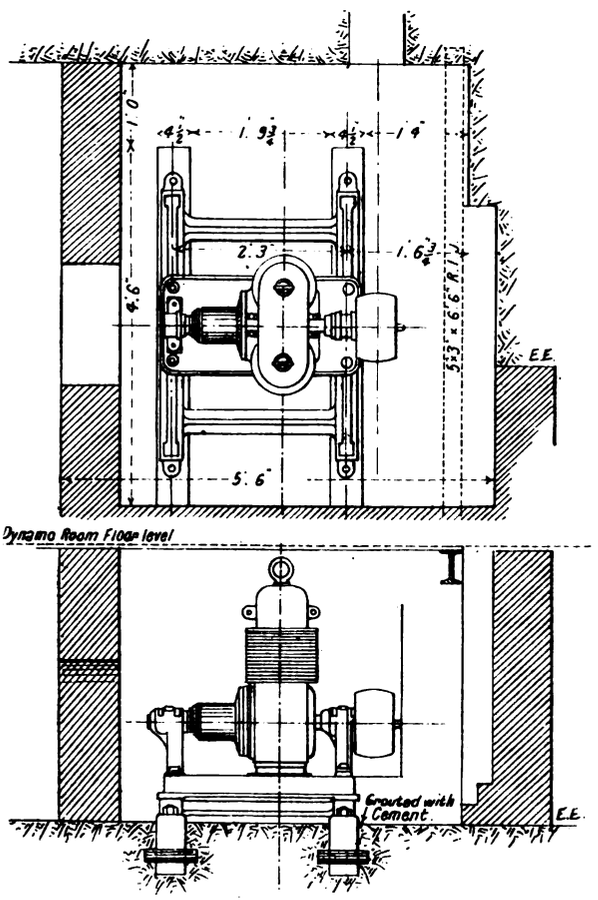
charges per unit are exceptionally low. Water is paid for at the rate of 7½d. per 100 gallons. The low cost per unit for repairs should be specially noted, as throwing light on the probable cost of upkeep of these high-speed steam-turbines. It is also worthy of note that the average total cost for the last three months tabulated is only 1·92d., including every item that can possibly be charged. Such a low figure, in spite of the cost of coal per ton, does credit to Mr. J. Weatherby, and shows that he carefully considers the working arrangement. In fact, care is taken to work the unit always nearly at full load, so that the best efficiency is obtained. Overloading is also indulged in at times, and the machines stand such treatment well. The curve



FIGS. 17 AND 18.—View of the "Castle" Motor used in the Laundry.

(Fig. 20) shows an average curve of voltage at the Hotel Cecil as obtained on a recording wattmeter. It will be noted that there are no sudden kicks, so often found with reciprocating engines as the motive power.

Mr. Beckton has also kindly given us a few details of the extensive decorations he has in hand for the Jubilee festivities. Over the main portico three large signs will be erected. The central one is a coloured representation of the Queen, and the supporting designs are the royal arms and the arms of the hotel respectively. They will be illuminated from behind, and will be wreathed in evergreens.

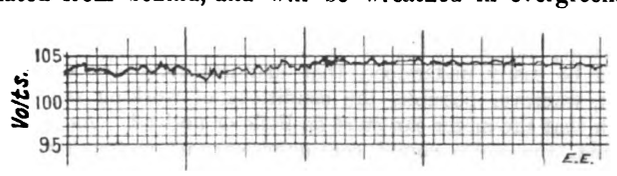


FIG. 20.—Voltage Record at Hotel Cecil.

The top of the portico will also be lined with coloured lamps. Up each side of the main courtyard will be placed six Venetian masts, carrying trophies to represent respectively the various Colonies. As the hotel is to be largely used for our Colonial guests, this will be most appropriate. The masts will be draped in bunting and evergreens, and festooned with lamps enclosed in the General Electric Company's celluloid balloons scattered along the bands of evergreen. Over the central fountain, which can be illuminated from below, will be placed a skeleton kiosk formed of lines of coloured lamps, and lamps will also be distributed amongst the plants in the central beds. On the top of the two domes we regret to hear that gas is to be used in the shape of large flambeaux. We are only consoled by the fact that the use of this effective gas-wasting illumination is not attended by economy. On the roof a 36 projector is being erected on rails running the full length of the hotel. The projector will take some 150 amperes, and will be used to point with light any desired building within the range of vision.

We are indebted to the management of the hotel for permission to publish the above, and to the chief engineer (Mr. Beckton) and his assistant (Mr. W. A. Poynton) for the facilities for obtaining the information.

THE LOCAL DISTRIBUTION OF ELECTRIC POWER IN WORKSHOPS, ETC.

BY ERNEST KILBURN SCOTT.

PART II

(*Continued from page 649.*)

In considering the question of the non- or asynchronous *polyphase motor*, we are met at the outset by the question of what number of phases to employ. Until quite recently three phases were used almost exclusively; and as will be seen by Table XII., compiled by the Electrical Company, some very large installations have been carried out on this system.

TABLE XII.—Examples of Three-Phase Installations in Workshops and Factories on the Continent.

Name.	Place.	Kind of factory.	Dynamos. No.	Dynamos. Total H.P.	Motors. No.	Motors. Total H.P.
Meyer and Son	Tangermunde	Sugar refinery.	2	210	18	135
Von Schollerand Co.	Czakowitz.	Sugar refinery.	4	420	52	310
Moscow - Rasan Railway.	Moscow.	Railway works	2	160	11	88
Zrardower Mills.	Zrardow.	Cotton mills.	1	430	34	290
Kunheim & Co.	Niederschon-wiede.	Chemical works.	1	80	8	50
Kunheim & Co.	Gr. Rischen	Chemical works.	1	105	7	68
H. A. Furst.	Berlin.	Silverware makers.	1	80	4	40
F. Rabeneck and Co.	Moscow.	Dyeworks.	—	50	6	18
Cellulose Manufactory	Feldmuhle.	Cellulose works	1	105	4	95
Breitenburger Works.	Lagerdorf.	Portland cement works.	1	105	6	83
Kolomna Engine Works.	Kolomna.	Engine making	3	800	35	453
Trotschler & Co.	Lingen.	Cotton spinning.	1	90	1	70

There appears to be now, however, a disposition to employ two-phase currents.

As regards the actual design of two and three phase alternators, transformers, and motors, there is, perhaps, not much to choose between them. Machines designed for similar outputs, whether synchronous or non-synchronous, are found to have about the same efficiencies, starting torque, weight, and apparent watt consumption. The three-phase machines are, if anything, slightly better (according to experiments made by Mr. Kolben, the chief engineer of the Oerlikon Works), but this is balanced by the winding details of the two-phase type being a little simpler. The main difference between the two systems lies in the relative weights of copper required in the conductors for given conditions, and the ease with which the currents may be handled, regulated, and controlled.

The first experiments with three-phase working brought to light difficulties in the regulation of pressure between the three mains at the points of supply, when the currents in the three circuits were not approximately the same, which, though since overcome to some extent, are greater than those obtaining with two-phase currents—they lie chiefly with the design of alternators and transformers.

Two phase currents, if worked with two separate circuits, are almost as easily dealt with as single-phase currents, and serve readily most purposes to which single or poly-phase currents are usually applied. With two separate circuits,

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lamps may be run by either circuit alone, and thus one-half the armature may be cut out without causing inconvenience. Of course, both circuits must be used for the motors. Four transmission wires are usually employed, but three only may be used, the two inner legs of the circuits being made into one wire of nearly equal cross-section, so that the three wires require almost as much copper as the four.

It may, therefore, be taken as a general rule in alternating-current work, that for power distribution in workshops where lighting is a secondary consideration and the amount of lighting is small in comparison to the amount of power, the three-phase system is preferable; but where power and light are to be delivered in approximately equal amounts, the two-phase system should be used in order to simplify the lighting circuits; whilst if the load is nearly all lighting, single-phase is best. It will be noticed from Table X. that only one firm in this country, the General Electric Company, Limited, of Manchester, have gone in for polyphase motors to any extent, although Messrs. Clarke, Chapman, and Co., Limited, of Gateshead-on-Tyne, have also got a few at work. It is in the United States and in Switzerland where most work has been done in this line, and it would almost appear that, thanks to their unequalled water powers and the boldness of their engineers, these two republics are destined to wrest from us the title of being the workshops of the world.

In England, the absence of any considerable water powers and the excellent running of the continuous-current motor, have undoubtedly been the principal causes which have prevented us having a more practical acquaintance with polyphase work.

The question of patent rights may also have had something to do with our being behind in this matter; and although there appears to be no question that Bailey's description of an alternate-current motor before the Physical Society in 1879, and the important communication of Prof. Galileo Ferraris in 1888, knocked the bottom out of any *fundamental claim* for a rotary-current motor, yet, at the same time, it is very questionable indeed whether an English court would set aside the work of Tesla, Brown, Dobrowolsky, and Kolben. These men—or rather the firms they were connected with—have all helped, by working out details, to convert an interesting theory and toy into a practical machine which would meet the requirements of commercial work; and if what they have done is not to receive reward, then what is to become of our whole system of patent law?

To return to the subject immediately under discussion, it will be found that all *asynchronous motors* have the following points in common: (1) that the iron core of both the rotating part—armature, or "rotor," as Dr. Thompson calls it—and the iron circuit of the outside and more massive stationary part, or "stator," are built up of laminated iron; (2) the windings of both the rotor and stator are in slots or tunnels in the iron cores, so that the air-gap is a mere mechanical clearance; and (3) no excitation of field magnets—as we understand it—in the dynamo and alternator is required.

Naturally, there are many variations and special designs, but the following descriptions will be found to fairly represent the general run of motors at present on the markets: For small motors—say, below 2 h.p.—the rotating part, or rotor, is usually wound in what is known as squirrel-cage fashion; that is, solid copper bars laid in the slots or tunnels, and simply short-circuited on themselves at the ends. No brushes are required, because the line current is supplied to the external fixed part, or stator. Sometimes motors are built with squirrel-cage armatures up to 8 h.p. or 10 h.p., but in this case, in order to obtain a good torque, whilst preventing an inordinate rush of current from the line, either the ends of the revolving coils are connected to collector rings, and closed through separate resistance coils, or else the resistance is carried in the body of the rotating part itself, with a kind of friction clutch device on the shaft for short-circuiting it after the motor has got up speed. For the larger sizes of motors, it is better to connect the line current with the revolving portion, so that the losses due to hysteresis, eddy currents, and self-induction are limited to the smallest part of the machine, whilst the more massive stationary portion is magnetised by currents of frequency equal only to the difference between the speed of the revolving coils and that of the rotary magnetic field. As these machines require either a clutch or collecting rings and brushes, simplicity of design is departed from. In the still larger sizes, the arrangements are still more complicated, and each maker's practice varies. For motors above 36 h.p, the Oerlikon Company, for example, provide a special starting device, with what is called an auto-transformer. This *auto or "one coil" transformer* consists of a coil of wire wound on an iron core, and connected across the mains. A branch wire is attached to some point between the two ends of the coil, and a large current at a low voltage is drawn off from that part of the coil between the branch and one end which is connected to the motor. A much larger current can be drawn off than is supplied to the mains, because the part of the coil between the branch and one end acts for the time being as the secondary of a transformer. In this way, it is said that motors may be connected to lighting circuits without bringing down the voltage at the lamps unduly. The auto-transformer is an exceedingly neat device; but, of course, it adds to the expense of the motor.

Summarising the above, it is evident that although the revolving part, corresponding to the armature of a continuous-current machine, has no commutator, yet, if the motor has to approximate to the conditions which a good motor should fulfil—namely: (1) starting at full load from any position with no more than normal current, so as not to disturb the pressure on the circuit; (2) starting up with a torque much greater than that exerted when running; and (3) its speed being approximately constant under great variations of load—then either it is necessary to have a collector and brushes, or else an arrangement for short-circuiting a resistance built into the revolving part, or even still more complicated devices in the larger sizes.

It is, therefore, seen that the simplicity of design which is so often claimed for the polyphase motor is considerably departed from, and the cost of the necessary adjuncts and resistances may counterbalance the cost of commutator of a continuous-current motor. Some further information on this point, with comparative curves, is given further on.

A point in connection with the above-mentioned special starting resistances is that if the speed be suddenly brought down by an overload, the motor has not got the resistance in circuit with which to recover itself; whilst in the event of the motor being stopped dead and no attendant being near to switch off the main current, there may be a burn-out. The only way to obviate this is to leave the resistance always in circuit, either in the armature itself by winding it with finer wire, or outside in the form of a separate resistance, and be satisfied by a much lower efficiency, with a variation in speed from 10 to 15 per cent. Generally speaking, the ordinary asynchronous motor is in *constancy of speed* about equal to a continuous-current shunt-wound motor of the same power, and the total drop in speed may average about 5 per cent. There is this difference, however, in the two cases, that whereas in the continuous-current machine the drop in speed can be remedied by merely putting on a series winding (or what is known as compounding the machine), in the other the drop in speed, or "magnetic slip," as it is called, is an absolute necessity of running. Therefore, for a mechanical force to be exerted at all in the polyphase motor, it is essential that there shall be a variation in the speed of rotation between the field and armature, so as to give the necessary variation in magnetic flux passing through any armature coil.

Practically speaking, when a *good starting torque* is required efficiency and speed regulation must be sacrificed; and it will thus be easily understood that manufacturers are anxious that, wherever possible, the conditions of working shall be such that the motor can start on little or no load. As before stated, the series-wound continuous-current motor has the highest initial torque, amounting in some cases to six or seven times the running torque.

By sacrificing efficiency and speed regulation, the initial torque of a polyphase motor may be as high as three times the running torque. Therefore a polyphase motor requires to be relatively of about twice the capacity for similar starting power, and this brings in another difficulty, inasmuch as, when running on the load, such a motor would only be doing half the work it was capable of exerting, and would consequently give a still lower efficiency, probably not more than 60 per cent., seeing that asynchronous motors are only efficient at high loads. From this point of view also, there would appear to be a distinct advantage with continuous-current motors,

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Overloading is a weak point in the use of alternate-current motors, for they are all liable more or less to be stopped by a sudden overload; and makers advise, therefore, that, if possible, the machines be connected to their work through some form of slip coupling, arranged to give slightly when an extra load comes on.

The *regulating resistances* for a polyphase motor are not quite so simple a matter as for continuous currents, because the resistance should be a non-inductive one. Coils of wire are therefore objectionable, as the wire should be straight; it consequently takes up more room, requires more insulators, etc. The impedance coil, which gives such a simple form of resistance or damping action to certain alternate-current apparatus, is unfortunately not admissible in motor work, since its self-induction causes a lag in the current, and may increase rather than diminish the starting current.

From what has been said, and from the fact that increasing the number of phases is not, as some seem to think, an unmixed blessing, it will be obvious that the great desideratum is a *self-starting single-phase motor*. Especially is this so in this country, because practically all our alternating public supply stations work on the single-phase system. It was not, however, until the asynchronous two-phase motor had reached the stage of practical success that Mr. C. E. L. Brown found accidentally that such a motor would run even when one of the wires was disconnected; that, in fact, if the wire was removed whilst running at half-speed, it would continue to increase in speed up to its usual rate. It was at once evident that single-phase motors might be constructed on analogous lines to the poly-phase type. The Brown asynchronus single or mono- phase motor has a squirrel-cage armature with all the bars short-circuited at either end by solid metal rings. The stator, or external field, has two sets of coils superimposed, one set being the main winding, and the other the starting winding, of finer wire. The operation of starting is effected by what is known as splitting the phase—that is, the main coils are supplied with current as near as possible 90deg out of step with the current in the other or starting coils. The most effective way of doing this is to put the main winding in series with a coil of wire, wound on an iron core, thus giving it a comparatively large self-induction. The starting coils are given capacity by putting them in series with a voltameter or condenser, which thus serves to lead the phase of the current passing through it; and as the self-induction in the main coils retards the phase of its current, there is a fairly large torque.

Although the action of condensers has been known for a long time, they have not proved very successful in practical work. With improvements in details, however, so as to make them more suitable for rough handling, they would appear to have a large future, especially as they are a necessary adjunct to the self-starting monophase motor. As before mentioned, this motor differs from the synchronous motor in not requiring to be run up to synchronism. All that is required is a start up to about one-fourth the normal speed, or sufficient to make the torque exceed the frictional resistance of running light, and thus very small motors arranged with a fast and loose pulley on the shaft which receives the power may be started by giving a vigorous pull on the belt by hand.

An auto-transformer is used to give a large current at reduced voltage for the larger sizes of motors. Messrs Siemens, of Charlton, are making somewhat similar machines. A 15-h.p. machine which they have built has three collecting rings on the rotor shaft, which are connected up to the usual form of Siemens resistances in iron tubes. The starting box, which is about half the size of the motor, carries these tubes and a somewhat complicated switch for cutting them in and out, etc., and also a choking coil for splitting the phase and so getting the necessary starting torque. The large size of the motor, when compared with a continuous-current machine to give the same power, is striking, and when we are told that an extra 2 h.p. or 3 h.p. is sufficient to pull it up, the alternating-current motor loses still further by comparison with its rival, which, unless prevented by a cut-out or time switch, will run to its death. Remembering the outcry made by customers of the City of London Company when it became known how much cheaper the electric light could be obtained in Brighton, one may be excused from wondering what position some so-called consulting engineers will take up when a section of the general public become alive to the fact that being connected to a *single-phase* alternating network handicaps them with regard to motive power when compared with those who are fortunate enough to be within the area of supply of a continuous-current system. To infer, as some do, that because there is no great demand now there never will be, is mere idle talk, as an examination of some of the figures of American stations will show.

Impedance, lag, and idle currents develop as the size of self-exciting motors increase, and this practically limits the distribution of power on a single-phase current to motors not exceeding in size 100 h.p. It has been shown, for example, that whilst a single-phase generator may be of 1,000 h.p., any one of the motors must not be larger than 100 h.p., unless independently excited and started.

(To be continued.)

CITY AND GUILDS OF LONDON INSTITUTE.

ELECTRIC LIGHTING AND POWER TRANSMISSION.

The following are the questions set by the Examinations Department of the City and Guilds of London Institute, 1897:

HONOURS GRADE.

Candidates in honours must have previously passed in the ordinary grade. They may select their questions from one only of the sections:

Section III.—Lighting and Power Supply.

Answer questions 3, 4, and 10 of the ordinary grade, together with not more than *six* of the following:

41. Describe a commercial ohmmeter, with sketches, and explain how it is used. In drawing up a specification for the wiring of a private house, what standard of insulation resistance would you require, and what maximum drop of pressure would you allow? (30.)

42. Explain exactly what steps you would take to localise a partial earth fault in a two-wire alternate-current network, the fault being either in the feeders, distributing mains, or house wiring. (25.)

43. What tests should a high-pressure cable stand, and why? What do you consider is the effect of high direct and high alternating pressures on cable insulation? (20.)

44. How could a five-wire low-pressure network be fed off a two-wire alternating high-pressure system of mains? (30.)

45. Would you prefer Lancashire or tubular boilers for (1) a small, (2) a small alternating station? Give full reasons. (25.)

46. In what ways can vibration be successfully diminished in a central station? (30.)

47. Explain fully the uses of storage cells in connection with a public system of electric lighting. Give examples of the actual results obtained. What means have been employed to obtain storage when alternating currents are used? (30.)

48. In a feeder system do you prefer to keep the pressures the same at the home end of all the feeders, or to vary the pressures according to the lengths of the feeders and the loads. How would you work in each case? (20.)

49. You are required to design a system of electric traction suitable for the underground railway in London. Give particulars of the system which you would recommend in such a case. (35.)

50. Consider the merits and demerits of direct-current, single-phase alternating, two-phase and multiphase alternating current, for long-distance transmission of power. (30.)

Cologne.—Tenders will be received by the Municipal Authorities on September 3 for the working of about 12½ miles of electric tramway at Cologne. Particulars are obtainable for 3 marks (3s.). Application to die Registratur B.

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"HE THAT WOULD NOT WHILE HE MAY."

The ceremony of laying a foundation stone at Southampton for the extension of the central station brings into relief two opposite tendencies. On the one hand, we have such towns as Liverpool and Southampton taking over the work of private companies, and, on the other hand, we see local authorities parting with their provisional orders to companies. It is hardly possible to reconcile such different views, and, in fact, they can only be reconciled upon the hypothesis that one or other party is utterly ignorant of the real facts concerning the carrying on of the business of electric energy supply. No doubt it becomes somewhat monotonous to periodically call attention to this matter, especially as the loss which ensues from these proceedings falls upon the men who are answerable for them. By this we mean that voters who send incompetent business men to councils must in the end pay the piper for so doing. Every town that has bought out a company has had to pay more and be in a considerably worse position than if the town had originally undertaken the work. The credit of corporate bodies, although the total indebtedness of such bodies reaches the enormous amount of about two hundred million pounds, is exceptionally good. They can borrow money upon easy terms, say from 3 to 3½ per cent., and pay such money in half-yearly or yearly instalments over a period of from thirty to forty years. Their management expenses ought to be less than those of any company; and as the shareholders of a company like to distribute all profits as dividends, making the dividends as large as possible, the charge per unit is a maximum. The authority, on the other hand, ought to charge a minimum per unit in order to benefit the whole town. We have very carefully watched the arguments put forward by opponents to lighting schemes in vestries and councils and in local papers, and find that the general cry is that the ratepayers' money is to be wasted. The large sums involved are taken at once as total losses. None of the critics seem to comprehend the difference between money spent productively and money spent unproductively. If an outcry was made about spending money on roads, we could conceive of men not understanding how such money was useful indirectly; but the case of electrical energy is different, the return is direct. It is a manufacture, the business being to produce and sell. The produce is required by every householder, and the extent of the demand is limited only by the number of houses. It can be calculated to the uttermost fraction; and it is preposterous in opponents arguing that because the demand is small during the first few years of the factories' existence, hence the factory is a failure. In entering upon a business the capital expenditure is not regulated by the first day's or the first year's demand, but upon the probable demand when in full working order. To obtain that demand is a work of time. In electrical undertakings, when once the probable demand is obtained, that demand is more or less constant. Of course, in a town rapidly increasing in size it would increase, while in a town with a fairly constant population it would be con-

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stant. The returns upon capital expended would also be constant, and would far exceed those obtained while the demand was rising. If the opposition to electrical undertakings arose from the possibility of some other system of illumination coming along within the next few years, that would be a point more difficult to meet. Some alarmists do point out a probable early development of acetelyne. No one can foretell what the immediate future may bring forth, and the opinion of one person conversant with the subject is as good as that of another. Hence we have no hesitation in expressing the opinion that acetelyne is not destined to become a general illuminant. There is still the rejoinder, that something else may turn up, to which we have no reply. If councillors are to wait till they see perfection and for what may turn up before embarking in work of any kind, why have councillors? At the present time, and so far as those fully acquainted with the subject can see, there is no possible or probable competitor with electricity except gas. Notwithstanding all that may be said in favour of gas, electricity can successfully compete with it, and will do so more and more easily as time goes on. Holding these views, we have consistently urged local authorities to undertake the work themselves, knowing that if they permit the ground to be occupied by a company, it will cost more ultimately to obtain control than if they carry out the work from the commencement. There are exceptions to every rule, and it is no use discussing exceptions. What we have to do is to obtain acceptance of "the rule." But if we were to mention exceptions, one would come first that, in the earlier days of the industry, the authorities were perfectly justified in welcoming the action of companies. These pioneer companies deserve all the praise we can give them for their foresight and energy, and all the returns they can justly get upon the capital expended.

CORPORATION ENTERPRISE.

A novel phase of corporation electrical enterprise has just been inaugurated in Glasgow by the opening of a pleasure resort under the name of the "Scottish Zoo."

The building is situated just beyond the centre of the town, and has been occupied by variety shows, people's palaces, etc., till recently it has been acquired by Mr. E. H. Bostock, who has entirely altered the old building and reopened it with all modern improvements, including, of course, electric lighting. Tenders were advertised for to carry out this work, but the Corporation electrical department, apparently reluctant to lose such a satisfactory client as these premises promised to become, proposed to put down a temporary gas-engine plant and supply the current by meter till such time as their mains were extended to this district. This, we believe, will now be shortly done, seeing that the increase in pressure from 100 to 200 volts gives them such a much larger possible area of supply; and we look forward to the close of the present financial year to see large extensions in the mains of the Corporation.

The temporary plant which the Corporation have laid down consists of a 12 nominal horse-power Crossley's Otto gas-engine, driving a dynamo of W. T. Goolden's make having an output of 105 volts and 120 amperes at 680 revolutions. As we have before mentioned, the current is supplied by meter with the standard discounts as measured by Wright's maximum supply indicator. The installation in the building itself was carried out by Messrs. Ramsey and Co., of Glasgow, and consists of 24 10-ampere arc lamps, supplied by the Edison-Swan Company, and about 200 16-c.p. incandescent lamps distributed throughout the building. The principal lighting of both the "circus" and "zoo" is by the arc lamps, while the incandescents are utilised in entrances, passages, side-shows, etc. Among others, we noted a fountain illuminated by coloured lamps in the aquatic birds' pond.

One turn in the circus deserves mention here, and that is the electrical equestrienne performance of Mdlle. Rosina. This lady appears in the ring, which is otherwise in darkness, with both herself and her horse outlined with miniature electric lamps, which give sufficient light to enable her to go through her performance of juggling, etc. By the courtesy of her husband, Mr. Sharman, we were enabled to examine the batteries that gave this result, and which have been made to his own ideas and requirements. There are 35 lamps on the horse and lady, each of 12 volts, and as they are only in use for eight or ten minutes at each performance it is found economical to overrun them considerably. There are six cells, each giving about 2 to 2·25 volts, carried in the saddle of the horse, and each cell measures 1¾in. by 4in. by 9in. high, and weighs 6lb. 6oz., so that the extra weight carried by the horse is only a little over 38lb. Mr. Sharman told us that he had some difficulty in getting anybody to undertake to supply the cells to weigh under 40lb., and at the same time to give sufficient output to keep the lamps brilliant during the turn. However, eventually Mr. Ellison, of the Lamina Accumulator Company, undertook the job, and after six months' use the cells appear to be still in perfectly good condition. Mr. Sharman carries about with him a small 7-ampere 20-volt dynamo and a small "Cripto" gas-engine, made by Barker, of Leyton, for charging the cells, so that he is always independent of any outside supply for his current.

SOUTHAMPTON ELECTRICITY WORKS.

A notable event in the history of municipal electric lighting occurred at Southampton on Tuesday, when the Mayor of the town (Mr. Edward Gayton) laid the foundation of the new central station, which is being erected in Back-of-the-Walls. The site was gaily decorated, and a large number of councillors and townsmen accompanied the Mayor, who was preceded by the mace bearers and attended by the various civic dignitaries, including the town clerk (Mr. George B. Nalder), the borough engineer (Mr. Bennett), the borough electrical engineer (Mr. Lee), the members of the Electric Lighting Committee, etc.

The plant at present consists of 520 i.h.p. of engines, and boilers of 600 i.h.p. There are also two old boilers—one of 80 h.p. and one of 120 h.p.—which are used for helping and stand-by. Originally there was a 45-h.p. dynamo, 30 kw., driven by a Robey engine. This is used as a stand-by. Practically all the original plant is used as a stand-by. The plant in use consists of a 60-i.h.p. Willans engine, two 100 i.h.p. Willans engines, and one 140-i.h.p. Belliss—coupled to Crompton's dynamos. The capacity originally was 400, with Crompton-Howell plates. It is now about 200 amperes. Lamp connections in 1892, 2,200 equivalent 35-watt lamps; in 1893 they were 3,162; in 1894, 5,390; in 1895, 6,887; and up to last March 31 they amounted to 8,948, including 14 motors, with a total horse-power of 106. Four of them are big motors for cranes at the harbour. The total capital expenditure up to date is £28,425. In the first instance £56,000 was borrowed, and of this £21,000 was paid to the old lighting company, and £1,000 was expended in issue of Corporation stock, etc., and preliminary expenses. The works cost of current is 2·27d. per unit, and the total cost works out at 3·66d. per unit. The average revenue per unit sold is 6·2d. The gross profit on the year amounts to £1,472, and after repayment of interest on capital and one or two smaller items there is a real profit of £21. The extensions will include four low-tension machines, Robey engines, and two of the small dynamos will be removed. There are to be three engines of 150 h.p. each, with high-tension machines

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(alternating), and three rectifiers for street-lighting. There will be 62 street lamps at first, and there will be about 30 lamps on each rectifier. There are also an economiser and a water-purifier. The town water will be used. A Vicars mechanical stoker will be put in, also a patent coal elevator and conveyor. Three new boilers are to be put in, of 100 h.p. each, to start with.

Mr. MANVILLE (Messrs. Kincaid, Waller, and Manville), in a short speech, explained that for several years the business of the electric lighting company was carried on in the small temporary building at the Back, and the time had now come when the whole undertaking required to be put on a more firm and satisfactory basis. The new buildings which the Corporation were erecting would comprise an engine-house, a boiler-house, and offices of adequate size. The buildings would be of amply sufficient dimensions, not only to accommodate the new machinery in addition to the old machinery, but to allow of considerable extensions in the future—and, he hoped, in the very near future.

Alderman BONE, on behalf of the Electric Lighting Committee, welcomed the Mayor, and said very many of his predecessors had had similar opportunities of laying foundation-stones of public buildings, and with regard to the free library, the foundation-stone of which was laid by Mr. Lemon, it was referred to as the temple of literature. On the present occasion he would ask the Mayor to lay the foundation-stone of what he would call the temple of light. He hoped the concern would continue to go on and prosper, and that it would be a great success and a great source of profit to the borough of Southampton

The Mayor was then presented with a handsome silver trowel by Mr. Manville, and a polished mallet by Mr. Toole (Messrs. Playfair and Toole, contractors). The foundation-stone, which was of polished granite and bore a record of the event, was then lowered into position and declared "well and truly laid" by the Mayor, who had previously deposited the usual current literature and coin of the realm in a cavity, which was sealed by the foundation-stone.

The MAYOR said it gave him very great pleasure to occupy the position he did that morning to lay the foundation-stone, as Mr. Alderman Bone had said, of a temple of light for the town of Southampton. He hoped a structure would be reared of which the inhabitants of his native town might well be proud. He thanked the engineers and contractors for the very handsome presents they had given him. He thought it would not be the last foundation-stone he would lay during his year of office, because they were also going in for the housing of the working classes and for large hospital accommodation.

This terminated the first portion of the proceedings, and the party then went to the pavilion on the Royal Pier, where an excellent luncheon was partaken of at the invitation of the Mayor. The building was handsomely decorated, and a band played at intervals during the meal.

A short toast-list was afterwards gone through, and the toasts of "The Queen" and "The Prince and Princess of Wales and the rest of the Royal Family," proposed by the MAYOR, were received with musical honours.

The MAYOR then proposed "Success to the Corporation Electric Supply." He said that since he had had the honour of a seat on the Town Council—now 10 years—he thought he might safely say that the kaleidoscope of events had had many turns, but it had not turned in a more luminous direction than it had that day, when they had laid the foundation-stone of the electric lighting station in Southampton. He remembered the time, not very long ago, when that undertaking could have been purchased for the sum of something like £750, but the Corporation in those days were not wise men. They refused the offer, and within 12 months ago they had paid something like £23,000 for it. He thought the Corporation had done rightly in acquiring that property, because he believed it would be as time went on a very great benefit and boon to the inhabitants of Southampton, because it would go in a large measure to reducing the rates of the town. They had been told in the public Press and by men of eminence in Southampton that they were going too fast in the Corporation; that they had too many irons in the fire, and that they were too progressive. He maintained that if their predecessors had been a little more progressive they would not had at the present time such heavy rates, because if they had in their wisdom seen fit to have purchased the gasworks in the town they would to-day have had to pay no rates at all. That was a truism which could not be denied. What they wanted was men, now they had got this go-ahead policy before them—men with the courage to be radical and the wisdom to conserve. They wanted to throw on one side all petty differences and political principle, and to strive to do their utmost for the good of their native town. He was no Little Englander, and he was no Little Southamptonian, and he believed in doing all they possibly could, not only to enlarge the fame of the town, but also to raise it in the estimation of the whole of their fellow-countrymen. The Lighting Committee was under the chairmanship of their friend, Mr. Alderman Bone; and the ratepayers might rest assured that when they supplied electricity, not only to the houses, but to the tramways, which they were about to acquire, they would be able to show that they had gained a very handsome profit for the benefit of the suffering ratepayers of Southampton. During the past 12 months the Corporation had made a profit on its water undertaking of over £2,000, which had reduced the rates 2d. in the pound.

Mr. Alderman BONE, in reply to the toast, said he thought it would be admitted by everybody that electricity had made very rapid strides during the last few years. In 1882 a very celebrated deputation was appointed and visited the works at Reading, London, and Liverpool with reference to the introduction of waste-water machinery into Southampton. At that time there was a talk of having the electric light. They were very well pleased with what they saw, but they had not sufficient confidence in recommending the Council to adopt it, as it was then in its infancy. Up to 1889 very rapid strides were made, and at that date there were only 100,000 incandescent lamps in existence. At the present time it was estimated that there were more than 3,000,000. They at present had the continuous-current system in Southampton, but in the enlargement of their works they would introduce the alternating. In 1889, the Corporation having neglected to apply for the provisional order for a license, a few public-spirited men in the town applied to Parliament for the license. They were not opposed, and they formed their company. A short time afterwards they offered their licenses to the Corporation for the sum of £750, and Mr. Lemon brought forward a motion in the committee to purchase. There was a great deal of discussion and there were three divisions, and each time the voting was equal. The matter was referred to the whole Council, and there was then a large majority against it. During the latter part of the year 1895, Mr. Lemon, as chairman of the Works Committee, brought the matter forward in the Council, and eventually they agreed to purchase for the sum of £21,000. He took that opportunity of saying that the directors of the company met them in the most fair and liberal spirit. They had borne the brunt of the day, and then were willing to accept a sum of money equivalent to the capital expenditure and a few hundred pounds besides. During the past 12 months the working expenses were £2,016, and the receipts £3,491, showing a gross profit of £1,475. Of that, £924 was paid for interest on borrowed capital and £508 was repaid as capital, leaving a balance in hand of £43. Considering the great disadvantages they had suffered from, he thought their position was very satisfactory. They had already reduced their charges for motive power from 6d. per unit to 3d. per unit, and for lighting from 7d. to 6d., since March 31 last, and they had also adopted the rebate system of charging. They had increased their distributing mains 3½ miles, and they were exceedingly well satisfied with the way the residents in the neighbourhood had taken the current in their houses. They already had 30 new customers, and they looked forward to a much larger number. The contract for the building of the new station was let for £8,000, and the other tenders would before long be decided upon. They were fortunate in having as their engineers the firm of Messrs. Kincaid, Waller, and Manville, and they were also fortunate in their contractors, Messrs. Playfair and Toole. In Mr. Lee they had an engineer who was doing his very

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utmost to make the concern a profit-paying concern, and all who were under him were doing the same. He thanked the committee for the way they had rallied round him during the time these works had been under their control, and he hoped they might be associated together for a long time. Their utmost endeavours would be given not only for the advancement of the electric lighting works, but also for the benefit of the ratepayers.

A few other complimentary toasts having been honoured, the proceedings terminated.

THE MECHANICAL CONSTRUCTION OF ELECTRICAL MACHINERY.

BY F. M. WEYMOUTH.

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THE DYNAMO.

(Continued from page 692.)

Bearings (continued).—In Fig. 205 herewith we have a type of cap bearing as fitted to the pulley end of a belt-driven dynamo, this illustration, however, showing only a longitudinal section. Transverse sections are a matter for separate discussion, on account of the variety of design which they admit, while retaining practically the same section as that in the first given direction. We may note some of the points in the view now before us (Fig. 205).

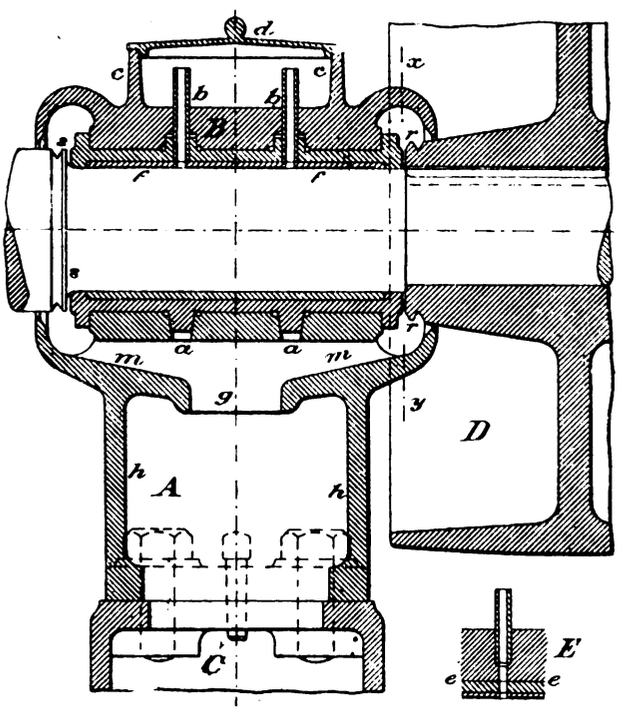

FIG. 205.

A is the main body of the bearing, and B the cap or cover, and C the top of the pedestal cast on the bed-plate, while D will be recognised as part of the pulley mounted on the shaft; and the shaft is also shown in the bearing. After the manner illustrated in Fig. 200 there is here also a bush split into two "brasses," one above in the cap, and one below, and these are lined with white metal, as indicated.

A disposition apparent sometimes in the design of bearings for dynamos is to cast the brasses lighter than the proportions given in connection with the plummer block shown Fig. 200. But these proportions as to thickness are practically adhered to in the present case. The brasses are supported for nearly their whole length within the cast iron by turned facings. The only breaks in this turning are caused by two snugs, *a a*, below for preventing the lower brass rotating, as before explained, and two corresponding projections on the brass above. These latter, it will be observed, receive tubes, *b b*, which are knocked down into them a tight fit equally in the cast iron and the brass. An oil-box, *c c*, is cast on the cap, with a lid, *d*, which may either be made to remove entirely as shown, or may be hinged to the oil-box on one side. It is usually of polished brass. To effect the lubrication, cotton wick loosely fitting the tubes, *b b*, is laid in the oil, and an end of the wick is pushed down each tube till it nearly or quite touches the shaft. The whole of the wick may first be soaked in the oil; but when in the tube a syphon-like action of the oil within the wick takes place, resulting in a continual drip of oil from the lower ends of the wick on to the rotating journal. It is not unusual to affix wires to the wicks whereby they may be easily pulled up and reinserted as required. A drawback to this method, however, is that the wicks are liable to become clogged through "gumming" of the oil, an evil varying no doubt with the kind of lubricant employed, and so, unless well attended to, the lubrication may be rendered defective, with the usual results as to heated bearings and want of freedom in running. The syphon effect above alluded to, it may be mentioned, is easily to be seen by hanging a piece of thick string from out of a tumbler of water. The string may be soaked in the water first; and one end being left well immersed, and the other end outside being a few inches below the level of the surface of the water, a slow but continual drip will be observed to take place from this outer end.

A point to be noted in Fig. 205 is that the tubes, *b b*, do not stop short with the cast iron; but, by being continued down at least to the white metal, they form an unbroken passage for the oil without chance of the oil leaking behind the brass, and getting between it and the cast-iron cover. This may be compared with the arrangement presented at E, where the tube stops short, as shown, and consequently the oil is able to, and in practice in such a case does, leak into and spread in the joint, *e e*, between the brass and the cap. This waste, and so to speak, untidiness, is thus prevented by running the tubes through. An oil-way may be cut along the white metal at *f f*, as was mentioned in the case of Fig. 192. For catching the waste oil, it will be noted that in the first place annular oil-throwing ridges are formed at *r r* on the pulley, and at *s s* on the shaft. From

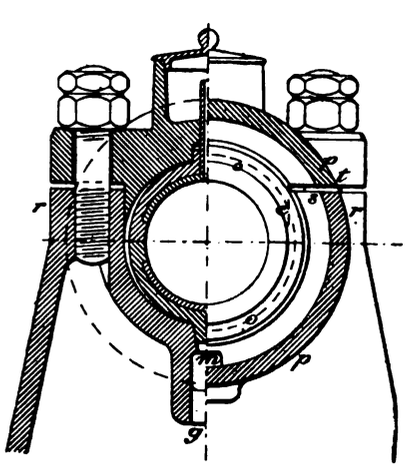

FIG. 206.

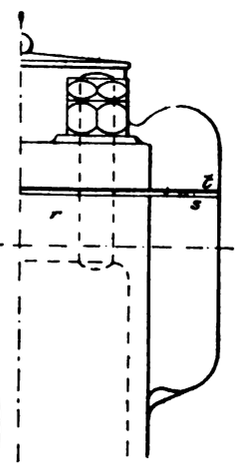

FIG. 207.

these the oil thrown off by centrifugal force is caught by the hoods, *k k*. Inside these latter it gravitates to the bottom, and thence finds its way along passages, *m m*, to a drip-hole, *g*. Now this bearing is designed to stand on a pedestal having an open top, but a closed bottom, for the purpose of forming a receiver for waste oil, such as we have illustrated in earlier pages. Thus the base of this bearing has four complete sides, as at *h h*, but is open at the bottom, as shown in the drawing together with the top of the pedestal. Hence the oil from *g* can fall straight through to the receiver bottom. There are thus no joints anywhere for the waste lubricant to pass; and all creeping of the oil down the sides of the base, *h h*, or inside the pedestal, is avoided, and opportunity for it to become oxidised or gummy from exposure to the air, consequently, lessened. A tap at the bottom of the pedestal will enable the oil to be drawn off at intervals, as formerly mentioned.

We may now turn our attention to the cross-sections. These latter will show more precisely the attachment between the cap and the base than can well be indicated

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in a longitudinal section such as that given in Fig. 205. We may commence with a method represented in Figs. 206 and 207. This follows closely the lines of the plummer block illustrated in Fig. 200. The same two jaws, *r r*, will be observed carried well above the horizontal centre line; and the small jaws projecting downwards from the cap. But the oil-catching hoods at either end have now to be reckoned with. These form a difficulty in adapting this design of cover too closely. The dotted circle, *o o*, is the lip of the hood at the back of the view, and *p p* is a section on *x y* in Fig. 205. It will now be noted that, due to the transverse section of the cap and its small jaws being continued through the hoods, small spikes are formed on the outer lip of the hood, as shown in one case dotted at *c*, which is not a desirable thing: yet if this spike gets broken the lip of the hood will to that extent lose its continuity. But also it will be perceived that at *t* and *s* sharp acute angles are formed, such as, on an early page, we pointed out are best avoided in cast iron. A difficulty also is that the gap between *t* and *s* will need filling up to prevent oil

FIG. 208.

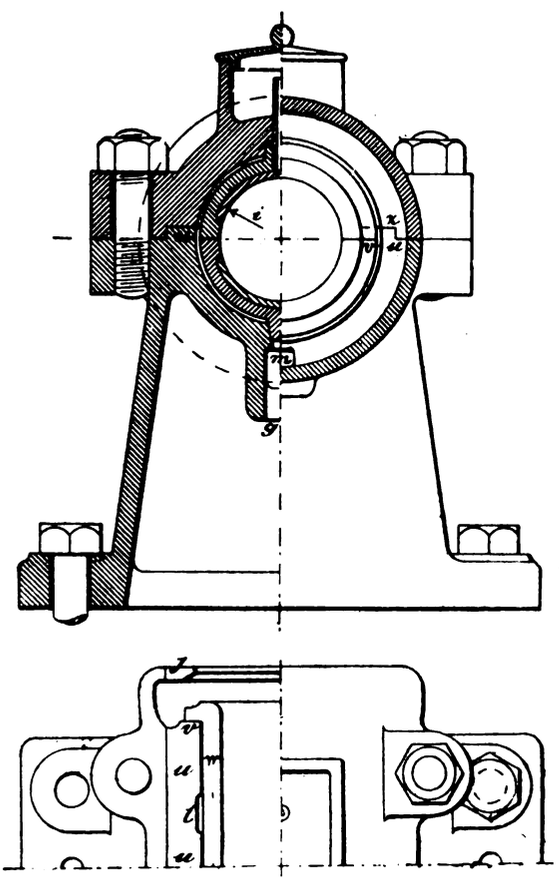

FIG. 209.

from exuding. Further, however, inasmuch as the hoods are not turned, and only retain the circular form and rough skin they bring from the mould, it is apt to come about that after the various processes of machining, the hood in the cover will no longer continue in quite the same circle with the hood in the base, a very little raising or lowering of the cap making a visible difference at the gap, *s t*, much marring the effect in appearance. Consideration will show that this is due largely to the gap being so high above the horizontal centre line. It is hence advisable to modify the design so as to retain as many of its advantages as possible, and yet to remove these peculiar difficulties with the hoods. A further reason for such modification relates to the *raison d'être* of the gap, *s t*, this latter, as already mentioned, being to permit lowering of the caps to suit wear of the brasses. But as this quality involves lowering the axis of the shaft also, which is not allowable in dynamos and motors, it has no value in this latter connection.

Before leaving these views, we may observe that in Fig. 206 the end view of a passage, *m*, is visible, as in illustrations following, also the drip-hole, *g*. Regarding the latter, it will be noted to be so formed, with a large mouth, that it is easy to extract the core after casting; and, when the shaft is not in, it is not difficult to clean the passage out if desired.

Figs. 208 to 213, which we now approach, show various methods of arranging the junction between the cap and the base, so as to obviate more or less the above-mentioned difficulties with the hood. In Figs. 208 to 211 one of these methods is drawn out more completely, inasmuch as it best preserves the special advantages of the plummer block. It will be perceived here that the joint between the cap and base is brought down to the horizontal centre line, though with a slight step up, indicated at *u*. This latter may perhaps be described as a remnant of the uprising jaws, *r r*, of the plummer block. It will thus be noted that, as in the case of the plummer block, the flanges of the upper brass overlap at the corners the uprising jaws, *u*, as shown at *v*, in Fig. 208. End thrust from the collars or shoulders on the shaft, or from the boss of the pulley, is hence borne by the upper brass equally with the lower, as with a true plummer block.

With reference to transverse steadiment of the cap and upper brass, the cap is held sideways by the small jaws, *u u*, as is evident on inspection. This will also steady the upper brass if the cap is stiff. It is to be noted that any possible pressure by the shaft on the cap in direction of arrow *i* will be met by the cap being hooked on, so to speak, to the jaw on the other side at *z*: thus the tendency will be to straighten out the cap; and it may be hence conceived that the cap will spring slightly, and so fail to afford rigid, oblique, and downward support to the shaft. On the other hand, when tightly bolted down, this difficulty will not probably amount to anything appreciable. Again,

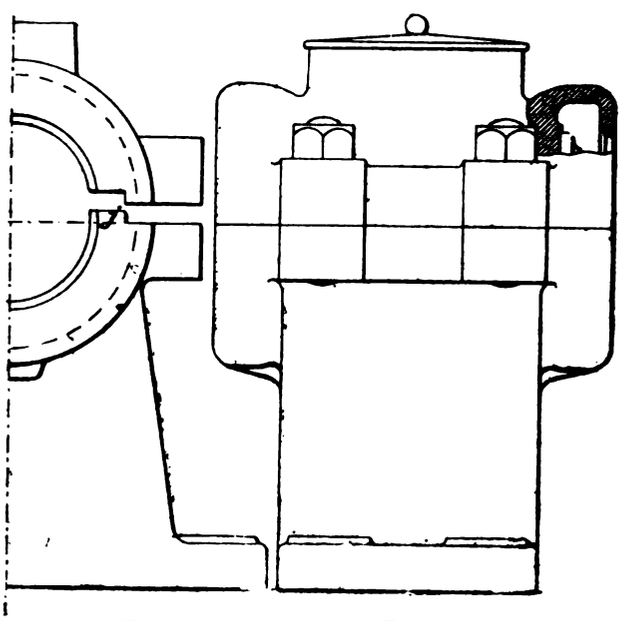

FIG. 210. FIG. 211.

however, it needs to be noted that, while the cap fits outside the jaws, *u u*, the upper brass fits inside: in fact, the inner edges of *u u* may require a little easing off with a file, so as to let the brass drop in; and this upper brass is thus securely held both endways and crossways.

Having regard now to the hood it will be observed that, inasmuch as the transverse section is carried straight through, small upstanding portions as at *j j*, corresponding to the jaws, *u u*, are formed on the lips of the hoods. Further, we must note that inasmuch as the power of raising and lowering the cap to adjust it to the wear of the brasses is not required, the result amounts in effect to the two brasses being treated as though they were a bush in one piece. Hence, the brasses being bored to a working fit on the journal, they and the cap and base are all machined to a mutual fit one within the other. Hence the meeting surfaces between the cap and base must be planed. To stand a light cut of the planing tool safely therefore, the upstanding part, *j*, will preferably not be less than, say, $\frac{3}{8}$in. thick. It may be optional however to confine the planing to the parts *u u* only, and then to finish the surfaces on *j j* carefully by

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filing, so as to obviate risk of fracture under the strain of the planing cutter. For the sake of avoiding acute angles on the parts *j j* in plan, it will be noted that the outline of the hood is slightly altered here from what was shown in Fig. 205: otherwise the views will precisely agree. We have already remarked on the turning of the outsides of the brasses, and as this cannot be effected where the snugs come, corresponding unmachined surfaces must be arranged on the base and caps, as indicated more clearly at *l* in the plan, one half section in Fig. 208 passing through this annular recess, as will be clear on inspection. It will be noted, finally, that as the cap is held by the jaws, *u u*, so that it cannot move, clearance holes may be used in the cap for the holding-down studs, as shown, as was the case with the plummer block, and the studs need not be turned bright. Thus in this design practically all the advantages of the plummer block are retained.

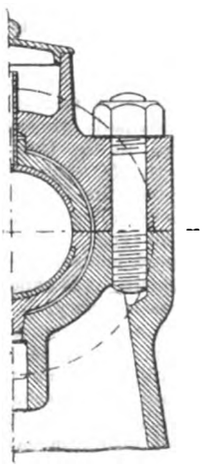

FIG. 212.

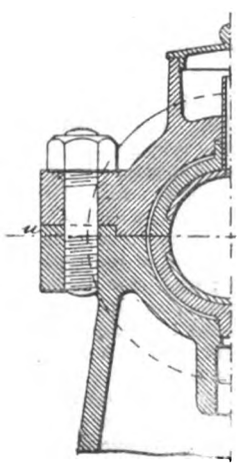

FIG. 213.

Other modifications, however, are represented in Figs. 212 and 213. The difference between the latter and that shown Fig. 208 is that the uprising portion, *u*, of the base is outside instead of inside, and is beyond the flanges of the brasses. Thus the flanges of the upper brass do not engage with the base: and although the transverse steadiment of the cap and upper brass is complete, as is evident, yet there is no steadiment parallel with the shaft. It is necessary therefore, to this latter end, to use turned studs fitting drilled holes in the cap, and thus to rely on the shear of the bolts, and their fit, for endways steadiment.

In Fig. 212 there is no step up whatever; and all steadiment of the cap and upper brass is made to rely on a fit of the cap on the turned studs. This method has the advantage of being simpler and cheaper than any of the foregoing.

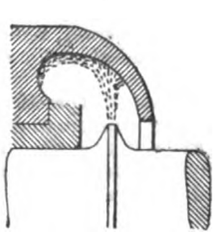

FIG. 214.

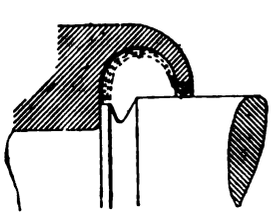

FIG. 215.

There is no fitting of the jaws required; and the meeting surfaces of the cap and base need but simple planing on one level. It would seem that this last method (Fig. 212) was much in vogue in actual practice wherewith under the stress of competition a low prime cost is often a necessity, overriding more technical considerations.

In all these latter designs, Fig. 208 to 213, the circle of the hood is the more easily kept, through the joint or parting being on the horizontal centre line, and is not so much affected by any slight raising or lowering of the cap, as was the case in Fig. 206. A further point however in connection with the hoods, is illustrated in Figs. 214 and 215. It will be noticed that in Fig. 205 the curvature of the interior of the hoods is such that the oil flung from the throwers will strike surfaces tending to deflect its further flow inwards towards the brasses rather than outwards towards the lip. This advantage is thus exaggerated yet more in Fig. 214, which may be compared with the very bad arrangement shown, Fig. 215. For in this latter, as is evident, if there is a free flow of oil flung from the thrower rotating at a high speed, there will be a tendency for the oil, under the influence of the momentum imparted to it, to run round the curve to the edge of the lip, as shown, and thence to drip on to the shaft, and spread thereon outside the bearing; and thus the hood in this case will defeat its own purpose.

(To be continued.)

INSTITUTION OF ELECTRICAL ENGINEERS, May 20.

On Dynamos.

BY W. M. MORDEY, MEMBER.

The development of the dynamo has been very rapid. The subject from the first proved attractive to engineers and scientific men, as well as to commercial people. After quantitative methods were introduced, a few years' work sufficed to bring the machine up to a high degree of excellence, as changes were easily made and their effects readily observed. Rapid progress on sound lines was greatly facilitated by the remarkable paper read by Drs. J. and E. Hopkinson in 1886 before the Royal Society. The paper read in 1893 by W. B. Sayers before this Institution indicated possibilities of progress in a new direction. In spite of this suggestive paper, practice appears to have settled on certain regular lines. For some years little or no advance has taken place, and the dynamo has come to be looked upon as having substantially reached its full development—except, perhaps, as to size—present practice and present proportions being regarded as very unlikely to be departed from.

Does it deserve its high reputation? As a working machine it certainly does. The results it gives are excellent. It is cool, reliable, durable, highly efficient, has good regulating qualities, and good collection, even in some cases with fixed brushes and varying load. But these excellent qualities, possessed, at any rate, by the best machines, are obtained at a high price by the lavish use of costly materials, at the cost of a large air-gap, of excessive excitation, and magnets larger both in length and section than the armature should require. If designs which require a lavish expenditure of material to attain a desired result are unsatisfactory, then the best modern dynamos leave plenty of room for improvement. Instead of being regarded as a finished product, they should be considered crude, imperfect, and unsatisfactory.

To establish this contention, a statement of one simple fact should suffice. One-tenth of the present exciting power would amply suffice to magnetise the iron of the magnetic system (and a gap sufficient for clearance) to its required value; the other nine-tenths may be looked upon as spent directly or indirectly in overcoming armature reaction. In attempting to improve dynamos, our aim should be, while retaining a high standard of practical working, to get more work than at present from a given value of material and labour.

Output is limited by sparking, by heating, by questions of regulation, and by strength of the working parts. It is better that the limit should be heating rather than sparking, in order that overloading for short periods may be possible. If a machine sparks much when overloaded, then its normal output cannot well be exceeded; but if it does not spark, it may be overloaded for a short time, as it only heats slowly. Too much attention can scarcely be given to this subject, for on cool working the life of the machine mainly depends. It is to be feared that attention has often been given to preventing heat losses by aiming at a high efficiency, and not sufficient attention to getting rid of the heat that is generated. This paper deals especially with conditions bearing on the reduction of material and labour by minimising sparking and armature reaction. But it must not be overlooked that the more we may succeed in reducing these, the more important becomes the question of cooling—of ventilation, radiation, and conduction—in order that we may safely avail ourselves of any possible gain of output.

It may be thought that in the present paper references to sparking should be condensed, after the fashion of the famous treatise on snakes in Ireland, into "There is no sparking in modern dynamos." But a natural historian, in explaining the absence of snakes, might perhaps have argued that there were incipient or suppressed or potential snakes, and that their outward and visible manifestation was only prevented by equal and opposite snakes, or equivalent devices. So with dynamos. Good dynamos do not spark, or the sparking is negligibly small, or only troublesome under varying loads with fixed brushes. But sparking is kept under by expensive means.

A large part of the present waste is surely preventible. That

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the above estimate of this waste is not excessive may be judged from the consideration of the following imaginary case : consider a dynamo designed, so far as the armature is concerned, on ordinary lines, and with a field, in the first place, sufficient to enable full volts to be obtained, but no current ; the armature conductors being, however, large enough to carry the full current. Such a machine might have a toothed armature, an air-gap only sufficient for clearance, and a short magnetic circuit. As showing how small an air-gap suffices for mechanical purposes, the practice in the case of polyphase motors may be referred to. In these machiues large "armature reaction" is essential to their success. The following are the clearances adopted by one maker :

H.P. of motor.	Clearance in millimetres.
¼	0·3
5	0·5
30	0·7
100	1·5
300	2·5

It would require very little excitation. Now attempt to load it—reaction sets in, and to check this the gap is increased ; then we must add field winding, add length to the magnet in order to provide space for the increased winding, add section to the field magnet in order to convey the leakage magnetism which results from the increased gap, and so on, cumulatively, till, finally, we have increased the excitation 30 to 50 times, and made the magnet much larger (in length, in second, and in copper) than when we started. Practically, the whole of this increase is a direct result of armature reaction.

Let us examine the excitation data of any well-known dynamos. For example, let us take the Edison-Hopkinson dynamo, fully described in the Hopkinsons' 1886 Royal Society paper, as an example of a smooth core, and the 150-kw. "railway generator" of the General Electric Company of America, fully described in the 1896 edition of Prof. Thompson's "Dynamo-electric Machinery," as a very recent example of a toothed-core machine, based on an extensive experience.

Comparison of Distribution of Excitation.

	"Railway Generator" 150-kw. (1896). (6 poles.) Per cent.		Edison-Hopkinson 34-kw. (1886). (2 poles.) Per cent.	
Air-gap	44·39	88·15	80·2	89·8
Teeth	3 06		—	
Compounding	40·70		9·6	
Armature core	0·71		0·68	
Field cores	4·58	11·04	6·61	9·53
Yoke	6·56		2 92	
	100·00		100·00	
Ampere-turns, total	19,630		20,156	

The machines are taken as examples mainly because the full information necessary for the present purpose is available. They are admirable machines.

An examination of the table reveals some interesting resemblances. If any part of the magnetic circuit of a dynamo may be considered more essential than any other part, the armature core is probably entitled to that distinction. In the two cases this essential part absorbs respectively 0·68 and 0·71 per cent. of the excitation ; the other 99·3 per cent. is taken up in getting the magnetism through the rest of the circuit. And when we compare the initial and the full excitation we see that, although the former is small in the toothed machine, the ultimate result in the two cases is about the same, the large reaction in one being balanced by the large air-gap in the other. So that Peter is robbed to pay Paul. The inference must not be drawn that there is little to be said for the use of teeth in this instance. On the contrary, the teeth have very great practical advantages, even if the excitation were the same in both cases. The above comparison is perhaps a little unfair to the English machine, which was a rather small one, and was brought out 10 years ago. No doubt the designer would improve somewhat on it now, but it is given exactly as published, and serves very well to show that Dr. Hopkinson raised the dynamo in 1886 to so high a level that subsequent improvement has been comparatively slight, and very difficult ; and it must not be forgotten that he started from chaos.

The Magnetising Space.

Before proceeding further, attention is drawn to the subject of diagrams. The consideration of excitation and armature reaction is simplified by clear diagrams. Instead of showing helical windings disposed about the field magnet, it seems better to show merely a flux of current through a space bounded by the armature core, the pole-tips, and the part of the magnet joining the pole-tips. This space may conveniently be termed "the magnetising space ;" it is shown in several of the figures used for the illustration of this paper. Bearing in mind that the primary object is, or should be, to magnetise the armature, the diagram shows clearly the essentials of the magnetic circuit. The winding is shown in section by circle which are respectively black or dotted, to indicate the two directions of the current. Clearly it is not necessary, so far as the direct influence on the armature is concerned, to show the completion of the field turns ; they may be completed by going round the armature, or round any part of the field, or, for the matter of that, they need not be completed at all so far as the armature care. This kind of diagram reduces all forms of field magnet to a common basis, and illustrates the essentials of the magnetic circuit. And it helps to the understanding of the problem of self-exciting armatures by showing how the armature conductors supply the "magnetising space" with current, in the magnetising direction or the reverse.

In earlier days we often debated the weighty question, What part of a dynamo or motor should be the heavier ? We are now probably all too wise to spend time in such discussions. Our point of view has altered, and we wish only to make each part as light, or at least as inexpensive as we can. A simple diagram of this sort helps to the appreciation of what seems to be the true function of the field magnet. A field magnet should be a mass of iron so arranged as to complete the magnetic circuit between one side of the armature and the other, in the shortest possible distance, and with as small a cross-section as is consistent with the economical conveying of the magnetism of the armature. Field magnets seldom accord very closely with this definition.

Comparison of Types.

Of the two classes* of dynamos—smooth-cored and tooth—the former is preferred in this country, principally because the collection is so good ; the latter is preferred on the Continent and in America. In the United States the 500-volt railway generators are almost always toothed ; but for low-tension lighting work, where large currents have to be collected, smooth cores are often used. In comparing the two types, we may say of the smooth-cored type that in practical work it gives excellent results ; that its collection is excellent, but that it is expensive in material, and in some other respects unsatisfactory.

The toothed kind does not collect well, and is not a good regulator, but it has so many good qualities that it is of the greatest importance to remove what is objectionable in it. What may be termed its latent advantages—mechanical, electrical, and magnetic—as compared with the smooth-core type, are : (1) small excitation ; (2) small magnetic leakage ; (3) absence of eddies in armature conductors, and (4) armature conductors solid instead of laminated ; (5) drag on armature conductors small, and (6) armature conductors easily supported ; (7) cooling qualities very good ; (8) it is cheaper to make.

These are termed latent advantages, because they are not at present all realised. Referring to the various points :

(1) *Small Excitation.*—The excitation is usually smaller than in smooth-cored machines, but not nearly so small as it might be made. The reasons are that to check armature reaction and to keep sparking within limits the gap is usually made a good deal larger than would suffice for mechanical clearance ; and the teethed are often worked at a very high density, giving the effect of a still larger gap.

(2) *Magnetic Leakage.*—As leakage depends principally on the difference of magnetic potential across the gap, it follows from (1) that it is larger than it ought to be. Some general observations on this matter will be found in another section of this paper.

(3) and (4) *Absence of Eddies in Armature Conductors.*—This advantage is fairly realised. Except when the teeth are saturated there is very little magnetism in the slots, and the conductors need not be laminated. This saves power, reduces cost, and makes the conductors more mechanical and easier to wind.

(5) and (6) *Drag on Armature Conductors.*—As this is practically absent, the conductors require only sufficient support to drive them, without reference to the load. Even if this were not true (and the question is considered in another part of the paper), the mechanical support afforded by the teeth would offer a very great advantage.

(7) *Cooling.*—This is very important. In a smooth-cored armature the core is covered by insulating materials, which unfortunately, insulate heat nearly as well as electricity. In a toothed armature the exposure of the bare metal surface assists very materially in getting rid of the heat. The value of this feature can hardly be over-stated.

(8) *Cheapness.*—The toothed type for any given output is, even now, cheaper than the smooth-cored.

If the above statements are correct, the toothed type has everything in its favour except sparking and armature reaction. Advocates of smooth-core construction may assert that the drawbacks to their favourite type are more apparent than real—that when once set in the bearings the armature gives no trouble. But this is no answer to the really inherent objections to the type, and we all know that in building and handling

* Dynamos with "coreless" armatures are not important enough to form a class. The reasons which led to the use of "coreless" alternators do not apply to dynamos : in the latter, the periodicity is not high enough to justify the omission of the iron.

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it requires much more care and skill than the toothed kind. And, on the other hand, advocates of toothed armatures may say that it is rather late in the day to insist on the advantages of the machines they have been building and using for years; that the machines are excellent, do not spark at all, and so on. All which may be quite true. Some of the machines are excellent. But there are two extremes (and a great many intermediate varieties) in the class of toothed-armature dynamos: (i.) those with a small gap reluctance and bad collection; and (ii.) those with a large gap reluctance and a better collection. In neither sort are the full potential advantages of the type realised. The large-gap variety ought, perhaps, to be considered intermediate between the smooth-cored and the toothed kinds. The teeth support and drive the conductors, but the excitation is not small, and the armature reaction is very great in spite of the gap (as is seen by the comparison quoted above); and to the extent that the magnetism is not carried by the teeth, so are the full benefits and economies of the toothed type lost: the direct drag is felt by the conductors; they have eddies generated in them, and, if they are large, require to be laminated; the magnetic leakage is considerable, and the machines are not very cheap to build.

Magnetic Leakage.

Magnetic leakage is a much more serious evil than is generally admitted. In most dynamos it is enormous, even in machines which enjoy the reputation of being nearly perfect examples of design—and which, indeed, are nearly perfect, judged by present standards. For example, the ordinary two-pole drum dynamo only utilises about 70 per cent. of the magnetism produced. The leakage coefficient, v, given in the Royal Society paper already referred to was 1·32—which means that out of every 132 lines of force produced in the field magnet only 100 pass through the armature; the other 32 leak past the armature and are wasted. This coefficient was obtained from an unloaded machine; at full load v would probably be 1·4 or more. Values of v for six varieties of machines given by Prof. Thompson* range from 1·25 to 1·49; average, 1·34. The proportions of all dynamos have to be seriously modified to allow for this waste. The section of the magnet is increased from 20 to 30 per cent., or, if not increased in section, it must be increased in length to carry the greatly-increased field winding. The incidental disadvantages connected with leakage of magnetism are well known—disturbance of compasses on board ship, and of watches, the use of non-magnetic distance-pieces, and so forth—and there is no incidental advantage of any sort. It is sheer waste.

The magnetic system of a dynamo is usually considered from what appears to be a misleading point of view. It seems to be a mistake to begin by magnetising the field magnet when the real object is to get the armature magnetised. It may be answered to this that there is no beginning, that the whole magnetic circuit has to be magnetised, that the armature is only one part—and a very small part—of it, and that it comes to the same thing however or wherever we magnetise the circuit. But there is a difference, as was recognised long ago by Forbes,† and realised by Eickemeyer, who placed the exciting coil directly round the armature, where its effect was primarily wanted, instead of round the field core. The full significance of this construction has perhaps not been generally recognised. Its effect on magnetic leakage is very important, for it makes the leakage negative. In other words, as the armature carries more magnetism than the field, instead of less, the leakage becomes a friend instead of a foe; for practically all the magnetism generated is now useful, because it traverses the armature. It is, of course, not to be inferred from this that the leakage should be encouraged by skimping the iron.

The practical objection to this construction is that it is not so simple to dispose the field winding round the ends of the armature as round the core of the field magnet, and that there is no gain in copper or energy, as the length of the turn round the armature is usually more than round the field. But the absence of external stray field and shortness of the magnetic circuit are points of much practical importance, worth some effort to obtain. The inconvenience of inside windings will become less as we learn how to reduce their amount. And what would help materially would be the reduction of the cost, and the improvement of the quality, of steel castings. This country is behind others in this important trade, and it behoves our steelfounders to give it their attention. Magnetic steel castings are being produced in the United States in large quantities, with ribs and other thin parts clean and thin as if of cast iron.

The considerations affecting leakage, as connected with the disposition of the field magnet, become of diminishing importance as the air-gap is reduced. If there were no gap there would practically be no leakage—a further reason for using toothed armatures.

What we want is the sparkless collection and small armature reaction associated with smooth cores, together with the advantages of economy and of energy which are inherent in toothed armatures, but which are at present not fully realised in practice.

It is a very singular thing that the windings originally introduced have continued in use practically without change ever since. For instance, in ring armatures the ordinary endless helix, coiled round an iron core, with connections taken at regular intervals to a collector, is in use to-day just as it was introduced by Gramme and Pacinotti about 27 years ago.

With this, as with all ordinary windings, we have the condition of things shown in the three diagrams in Fig. 1. With no lead, the positive and negative directions balance. With brushes lagging to the backward pole-tip the armature current helps the field; with brushes leading to the forward tip it opposes the field—the usual collecting position necessary to secure good

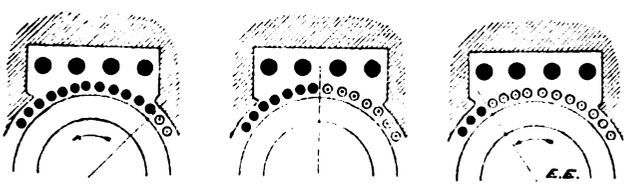

Fig. 1.

collection. There are other well-known aspects of armatures, but they do not come within the scope of this paper. We should use some arrangement such that, without loss of E.M.F., the armature conductors in the "magnetising space" shall produce no weakening of the magnetising force, or, preferably, shall add to the magnetising force in that space. If we can collect with a lagging brush,* the armature current will help the field winding. Or if we can collect in a midway position the armature currents will be equal and opposite, and there will be little or no counteracting effect. The two latter conditions are ordinarily prevented by sparking, as the coils under commutation have an active E.M.F. in them, and a large current is generated in the short circuit.

Sayers Winding.—Sayers indicated the right direction to work. The investigations of Hopkinson, Swinburne,† and others‡ paved the way for Sayers, who set himself a double problem—to prevent or reduce armature reaction by collecting in a position where the armature current should assist the field, and to short-circuit active coils without sparking; and he obtained a solution of that difficult problem. By means of auxiliary coils connected between the ordinary coils and the commutator, but which were idle except during the moment of commutation, he injected into the armature coils under commutation an E.M.F. counter to the mischievous spark-creating E.M.F., and so succeeded in collecting in the desirable backward position.

Ring Armatures.

Let us consider the ring armature, and enquire whether we have exhausted all simple expedients. Let us vary the monotony of the ordinary Gramme winding, and find whether, by a little rearrangement, it does not give what is wanted. Consider such a winding having, say, four turns to each sector of the commutator, as in Fig. 2 (i.) Call this an "element"

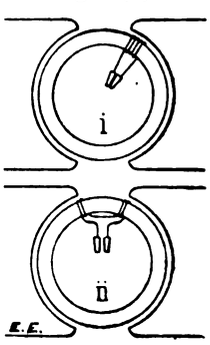

Fig. 2.

of the winding. Now arrange that element as in Fig. 2 (ii.), disposing the four turns, not all together, but two and two, with a gap between them about equal to the gap between the pole-tips, and dispose all the rest of the winding in the

* "Dynamo-Electric Machinery," 1896, p. 151.

† British patent 4,120, 1885.

* The expressions "forward lead" and "backward lead," although sanctioned by misuse, are not happy ones. "Positive lead" and "negative lead" are better. "Lead" and "lag" are shorter terms.

† *Journal*: "The Theory of Armature Reactions in Dynamos and Motors," vol. xix., p. 90 (1890).

‡ Reference must not be omitted to Ryan's work, "Method of Balancing Armature Reactions" (*Sibley Journal of Engineering*, October, 1892). See also Ryan and M. E. Thompson, Amer.I.E.E., 1895—a most complete and interesting solution. An equal and opposite circle of currents is applied round the armature, counteracting the armature reaction. See also pp. 391-2, S. P. Thompson's book (1896).

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same order, filling in the space between the parts of each element by parts of other elements. Join all the elements in series, not exactly as in the ordinary Gramme winding, but so that the current passes along each side of the armature in a series following a zigzag course, instead of the usual one. It will be observed that in each side of the armature the parts of each element, as well as the whole elements, are in series, adding their E.M.F.'s exactly as in an ordinary Gramme armature; but that when any element passes through the region between the poles (where in an ordinary winding it would be adding nothing useful to the circuit), it becomes the

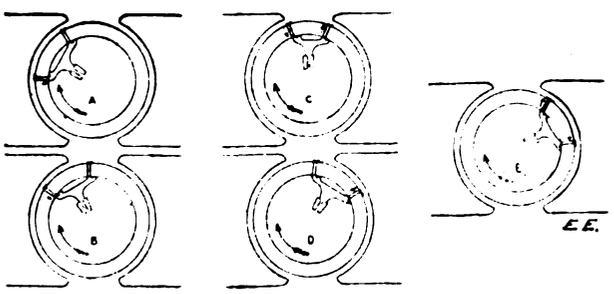

FIG. 3.

seat of two opposing E.M.F.'s, and that when those opposing E.M.F.'s are equal the element may be short-circuited without any current being generated in it, although in each part there is a strong E.M.F.

Fig. 3 shows five successive positions of an element in its passage from one side of the field to the other. Fig. 4 shows

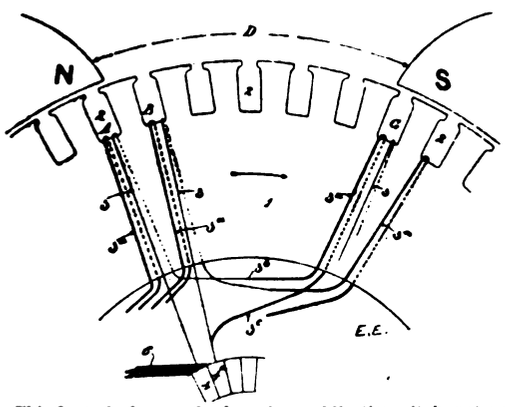

FIG. 4.—This figure is from a forthcoming publication; it is not necessary to explain the letters of reference here.

more clearly the winding of a single element and parts of others. Fig. 5 is a diagram showing a complete armature, and Fig. 6 is a diagram of an extended portion of an armature, showing the connections of the elements, and the directions of the current in them. To distinguish it, the element under commutation is shown thicker than the others. The field winding is shown by large black circles, and the two directions of the armature current are indicated respectively by small

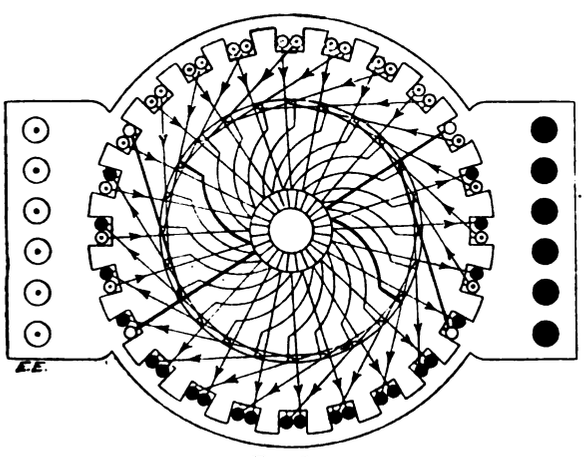

FIG. 5.

black circles and by dotted circles. It is important that the armature coils should show black circles rather than dotted circles, because the black circles are what are wanted in the magnetising space. On the other side of the armature the conditions would, of course, be reversed—the magnetising space containing dotted circles, and the armature conductors should show as dotted circles. In practice there is not so great a gain with this particular arrangement as the diagram shows, because of the cross induction and the slight movement for the reversal of the current. The relative value of this gain depends, of course, upon the initial value of the excitation. A reference to the results quoted further on shows that it may amount to a saving of about half the ordinary field winding, and that a further saving may arise from the possible lowering of the initial excitation.

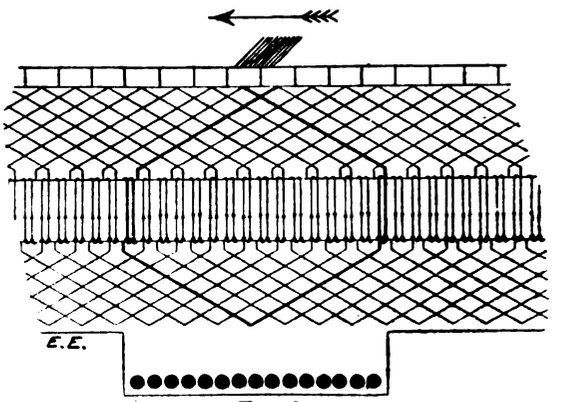

FIG. 6.

Figs. 5 and 6 show that this winding is quite symmetrical; the armature may be run in either direction, exactly as with the ordinary winding. Within the span of the element under commutation the armature conductors carry currents which alternate in direction, so that from this part of the winding there is no reaction on the field. It may be supposed there is some loss of volts, as the volts and current in the conductors comprised within this span are alternately in the same and in opposite direction to the E.M.F.; but this loss is not appreciable at no load, as might be expected from the small E.M.F. near the neutral line. As the load rises, there is a rapid and marked gain in E.M.F. as compared with an ordinary winding. It may be suposed that with this winding the breadth of the neutral line must be narrow, but this will not necessarily be the case if the slope of the field is slight in the regions occupied by the parts of the element under commutation.

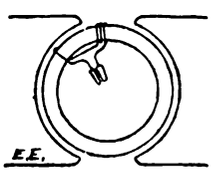

FIG. 7.

Other ways of arranging the element will suggest themselves, both as to the distribution of its parts and the span. Fig. 7 shows an element of four horns divided into two unequal portions—one and three, instead of two and two, the three horns leading. With such an element a balance would be obtained at no load when the leading part was in a much weaker field than the lagging part—a condition obtainable either by making the span less than that of the pole-tips, or by making the clearance less at the leading horn than at the lagging horn. The effect of

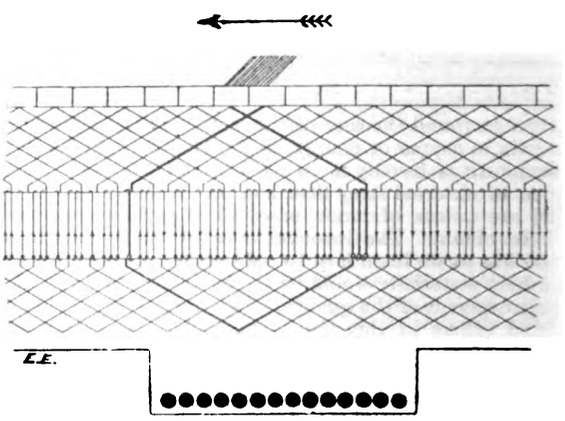

FIG. 8.

such an unequal division of the element on the magnetising space is seen in Fig. 8, which shows that there is a considerable strengthening reaction in that space as the load comes on. As compared with the usual loss of effective magnetising force, this may be very useful. And of course it is applied exactly where it is most effective in magnetising the armature. By proportioning the element in this way, the armature reaction may be utilised either for strengthening or weakening the effective field—as,

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for example, by "compounding up" in a dynamo or "down" in a motor.

Summarising the foregoing, we see that good results may be obtained by the use of toothed cores and windings, disposed so that at no load equal and opposite E.M.F.'s are produced in the connected portion of each element, the elements being so arranged in a series that during the greater portion of the revolution the E.M.F.'s in each element are additive, and that during commutation they are in opposition; commutation taking place, not when any coil is on or near the neutral line, but when it is away from that line. The coils in the neutral region being arranged in such an order that successive coils are traversed in opposite directions by the current, irrespective of their own E.M.F.'s, and in virtue of which alternation of direction these coils cease to exert any influence in the "magnetising space." Or, by a modification in the proportions of the element, we have seen how the armature current may, as desired, be caused either to increase or to diminish the magnetising force acting in the magnetising space.

Results have been obtained by testing a toothed Gramme machine of "Manchester" type, wound as in Figs. 5 and 6: it gave an output, with good collection, about one-third more than could have been satisfactorily taken from a smooth-core machine of this type. It was a 15-kilowatt machine, and at this load attained a rise of only 30deg. F. after a prolonged run. The current density in the armature was about 1,500 amperes per square inch; this low temperature was undoubtedly due to the exposure of the core, and to the absence of eddies in the conductor. The full-load excitation was only about 1 per cent., without an extravagant amount of copper in the fields. The reaction was so slight that by careful adjustment of suitable brushes it was found impossible to tell by an examination of the brushes whether the full load was on or off, the brushes being fixed. The armature had 48 slots, a 48-sector commutator, four turns in each slot, and ran at 1,100 revolutions per minute. The machine was run as a motor, and with fixed brushes and varying load it gave equally good results.

Drum Armatures.

Gramme dynamos have been particularly studied in the foregoing section, because it was in connection with such machines that the present consideration of the subject began, and because it is easier to trace the various actions in such armatures than in drums. When we turn our attention to drums, we find one important difference. In a drum each turn or coil has, or may have, two separate and distinct E.M.F.'s simultaneously impressed on it, as against one in a Gramme. This makes the study of drums somewhat less easy than rings. But, bearing this difference in mind, it is obvious that all the main considerations put forward apply equally to the two kinds of armature. It is only necessary to so arrange the winding that the circle of conductors seen in section, surrounding the core, shall present the same order in the two cases.

(To be continued.)

LEGAL INTELLIGENCE.

WEEKES v. ADAMS

Before Mr. Justice Wills on Monday, May 31, Mr. H. Gray appeared for the plaintiff, and Mr. Adams for the defendant. The action was to restrain the defendant by an injunction from infringing the copyright of a book entitled "Alternate-Current Transformers." The injunction was granted, with costs, without calling on plaintiff's counsel to reply.

DISPUTED CLAIM FOR ELECTRIC LIGHT.

In the Westminster County Court on Friday last, his Honour Judge Lumley Smith, Q.C., tried the case of Fulton *v.* Ridgways, in which the plaintiff, as landlord of some flats at Shaftesbury-avenue, sued the defendant, his late tenant, to recover £5 for electric light supplied for his benefit.

The defence was that the light was to be included in the rent, but this statement was denied by the **Plaintiff**, and was not borne out by the agreement, therefore his **Honour** gave judgment for the plaintiff for the amount claimed, with costs.

Forthcoming Events.—Most of the societies have suspended their sittings, and the usual list of fixtures may be discontinued. There is no change in the afternoon lectures at the Royal Institution. Mr. Preece discourses there to-night, and next Friday the last discourse of the season will be given by Mr. Crookes on "Diamonds." The list of papers for discussion at the Physical Society next Friday is given in our notes. The Chemical have a meeting fixed for Thursday. The Ingenieurs Civils de France continue to meet at Paris twice a month till July. We have also to acknowledge the receipt of the fixtures of the Franklin Institute, but as the meetings are at Philadelphia it would be little use to announce them here.

MUNICIPAL ELECTRICAL ASSOCIATION.

The second annual meeting will be held at Manchester on June 30, July 1, 2, and 3. The following excellent programme has been issued provisionally:

President: C. H. Wordingham, Manchester.
Vice-Presidents: V. A. H. McCowan, Belfast; F. Newington, Edinburgh.
Past-President: Arthur Wright, Brighton.
Committee: Wm. Arnot, Glasgow; A. H. Gibbings, Bradford; A. B. Mountain, Huddersfield; H. Faraday Proctor, Bristol; J. H. Rider, Plymouth; T. P. Wilmshurst, Halifax.
Hon. Treasurer: G. H. Cottam, Stoneyard, Lithos-road, Finchley-road, Hampstead, N.W.
Hon. Secretary: A. B. Mountain, Electric Supply Station, Huddersfield.

Wednesday, June 30.

General meeting for discussion of papers, Lord Mayor's Parlour, Town Hall, Manchester, 10 a.m. Presidential address by C. H. Wordingham, city electrical engineer, Manchester.

Papers for Discussion.

"The Generation of Steam": Two papers by J. F. C. Snell, borough electrical engineer, Sunderland; and J. J. Steinitz, borough electrical engineer, West Ham.
"Municipal Aids to Wiring": By A. H. Gibbings, borough electrical engineer, Bradford.
Reception by the Electric Lighting Committee of the Corporation of Manchester at the Dickinson-street Works, 3 p.m. Inspection of generating station and sub-station.
The following works may be visited by members of the association and visitors by kind permission of the proprietors during the afternoon: S. Z. de Ferranti, Limited, Oldham; Mather and Platt, Salford; Galloways, Limited, Ardwick; Hans Renold and Co., Manchester.
The association dinner at the Grand Hotel, evening dress, 7 p.m. for 7.30 p.m. Tickets (exclusive of wine), 7s. 6d. each if paid for not later than June 19; after that date 10s. each. Members may obtain tickets for friends, whose names should be given at the time of application.

Thursday, July 1.

General meeting for discussion of papers, Lord Mayor's Parlour, Town Hall, Manchester, 10 a.m.

Papers for Discussion.

"Street-Lighting by Electricity": Three papers by H. L. P. Boot, borough electrical engineer, Tunbridge Wells; C. D. Taite, borough electrical engineer, Southport; and S. E. Fedden, electricity mains superintendent, Edinburgh.
"Electricity Meters": By T. P. Wilmshurst, borough electrical engineer, Halifax.
"Prepayment Meters": By H. W. Couzens, borough electrical engineer, Taunton.
Visit to Liverpool by the 2.22 p.m. from Exchange Station, Manchester, arriving at Liverpool 3.10 p.m.
Reception by Electric Lighting Committee of the Liverpool Corporation, 3.45 p.m.
The following works may be visited by members of the association and visitors, by kind permission of the proprietors, during the evening: Liverpool Overhead Electric Railway; British Insulated Wire Company, Prescot.

Friday, July 2.

General meeting for discussion of papers, Lord Mayor's Parlour, Town Hall, Manchester, 10 a.m.

Papers for Discussion.

"Distributing Systems": Two papers by J. A. Jeckell, borough electrical engineer, South Shields, and J. R. Blaikie, chief assistant electrical engineer, Bristol.
"Localisation of Faults": By R. C. Quin, borough electrical engineer, Blackpool.
Visit to Bradford by the 2.25 p.m. from Victoria Station.
Reception by the Electric Lighting Committee of the Corporation of Bradford, 4 p.m.
Visit to Halifax and Huddersfield by the 2.25 p.m. from Victoria Station.
Reception by the Electric Lighting Committee of the Halifax Corporation at the Electricity Works, 3.45 p.m. Leave Halifax for Huddersfield, 6.42 p.m.; leave Bradford for Huddersfield, 6.8 p.m.
Reception by the Electric Lighting Committee of the Huddersfield Corporation at the Electric Supply Station, 7.30 p.m.

Saturday, July 3.

Business meeting for members and associates of the association only, 10 a.m., at Manchester Electricity Works, Dickinson-street. Election of president, vice-presidents, two members of committee, secretary, treasurer, and place of meeting for the convention of 1898. General business.

Arrangements have been made for members of the association and visitors to inspect the Blackpool Corporation electric lighting works, the Blackpool Corporation electric tramways, the Southport electric lighting works, and the Isle of Man electric tramway.

Copies of papers to be discussed and any further information may be obtained from the hon. secretary, Mr. A. B. Mountain, Electric Supply Station, Huddersfield.

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COMPANIES' MEETINGS AND REPORTS.

WESTMINSTER ELECTRIC SUPPLY CORPORATION, LIMITED.

An extraordinary general meeting of this Company was held on Wednesday at the office, Eccleston-place, S.W., Lord Suffield presiding.

Mr. Hayes Fisher, M.P., proposed: "That the resolution respecting the issue of the balance of 12,000 unissued ordinary shares, passed at an extraordinary general meeting held on November 28, 1894, and confirmed at an extraordinary general meeting held on December 13, 1894, be hereby rescinded, and that the following resolution be passed: 'That in order to carry out the scheme for the cancellation of the founders' shares, which scheme has now been accepted by the holders of those shares, the directors be authorised to allot the 12,000 unissued ordinary shares of £5 each in the proportion of 120 shares for each founder's share, to be paid at par, the founders' shareholders agreeing on their part to the cancellation of the founders' shares and all necessary legal steps to complete the transaction.'" Mr. Fisher said the shareholders would recollect that when they were last called together it was thought that it would be possible to get rid of the founders' shares by issuing to each holder of a founder's share 80 ordinary shares fully paid, but legal doubts and difficulties presented themselves as to the policy of that course, and thereupon the directors took the opinion of counsel, who had advised them that it would be safer and more prudent to abandon their original scheme and to adopt that contemplated in the resolutions now before them—namely, to offer each holder of a founder's share 120 ordinary shares of £5 each, each share to be paid for at the rate of £5 in cash. All the holders of founders' shares were agreed to these terms if the meeting were willing to offer them. He was sure that it was the wisest course they could pursue.

Mr. E Boulnois, M.P., seconded the motion.

Mr. Haro'd E. Young moved an amendment that the proposed resolution should be rejected in favour of the one originally passed in order to redeem the founders' shares. Since their last meeting the 8,000 shares which they then agreed to allot in exchange for the founders' shares had increased in value by £24,000. The present proposal was altogether different from that which they were asked to sanction at their last meeting.

The amendment was not seconded.

Mr. R. W. Wallace, Q.C., said that Mr. Browne Martin and himself were two of the largest holders of the founders' shares, and they would be perfectly contented to take the original offer which was made to them. In fact, most of the holders of founders' shares preferred the former offer. The founders as a body would much much prefer what Mr. Young had suggested—to keep their founders' shares.

The resolution was carried with one dissentient.

LONDON ELECTRIC SUPPLY CORPORATION.

A meeting of this Company was held at Cannon-street Hotel on Tuesday last, but we were informed that it was private and the Press were not admitted. The meeting was called on the invitation of Lord Wantage, who is the debenture-holder in possession.

WEST AFRICA TELEGRAPH COMPANY, LIMITED.

The twelfth ordinary general meeting of this Company was held yesterday (Thursday) at Winchester House, E.C.

The **Chairman** (the Marquis of Tweeddale) said the report was not very satisfactory. The expenses had been very heavy in connection with cable repairs. The ss. "Duplex" and "John Pender" had been engaged on repairs to the Loanda, Sierra Leone, and Bissao cables, the total expenses in connection with these being £20,695. The directors had to record with regret the loss of their former chairman, Sir J. Pender, and subscribed £200 to the Pender Memorial Fund. Owing to the state of the report, they could not recommend a dividend for that period.

Sir H. Mance seconded the motion, which was carried.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Wigan.—The Baths Committee require tenders for repairing and renewing the electric bells at the public baths. Particulars may be obtained from Mr. J. J. Charnock, town clerk, Wigan.

Blackpool.—The Corporation invite tenders for the supply and delivery of about 80,000 carbons. Samples for testing purposes are to be delivered by June 12. For full details see advertisement.

Lyons.—Tenders will be received on June 23, at the Prefecture of the Rhone, Lyons, for the installation of the electric light at the lunatic asylum at Bron. There are two contracts of about £4,000 each (estimate).

Ghent.—The city of Ghent has put out for competition the electric tramway service. Particulars are obtainable on application to le secretariat de la ville de Ghent, Belgium, and tenders must be in by July 2.

Mouseron (Belgium).—The Municipality announce that the lighting of the town is open for tender from 1900. It is not specified whether preference will be given to any particular method of illumination, electric or otherwise.

Tooting, S.W.—The Metropolitan Asylums Board are advertising for tenders for lighting the Grove Hospital, Lower Tooting, with electricity. Tenders are to be in by June 23, and full information will be found in our advertisement columns.

Paris.—The French Postal and Telegraphic Authorities will receive tenders for paper strip for telegraph instruments on June 22, but previous application for permission to tender must be applied for at Paris, Rue de Grenelle, 103, by June 12.

London, E.C.—Tenders are required for the supply, delivery, and erection of four separate duplicate electric lighting plants. Lighting capacity, 2,000, 4,000, and 5,000 lights. Delivered at Sydney, N.S.W., Australia. Apply to Mr. Henry Goodwin, Anderton's Hotel, Fleet street, E.C.

Morecambe.—The Urban District Council want tenders for a chimney shaft (129ft.), engine and boiler houses for the electric light generating station. Plans and specifications can be obtained from the Surveyor, at the offices of the Urban District Council, and tenders must be in by June 7.

Blackpool.—The Tramways Committee require tenders for supplying two bogie tramcars. Specifications can be obtained, and cars of the type required can be seen, on application to Mr. John Lancaster, manager, Tramway Depôt, Blundell-street, Blackpool. Tenders to be sent in, addressed to the Chairman, Tramways Committee, by June 21.

Santiago de Chile.—The Chilian Government Telegraphic Department will receive tenders on June 19, at Santiago, for the supply of galvanised iron wire, insulators, Morse instruments, paper for same, etc. Particulars (a summary only, and in Spanish) can be consulted at the Musée Commerciale, Brussels; otherwise application is to Santiago.

Rio de Janeiro.—The Secretary of State for Foreign Affairs has received a despatch from H.M. Consul-General at Rio de Janeiro enclosing a translation of an official notice setting forth the conditions under which tenders are invited for the telephonic service of that city and its suburbs. The tenders are to be presented by June 30, and the conditions may be inspected at the Commercial Department of the Foreign Office any day between 11 and 6.

Bray (Ireland).—The Township Commissioners require tenders for supplying, during ensuing 12 months, carbons, cables, house wires, switches, fuses, incandescent lamps, holders, casings, insulating materials, etc., and sundry articles more particularly specified in schedule, which will be forwarded, together with form of tender, on application to Mr. P. Macdonnell town clerk, Town Hall, Bray. Tenders to be delivered to the Town Clerk, properly sealed, and endorsed "Tender for ——," by 10 a.m. on June 7.

Glasgow.—The Corporation invite tenders for the supply of (1) battery regulators and (2) armoured cables for street mains. Copies of the specifications and forms of tender may be obtained on application to Mr. Wm. Arnot, the electrical engineer, 75, Waterloo-street. Sealed tenders, endorsed "Tender for Battery Regulators," or "Tender for Cables," addressed to Mr. J. D. Marwick, town clerk, City Chambers, Glasgow, will be received by him on or before June 7.

Bedford.—The Urban Sanitary Authority are prepared to receive tenders for the supply and erection at the sewage pumping works of two alternating-current motors coupled direct to two vertical spindle centrifugal pumps, and the necessary cast-iron piping, valves, etc., for fixing and connecting the same. Specification and plan may be obtained from Mr. T. S. Porter, town clerk, at the Town Hall, on receipt of an application enclosing a deposit of £2, which will be returned on receipt of a bona fide tender. Sealed tenders, marked "Motors," must be delivered at the Town Clerk's Office not later than Tuesday, June 8.

Glasgow.—The Caledonian Railway Company require tenders for the supply of telegraph and electric appliances for 12 months from August 1. Specifications and forms of tender and any other necessary information may be obtained from Mr. Jas. Lorrimer, stores superintendent, Caledonian Railway, Charles-street, St. Rollox, Glasgow. Patterns may be inspected from 9 a.m. till 5 p.m., at the company's stores, Charles-street, St. Rollox (Saturdays, 9 a.m. till 1 p.m.). Tenders, endorsed "Tender for Stores," to be lodged with Mr. J. Blackburn, secretary, 302, Buchanan-street, Glasgow, by June 7.

Brighton.—Tenders are required by the Council for the completion of the electric light wiring, etc., of the Municipal School of Science and Technology, Richmond-terrace. Drawings may be seen at the office of the borough engineer, Mr. F. J. C. May, C.E., Town Hall, Brighton, and specifications and forms of tender may be obtained after 5th inst. at the office of Mr. Francis J. Tillstone, town clerk, Town Hall, Brighton, on payment of £1. 1s., which amount will be returned on receipt of a bona fide tender. Sealed tenders, addressed to the Town Clerk and endorsed "Tender for Electric Lighting, Municipal School of Science and Technology must be left at his office before 10 a.m. on June 14.

York.—The North-Eastern Railway Company require tenders for the following articles, in such quantities as they may require, during six months ending December 31, 1897, delivered carriage paid at the company's telegraph stores at York: (1) telegraph apparatus; (2) telegraph wires and line stores. Payment for each month's delivery will be made at the end of three clear months, or in cash, less 2½ per cent. discount. Forms of tender may be obtained on application to Mr. Graves, Telegraph Department, York; and tenders must be sent to Mr. C. N. Wilkinson, secretary, sealed and marked "Tender for Telegraph Stores," by noon on June 7.

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Handsworth.—The Urban District Council invite tenders for providing and fixing the electrical plant and apparatus, etc., necessary for lighting the council house, the public library, and the new technical school and other buildings by electricity. Plans of the buildings can be seen, and the conditions of contract inspected, at the office of the Clerk of the Works, at the New Technical School, Stafford-road, Handsworth, between 10 a.m. and 4 p.m. A copy of the specification and form of tender may be obtained on application to Mr. H. Ward, clerk, Council House, Soho-road, Handsworth, and payment of a sum of £2. 2s., which sum will be returned after the receipt of a bona fide tender. Tenders, under seal, and marked "Tender for Electrical Plant," must be sent to the Clerk by June 7. The person or firm whose tender is accepted must pay the standard rate of wages.

Southampton.—The Corporation invite tenders for the supply and erection of water-tube boilers, mechanical stokers, coal-conveyor, pumps, steam and water mains, water-tank, water-purifier, fuel economiser, and ironwork. Specifications and forms of tender can be obtained at the Municipal Offices, Southampton, or at the offices of the engineers, Messrs. Kincaid, Waller, and Manville, 29, Great George-street, Westminster, on payment of a fee of £3. 3s., which sum will be returned on receipt of a bona fide tender. The contractor will be required to pay not less than the minimum standard rate of wages for the time being in each branch of the trade. The Corporation do not bind themselves to accept the lowest or any tender, and the contractor whose tender is accepted shall enter into a formal agreement, under seal, with sufficient sureties, for the due performance of his contract. Sealed tenders, endorsed "Electricity Supply, Tender for Contract No. 3." must be sent to Mr. George B. Nalder, town clerk, Municipal Offices, Southampton, at or before 4 p.m. on June 16.

RESULTS OF TENDERS.

London.—The City of London Guardians have accepted the tender of the National Telephone Company for setting up telephonic plant at the infirmary.

Salford.—The Town Council have approved a recommendation of the Town Halls and Markets Committee accepting a tender for the installation of the electric light at the Salford Town Hall for the sum of £724.

Leeds.—The City Council have approved the acceptance by the Lamp Committee of the tender of Mr. William Wharam for the supply and erection of arc lamps, conductors, etc., for street-lighting in connection with the electric tramways, at a cost of £988. 10s.

Dundee.—The Gas Committee of the Town Council have met for the consideration of the tenders for a new engine and dynamos, a new boiler, arc lamps and accessories, and a new battery. It was agreed to recommend the following offers for acceptance: Siemens Bros., London, engine and dynamos, £1,505; Cooper and Greig, Dundee, boiler, £493; Crompton and Co., London, arc lamps and accessories, £332. 4s. It was resolved to recommend the purchase of two new batteries, the contractor taking the old plant. On that footing the offer of the Electrical Power Storage Company, Limited, London, amounting to £1,112, was accepted.

West Ham.—The following tenders have been received by the Town Council for the erection of sewage pumping engine and boiler houses and electric lighting buildings, at the Abbey Wharf, Stratford:

Munday and Sons, Poplar, E.	£39,805
Kirk and Randall, Woolwich	38,745
B. Cooke and Co., Westminster	37,000
Shillitoe and Son, Bury St. Edmunds	36,750
Chessum and Sons, Haggerston	35,953
J. Jackson, Plaistow	35,790
W. Gregar and Son, Stratford (accepted)	35,430

BUSINESS NOTES.

Western and Brazilian Telegraph Company.—For the past week the receipts were £1,954

Paris.—The *Daily News* correspondent says that the cab company will soon have several motor carriages on every cabstand. The manager of the company is in favour of electricity as a motive force.

South Shields.—The Town Council have sanctioned the design of the borough electrical engineer (Mr. J. A. Jeckell) for illuminating the tower of the town hall by electricity at a cost of £50.

St. Pancras.—Upon the recommendation of the Finance Committee, the London County Council have agreed to lend the Vestry £2,945, the balance required to complete an electric light installation.

Bath.—At the meeting of the Surveying Committee, the Lighting Committee reported upon a variety of matters, most of which they had deferred till the autumn. These included the better lighting of Sion-hill.

Harrow.—At the Urban District Council meeting, the Surveyor reported that he had received notice from the Harrow Electric Light Company of their intention to further extend their mains at Greenhill.

Prize Paper.—Four prizes, varying from £10 to £2, have been offered by *Electrical Engineering* (Chicago) for the best papers on the "Economical Generation of Steam for Electric Light Railway and Power Plant."

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended May 30 amounted to £1,310, as compared with £1,809 in the corresponding week of the previous year, being a decrease of £499.

Guernsey.—The Treasury has decided to allow the inhabitants of Guernsey to establish and conduct their own telephone service. The money required to carry out the scheme was voted by the States of the island nearly a year ago.

Birkenhead.—Several letters are appearing in the local papers on the proposal of the Town Council to adopt electric trams, and the opinion seems to be that the Council should not jump at the first offer that comes along, but take the matter slowly.

Bristol Tramways and Carriage Company, Limited.—The traffic returns for the week ended May 29 were £2,473. 2s. 6d., compared with £3,385. 13s. 3d. for the corresponding period (Whitsuntide) of last year, being a decrease of £912. 10s. 9d.

Sunderland. — At the Town Council meeting Councillor Summerbell took exception to the expenditure of money for the illumination of the town hall by electric light on the evening of Jubilee day, but ultimately the recommendation was carried.

Beckenham.—At the Urban District Council meeting a letter was read from the Local Government Board notifying the Council that a public enquiry would be held in reference to the Council's application for sanction to borrow £2,820 for various purposes.

Isle of Man.—On Monday telephonic communication was established between Douglas, Castletown, Port St. Mary, Port Erin, and south of the island. With the exception of Douglas and Laxey tramway terminus, this is the first extension of the system to towns outside Douglas.

Corbridge Electric Lighting Company, Limited.—This Company has been registered, with a capital of £4,000 in £5 shares, to carry on at Corbridge and elsewhere in Northumberland the business of electricians, electrical and mechanical engineers, suppliers of electricity, etc.

City and South London Railway.—The returns for the week ended May 30 were £929 compared with £842 for the corresponding period of last year, being an increase of £87. The total receipts for the half-year 1897 were £22,390, compared with £20,535 last year, being an increase of £1,855.

Yorkshire Motorcar Company, Limited.—This Company has been registered, with a capital of £2,500 in £1 shares, to take over the business carried on by James E. Tuke, at Bradford and Harrogate, and to carry on the business of motorcar factors and agents, cycle manufacturers and dealers, etc.

Buenos Ayres.—Buenos Ayres now enjoys electric tramcars. The export department of one of the leading United States electrical companies has, according to its managers, shipped more electrical machinery and apparatus to Buenos Ayres during the last month than in any other previous month in the record of the company. This is said to be due to the activity with which electricity is being used here.

Eccles.—At a meeting of the Electric Lighting Committee, the Town Clerk reported that the Board of Trade had consented to an extension of the Eccles electric light order for a period of 12 months. The Town Council have confirmed the action of the committee, who had adopted the plans prepared by Mr. Clirehugh for the electric lighting works, and application will be made for the necessary borrowing powers.

Tunbridge Wells —At the meeting of the Town Council Councillor Ashly Wood moved the adoption of the Lighting Committee's report, and the subject of new lamps and other extensions occupied the attention and met with the approval of the Council. The question of the disposal of the surplus shown by the accounts up to March 31 was also considered.

Poplar.—After considerable discussion, the Board of Works have decided "that the services of Mr. Morgan Williams, electrical engineer, should be engaged to advise the Board on the question of putting into force within the whole district the provisional order obtained in 1892, and the probable cost of such a proceeding, and also as to the desirability, as an alternative, of transferring the order to a public company."

Liverpool.—Upon the recommendation of the Finance and Estate Committee, the City Council have agreed that an application be made to the Local Government Board, in accordance with the provisions of the Electric Lighting Act, 1882, for their sanction to the borrowing by the Council of a sum of not exceeding £100,000 for extensions and additions to the Corporation electric lighting undertaking, which have been already or may be hereafter authorised by the Council.

Greenwich.—At the meeting of the District Board of Works the St. Paul, Deptford, Committee recommended, and it was resolved, to give conditional permission to the London Electric Supply Corporation to lay mains for carrying the electric current over Black Horse Bridge. The National Telephone Company were given permission on the usual conditions to lay tubes for carrying their cables under Nelson-street, and Romney, Trafalgar, and Woolwich roads to the boundary of Greenwich and Charlton.

Forthcoming Book.—Messrs. Whittaker and Co. will immediately publish a work on "Organic Chemical Manipulation," on which Dr. J. T. Hewitt, of the East London Technical College, has been engaged. The first part of the text-book will give an account of the methods adopted in organic analysis, and the determinations of molecular weight, the second part being devoted to a typical set of organic preparations, systematically arranged, and intended to give an idea of the methods adopted in organic work.

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West Hartlepool.—The Electric Lighting Committee recommended at the Town Council meeting that Prof. Kennedy be engaged to advise the Council generally in reference to an installation of the electric light within the borough. It was stated that Prof. Kennedy's terms were 5 per cent. upon the outlay. Alderman Pyman observed that this seemed a large charge. The Mayor replied that the terms of the principal experts were practically all the same. The recommendation was accordingly adopted.

Bradford.—The illumination of Forster-square on Jubilee night will consist of 1,000 electric lights in coloured globes. These will be hung from a pole in the centre, and will be carried in festoons to 20 poles surrounding the square. The centre pole will be surmounted by four large electric globes, and these will be topped by a large illuminated crown. Alternating with the electric lights there will be 10 festoons of flags and ensigns. In the gardens opposite the Midland Railway Station there will be placed an illuminated device.

West African Telegraph Company.—The report for 1896 says that the revenue amounted to £70,989, against which £17,898 is charged for ordinary expenses, and £20,695 for expenditure relating to repairs of cables, etc. There is a total available balance of £33,186. From this balance there has been deducted £10,726 for interest on debentures, and £13,000 for sinking fund, leaving £9,459, out of which the directors have placed £9,000 to the general reserve fund, and the balance of £459 is proposed to be carried forward to next year.

Capetown and District Gaslight and Coke Company.—At the ordinary general meeting of this Company at Winchester House, the Hon. Henry Noel, who presided, said that during the year the Company had made 94,083,000 cubic feet of gas, or upwards of 4,000,000 more than last year. Those figures, however, showed a falling off compared with the increases of former years. The introduction of electric light at Capetown had not only deprived them of the street-lighting for the municipality, but also of some of their best customers.

Salford.—The report of the Gas Committee for the year ended March 25 last, which was approved at the Town Council meeting, stated that the demand for supply of current for the electric light had increased considerably during the year, and the committee in December last reduced the charges from 6d. to 4d. per unit for lighting, and from 4d. to 2d. per unit for motive power. As this was an exceedingly low price, it was anticipated that it would induce a larger demand for current. The number of lamps equivalent to 8 c.p. now connected with the mains was 11,467.

Exeter.—At the City Council meeting a letter was read from the gas company, asking if, under the new arrangement for lighting the main streets by electricity, arrangements could be made for allowing the six large lamps which had been fixed, and were the property of the company, to remain in their present positions. They were all fitted with special burners. Dr. Domville moved that the surveyor and town clerk be deputed to have an interview with the gas company officials on this matter, and also as to the lighting of the city generally. The resolution was carried.

Blackpool and Fleetwood Tramroad Company.—This Company has been issued, with a share capital of £120,000 in 12,000 ordinary shares of £10 each. The Company has authorised borrowing powers of £40,000. The Company is formed to work a tramroad by the overhead system of electricity from the Talbot-road Station, Blackpool, to the borough boundary and Fleetwood. The directors put forward an estimate of an annual profit of £14,400, from which they deduct the interest on the debenture issue of £40,000, say £2,000, leaving £12,400 for dividend on the ordinary shares.

Ealing.—The Electric Lighting Committee reported at the District Council meeting that the number of applications on the books represented 10,416 lamps. The committee recommended that the charge for electric light used in connection with Diamond Jubilee illuminations should be 4d. per Board of Trade unit, and, further, that £2,000 should be borrowed for the purpose of laying cables in the Avenue, Hanger-lane, and Madeley-road. The Surveyor stated that the application for lamps for the roads mentioned would represent 10 per cent. on the initial outlay. The recommendations of the committee were adopted.

Lancaster.—Mr. Hall, in proposing the confirmation of the Electricity Committee's minutes at the Town Council meeting, drew attention to what appeared something of an anomaly in the estimate of current supplied to street lamps in 1897. This item was considerably less than in 1896, whilst the amount received for public lighting was considerably more. This arose from the fact that in 1896 the arc lamps were running all night, but in 1897 the light was transferred to incandescent lamps after 12 o'clock, and much less electricity was required. The minutes were confirmed.

Appointments.—The Corporation of Birmingham require the services, in September next, of a lecturer and demonstrator in mechanics and physics at the Municipal Technical School. The salary is £125 per annum, and full particulars will be forwarded on receipt of a stamped directed envelope sent to Mr. Geo. Mellor, the secretary, at the offices of the school, Suffolk-street, Birmingham. The last date for applications is July 1.—As will be seen by our advertisement columns, the Electric Lighting Committee of Shoreditch require a superintendent of mains and an electrician-in-charge. Applications are to be sent in not later than June 15.

Worthing.—At a meeting of the Electric Light Committee, held on May 14, a letter was read from Mr. R. Rowe that he is prepared to form a company for the purpose of introducing the electric light into the borough, and enquiring whether the Council would be prepared to transfer to himself, or his nominees, the provisional order obtained from the Board of Trade; but the committee resolved, prior to considering Mr. Rowe's letter, that the town clerk should write to Prof. Kennedy, and ascertain whether, in the event of the Council being desirous of consulting him in the matter, he will act on their behalf. The Town Council confirmed these proceedings.

The London Electric Supply Mains.—Lord Wantage, who is a debenture-holder in possession, has stated that he has come to the decision to relay "the so-called Ferranti trunk mains" which carry the current from Deptford to London. There were altogether four of these mains. On two occasions last March three of them broke down within a short time of each other, and had the last main also failed no light whatever could have been supplied until the repairs had been made. As possible breakdowns of this nature were too serious a risk to be incurred, he at once determined to lay down two new trunk mains between Deptford and London to replace two of the Ferranti mains.

Derby.—The Electric Lighting Committee have engaged the services of Mr. E. Manville, of 29, Great George-street, Westminster, to report upon the specification prepared by Mr. Stewart for additions and extensions authorised by the Council at the April meeting. The committee have determined to recommend the Council to alter the mode of charging for electricity for lighting purposes on the basis that a charge at the rate of 6d. per Board of Trade unit be made on a consumption of current equal to 1½ hours' average consumption of the maximum demand per day, and for all electricity consumed beyond this amount the charge to be at the rate of 3d. per Board of Trade unit.

Croydon.—To meet the large and constantly increasing demands for the electric light, the Corporation have decided to extend the present plant and stations. The number of lamps connected at present is equivalent to about 6,600 of 8 c.p., and there are about 4,000 further applications, making a total of 10,600. It is estimated that by December next the number of lamps will be increased to 12,000, and that at the end of 1898 there will be 10,000 more lamps to supply than at the end of the present year. Meanwhile the Council have decided to apply to the Local Government Board for sanction to borrow a further loan of £5,500 in order to cope with the public demand for the light.

Leicester.—The subject of the electric light plant was introduced at the annual dinner of the de Montfort Ward Conservative Association, and the Mayor said he did not wish to pose as a prophet, but he was going to mention a few facts in order to show them that the attitude he took in regard to the electric light had been proved to be justified by their experience. There were three main items: the engines, dynamos, and cables. The engines went first, and the dynamos never had worked properly; the cables—well, that was a compromise. In the end the whole of his proposals had been adopted. If it had been done at the time when he first mentioned it, the town would have been saved £10,000.

Islington.—At to-night's meeting of the Vestry a report will be received from the Electric Lighting Committee stating that they have considered the desirability of revising the present scale of charges for the supply of electricity to private consumers, and have resolved to adopt the following scale on and after October 1 next—viz., for an average of one hour's consumption or under per day during the quarter, of the maximum number of lamps alight at any one time, 7d. per unit; for an average of two hours per day, 7d. per unit for the first hour, and 6d. per unit for the second hour; for an average of three hours per day or more, 7d. per unit for the first hour, 6d. per unit for the second hour, and 4d. per unit for the remainder.

The Birmingham Trams.—In view of the resumption on Thursday of the conference between the Public Works Committee of the Corporation and the representatives of the Birmingham City Tramways, Limited, the committee again considered the matters which remain to be settled. In consultation with their professional advisers the committee discussed at some length the questions of the cost of laying the proposed conduits for electrical traction, and of the time for which the lease should be granted to the company. No vote was taken, but it is stated that the feeling of the committee is strongly against the extension which the company asks of the period originally decided upon as that for which the lease was to be granted.

Dundee.—Mr. Tittensor, the electrical engineer to the Town Council, has been instructed to prepare a report on the rebate system of charging. At the beginning of the year it was estimated that the expenditure in the electricity department would amount to £4,493. 14s. 4d., whereas the actual expenditure was £4,860. 11s. 9d., a difference of £366. 17s. 5d. The income from electricity was estimated at £5,225, while the actual was £5,533. 13s., showing an increase on the estimate of £308. 13s. For the current year the income estimates are: for electricity, £6,300; discount, £300, leaving £6,000. The expenditure is expected to be £5,284. 6s. 7d., and it is therefore estimated that for the year ending April 30 next there will be a surplus of £715. 13s. 5d.

Madras Electric Tramways.—As the result of a meeting held at Madras of the shareholders of the Madras Electric Tramway Company, it was resolved to appoint a strong committee of shareholders in Madras with full authority to communicate with the Government of Madras, the Municipality, the directors of the company in England, and others, for the purpose of making such recommendations and proposals and eliciting such information as the committee considers proper for the protection of the interests of the shareholders. It was also resolved to retain a solicitor in England, under instructions to act for the Indian shareholders as their committee determines necessary. If placed on a proper

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footing, it is generally considered that the tramway would be a financial success.

Stockport.—Considerable discussion took place at the Town Council meeting upon a recommendation of the Electric Lighting Committee that an electric installation be laid down in the town with the view of supplying the electric light to a portion of the town, and that £25,000 be borrowed for the purpose. The Mayor mentioned that there was a proposal by a Paris firm to work the electric light in the town, with the condition that the Corporation could acquire the rights on certain terms at 12 months' notice. It might be as well, he said, for the Electric Light Committee to consider the matter. The feeling of the Council was decidedly against allowing any company to get hold of a monopoly on this important matter, and eventually the recommendations of the committee were passed.

Birmingham.—At the City Council meeting, Alderman Pollack, referring to the speech recently made by Mr. Fletcher on the question of acquiring the electric light, said he looked with the keenest interest and favour on the introduction of electricity, not only because it was the means of stimulating improvements in gaslighting, but because of its intrinsic value and convenience. He might, however, mention that to produce sufficient electricity to displace only the increase in the consumption of gas in the last financial year would, according to present knowledge, require an outlay in plant and mains of a million of money, and would take several years to carry out. The two illuminants could peacefully progress and prosper side by side in due proportions without interfering or superseding one another.

Norwich Electric Tramways.—On Monday the Select Committee over which Mr. A. de Tatton Egerton presides had before it the Bill to incorporate the Norwich Electric Tramways Company, and to empower that company to make and maintain tramways, to raise £240,000 in 24,000 shares of £10 each, and to raise on mortgage any sum not exceeding in the whole £6,000 in respect of each £24,000 of capital, purchase of lands by agreement, and for other purposes. Parties having come to an understanding on Saturday as to the matters in dispute, the Bill was passed as unopposed. A petition on behalf of owners of property in Stephen's-street, Norwich, in favour of this Bill has been deposited in the Private Bill Office of the House of Commons. Some of the opposition has been withdrawn.

Hull.—The question of the Corporation undertaking its own labour was discussed at the meeting of the Electric Lighting Committee. The labour representatives gained their point by one vote. It was a matter of spending £22 for painting the electric light station. One tender was 10s. below their engineer's estimate. At a meeting of the Electric Light Committee of the Corporation, Mr. Skinner (the chairman) made a statement as to the accounts for the past 15 months. During that period, he said, they had made a profit of £1,931. This covered charges on the sinking fund for two years. Had the charge been for 15 months only there would have been a total profit of £3,031. The cost of production was less and the number of consumers was increasing. This state of affairs, he considered, was highly satisfactory.

Electric Light on the Goldfields.—At the meeting of Scottish Westralia, Limited, the Chairman said that with regard to the scheme for the public supply of electric power on the goldfields, prolonged investigation had led those immediately associated with the proposal to the conclusion that under the special circumstances prevailing in Western Australia as to fuel, water, etc., the plan proposed was not the best means of supplying a great want in that district. Another scheme, however, had been proposed, which had the sanction and approval of the highest scientific and mechanical authorities, and it was hoped that this would shortly be placed before the public. Under this scheme it was proposed to deliver power at the mines at a price equivalent to 2d. per Board of Trade unit, and the importance of this supply could not be overestimated.

Swansea.—The case against Moses Davies. electrician, lately employed at Williams, Foster, and Co.'s Morfa Works, of stealing a quantity of copper, the property of the firm, has been concluded. Mr. Naylor (who appeared for the defendant) stated that he had examined the metal in question, and he found such unmistakable evidence of the identity of the pieces that he could not carry the case any further, but he asked for the leniency of the court towards a man who up to now had borne throughout life an unblemished character. The Stipendiary said he was glad to find that this was the defendant's first offence, but he was open to most severe blame for dealing as he had done with any property, however small, belonging to his employers. He would not, however, pass sentence of imprisonment, but would impose a fine of £10; in default, a month's imprisonment.

Hanover.—There are in all 32 miles of tramway lines in Hanover on which electric traction is used, and 17 miles on which horse traction is still retained. There are 29 motorcars for the trolley lines, and 63 which can be used either on the trolley or accumulator lines. In addition, 110 accumulator cars are being built, and before the end of the summer the accumulator system is to replace the overhead system on all lines. The generating costs averaged 0·66d. per kilowatt-hour during the first half-year of 1896, and 0·59d. during the second half-year, being during November and December only 0·54d. This improvement is attributed to the increased use of accumulators. The entire working costs amounted to 68·2 per cent. of the year's receipts, as compared with 75·8 per cent. last year. Fourteen thousand one hundred and seventy pounds have been set aside for depreciation, and a further sum of £400 for extra expenses in connection with the accumulators.

Taunton.—At the meeting of the Town Council, the Streets and Highways Committee and the Electric Lighting Committee presented a joint report in reference to a letter from the Taunton and West Somerset Electric Railways and Tramways Company, stating that they intended to apply, under the Light Railways Act, 1896, to the Commissioners for powers to construct an electric railway or tramway in the borough of Taunton. The committee recommended the Council to approve of the principle of the laying of a light railway in Taunton, to be worked by electric energy, but that the Council should reserve the fullest right to make arrangements with the company on all matters of detail, and to make suggestions thereon or objection thereto to the Commissioners at their public enquiry or at other times. The report was adopted, on the motion of Alderman Potter.

Leith.—At the Town Council meeting the minute of the Special Committee on Electric Lighting contained a report by Prof. Kennedy, Edinburgh, as to the proposed electric lighting of Leith. The professor, in his report, says: "As to the system of electric supply to be adopted, there are no special difficulties or complications occurring in Leith, and I should advise you to adopt at once a three-wire system, with lamps working at 230 volts. I think from the extent of your district, and the nature of your streets, that you ought to provide plant and mains for supplying from 10,000 to 12,000 lamps (equivalent to 8 c.p. each) wired, besides providing for the arc lamps necessary to light your scheduled area. For this about 64 arc lamps would be required. For this purpose there will have to be placed in the station about 400 h.p., besides a spare set of, say, 250 h.p. The total cost of this plant will be from £33,000 to £35,000." A deputation has been appointed to visit certain other towns and report.

The Telephone in Fifeshire.—At the meeting of the Kirkcaldy District Committee of Fife County Council a letter was read from the County Council submitting the recommendation of the Road Board to the effect that arrangements should be entered into with the National Telephone Company for so many instruments at an annual payment, and that the Telephone Company should pay 1s. per annum for each pole belonging to them on any of the public highways of the county. The Chairman explained that under the old system they had received only 12s. per mile from the Telephone Company for wayleave. A proposal had been made that a private system of wires should be fitted up for the police, but that had been thought too expensive, and they had now come to an arrangement to get nine stations for the use of the police. By charging 1s. per pole for wayleave, they would draw from 25s. to 26s. per mile, instead of only 12s. as formerly. The recommendation was unanimously approved of.

The Sheffield Trams.—The Corporation having applied to the Local Government Board for sanction to borrow £30,753 for tramway purposes, Colonel J. P. Marsh, R.E., one of the Board's inspectors, has held an enquiry into the matter. There were present the town clerk (Mr. Herbert Bramley), the deputy town clerk (Mr. H. Saver), Aldermen Carter and Clegg, the city surveyor (Mr. C. F. Wike), the city accountant (Mr. W. Fisher Tasker), and Mr. H. Mallyon (manager of the tramways). The Town Clerk first explained the circumstances under which the Corporation acquired the tramways, and stated the price agreed to be paid to the company, £30,753, less the amount for which the company were liable for dilapidations, £3,253. Alderman Clegg stated that an experiment was to be made on two sections with the overhead electric system. The Inspector concluded that there was no opposition to the application, as the money had been paid and the matter settled. The Town Clerk said they knew of no objection whatever.

The Manchester Tramways.—Some correspondence, says the *Manchester Guardian*, has taken place between the Manchester Carriage and Tramways Company and Mr. Talbot, the town clerk of Manchester, with reference to a re-lease of the tramways. The company are desirous of a re-lease to themselves, and suggested through their solicitors that the question of terms should be referred to a secretary of the Board of Trade, the Corporation on the one hand and the company on the other laying a statement before him. The special committee of the Corporation, having considered the suggestion, declined to entertain it. The town clerk was instructed to reply: "The Manchester Corporation are of opinion that the working of tramways should be permissible to the local authorities owning the same, and that such authorities should have unrestricted discretion either to work the tramways themselves or to lease them, and it is on this principle and with this object in view that this Corporation are making application to Parliament in the present session."

Electricity in France.—At the last general meeting of the Syndicat Professionel des Industries Electriques, the president, M. F. Meyer, quoted some interesting statistics as to the progress of the electrical industry in France. At the end of 1896 there were 428 central stations in the provinces in France, with an aggregate plant capacity of 51,300 h.p., while in Paris the figure was 25,000 h.p., making a total of 150,000 h.p. if private and isolated plants be also reckoned in. There are 19 towns with electric tramways, with a total track mileage of nearly 200 miles, representing some 10,000 h.p. to 12,000 h.p. Statistics of the Ministry of Commerce had shown that during 1895 533 tons of electrical machines had been exported in a finished state and 178 machine parts. The imports were, however, 745 and 204 tons respectively. In the manufacture of arc-lamp carbons and incandescent lamps the balance was on the other side; 39½ tons of carbons had been imported, against 282 tons exported, and there were 20,500 incandescent lamps imported, while 35,000 were exported.

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Personal.—The sub-committee of the Leeds City Corporation appointed to consider applications for the position of chief electrical engineer have decided to engage, subject to the approval of the Council, Mr. J. Burbridge, who has been acting as clerk of the works during the construction of the new electric tramways for the city. The salary will be £300 a year. There were six applicants.—The salary of Mr. W. R. Wright, electrical engineer to the Burnley Corporation, has been raised from £200 to £250 per annum.—The staff at the Blackpool electricity works will shortly lose Mr. Ernest Lawson, who has accepted a post in Lancashire under a well-known firm of London engineers.—The committee of the Liverpool Corporation entrusted with the working of the tramways have requested Mr. H. Graham Harris, of the firm of Messrs. Bramwell and Harris, to report generally upon the tramways, and upon the best mode of traction to be adopted by them. They have also requested an American engineer and a Canadian engineer. Mr. Pearson and Mr. Cunninghame, to report upon the question.

The Central London Railway.—We were informed last week in confidence that the contract for the equipment of this electrical railway was placed with the British Thomson-Houston Company. We must congratulate the British Thomson-Houston Company on acquiring the contract for this important work, the price for which will amount to some £275,000. The details of the equipment are not yet definitely fixed, and hence Mr. Devonshire, the secretary of the company, does not wish to publish much information. We are informed, however, that the system employed will be somewhat similar to that used on the Dublin-Dalkey line, only of much larger capacity. The generating station will be placed at the west end of the line, and will contain large three-phase generators. The high-voltage current will be transformed down to direct current at various points along the line by means of rotary transformers. Mr. H. Parshall is advising the British Thomson-Houston on the equipment of the line, and his remarks in the discussion on Mr. Baylor's paper before the Institution of Electrical Engineers will be interesting reading in this new light.

Milan.—The Edison Company of Milan, which was formed for the purpose of supplying electric light and apparatus, has, in consequence of the arrangement come to with the Municipality for working the city tramways from the beginning of 1897, increased its capital to £360,000. The company is to provide the cars and *personnel*, the motive power, and its adjuncts at its own expense, the lines being provided and kept in order by the town. The company pays the town a rent of £180 a year for each mile of single line, and receives 3·8d. per car mile for each independent car, and 1 94d. per car mile for each trailer car. After deduction from the receipts of this and the amount for rent of the lines, the remainder is to be divided between the company and the Municipality in the proportion of 40 per cent. to the former and 60 per cent. to the latter. It is calculated that this arrangement will bring into the town a net yearly profit of at least £30,000. As yet only one line is being worked by electricity, the traction on the other lines being still by horses, but the new system is to be extended to them as rapidly as possible. There are in the town 42 miles of single line, and in 1896 the tramways company carried over 35,000,000 passengers.

Sheffield —At the Town Council meeting Mr. H. W. Chambers moved, "That the Parliamentary Committee be empowered, should they deem it desirable, to fix the corporate common seal to an offer to be made to the Sheffield Electric Light and Power Company, Limited, of a sum of £200 of new Sheffield Corporation 2½ per cent. stock (or in the alternative, £200 in cash) for every sum of £100 properly expended by the company chargeable to capital account, together with a sum in cash equal to the aggregate amount of a dividend of 5 per cent. per annum on the said capital expenditure, less the aggregate amount of the dividends declared by the company from the date or dates of such expenditure, such offer of stock and cash being the price for the purchase of the company's undertaking, pursuant to the notice to purchase, given under the corporate common seal of April 15, 1897, given under the powers of Section 60 of the Sheffield order of the Electric Lighting Orders Confirmation (No. 4) Act, 1892; and that, in default of an agreement to purchase the undertaking of the company being come to by the committee, the town clerk be instructed to take such measures as he may be advised to enforce the requirements contained in such notice." Mr. R. Styring seconded the resolution, which was adopted without discussion.

Cardiff.—It was decided by the Corporation committee on Saturday to recommend an important addition to the electrical tramways, for the construction of which the Corporation have decided to seek provisional orders in the next session of Parliament. The additional section will take the form of a ring, running along Clifton-street, through Broadway, a portion of Newport-road, Albany-road, and Wellfield-road. There are three well-defined routes: (1) from the top of Cathedral-road, through Clare-road, Corporation-road to James-street, with branches through Tudor-road and Wood-street to St. Mary-street, and from the workhouse to Clare-gardens; (2) from Queen-street direct along Park-place to Colum-road; (3) from the southern end of Portman-moor-road, through Walker-road, Splott-road, and the western portion of Pearl-street, Clifton-street and Broadway, Copper-street, Planet-street, Glossop-road past the infirmary, thence *vid* Castle-road, Albany-road, Wellfield-road, and Ninian-road. Should the proposal of extension of the borough be carried, route No. 1 will be extended to Llandaff, route No. 2 to Maindy, and route No. 3 past the Roath Park lake. It was agreed that Mr. Harpur should be given special assistance in the making of the necessary surveys, and that the remuneration of the assistant should be £4. 4s. a week.

The Brockie-Pell Lamp.—In a circular letter addressed to the shareholders of the Brockie-Pell Arc Lamp, Limited, Lord Sheffield, as chairman of the directorate, gives explanations in reply to questions as to the progress being made. The directors' communication was to invite shareholders' subscription for 5,000 unissued shares at 5s. premium, and this was fully subscribed. It is now intimated that the company's works are engaged to their utmost capacity with orders from various districts in the United Kingdom. There are good contracts in hand for the railways, for the Government, for municipal corporations and trading organisations. They are about to conclude the contract for the sale of the French and Belgian patents upon advantageous terms, financially benefiting the company very considerably. They have secured from Mr. Brockie a share in his new automatic machine for the economical production of metalwork. To give some idea of the benefit to this company, says Lord Sheffield, "we are informed by Mr. Brockie that it will lessen the cost of the labour expended in the manufacture of our lamps by at least one-fourth." It will be recollected that the anticipations of the prospectus gave a profit of 17½ per cent. With Mr. Brockie's invention, it is expected this will be exceeded. The Board have the highest anticipations for the future of the company.

Amazon Telegraph Company, Limited.—This Company is issuing £125,000 5 per cent. debentures, redeemable at par by 25 annual drawings, commencing June 30, 1898, also in the event of the Government purchase of the undertaking. The Company reserve the right to redeem the debentures outstanding at any time after the year 1900 at 105 on giving six months' notice. The share capital of the Company is £250,000, which has all been subscribed and paid up. The Company has an annual subsidy of £17,125 from the Government of Brazil, and the traffic to be anticipated when the cable is in working order is estimated at £36,250. Deduct working expenses, renewals, etc., estimated at £20,000, there will be a balance of £33,375 available for debenture interest and annual drawings, which will require £8,900. The Company was formed in 1895 to connect by cable the city of Manaos, the capital of the State of Amazonas, and chief emporium of the indiarubber trade in Brazil, with the city of Pará, with 14 intermediate stations. At Pará the cable joins the land-lines of the Brazilian Government and the Western and Brazilian Telegraph Company's cables connecting with the rest of Brazil and the Argentine Republic, and is placed in communication with Europe and the telegraph system generally. The main cable was completely laid by February, 1896, but breakages and interruptions have occurred, and it became necessary to relay a length of 430 miles, the present issue of debentures being made for this purpose, and for other requirements of the Company.

Alexandria (Egypt) —Messrs. Eug. Nahman and Co., the well-known firm of electrical engineers of this town and Cairo, had, by the Daira of his Highness the Khedive, received the contract for the installation of electric light at the Grand Ras El Tin Palace at Alexandria. The trials for the installation have just taken place, and everything has turned out very satisfactory. The plant consists of two 25-h.p. nominal Robey boilers of the locomotive type, working at 140lb. pressure, and tested for hydraulic pressure, before setting to work, to 250lb. per square inch. The two feed-pumps are of the horizontal duplex type, and they are each capable of supplying 1,000 gallons of water per hour. The water-heater is of one special system. The motive power consists of two of the well-known Robey compound engines, one capable of giving off 60 effective horse-power and one for 100 effective horse-power, fitted with Richardson's patent automatic expansion governors. The dynamos, of the continuous current system, are supplied by Messrs. Brown, Boveri, and Co. (Baden); one dynamo of 500 amperes 110 volts, one of 300 amperes 110 volts, one of 50 amperes 50 volts. The two first mentioned work coupled in parallel for giving light to 2,400 incandescent lamps and 16 arc lamps, and the small dynamo is coupled in series with the two others for charging one battery of 60 Tudor accumulators. The small dynamo is excited up to 160 volts of the series. The switchboard is of marble, and the instruments to measure the various voltages and currents are of the Richard type. The whole installation has been completed by Mr. R. Levi, the consulting engineer of Messrs. E. Nahman and Co.

Handsworth.—Colonel W. Langton Coke, M.I.C.E., has held a Local Government Board enquiry into the application of the District Council for permission to borrow £2,200 for the purpose of lighting the public buildings by electricity. There were present: Councillors W. A. Ellis (chairman of the Council), D. Rose, J. J. Hughes, H. Loveridge, F. Lempriere, and S. Adkins, and Mr. H. Ward (clerk). Mr. Ward, in reply to the inspector, gave the population of the district as 41,600, and the annual assessable value as £161,233. The balance of outstanding loans under the Sanitary Acts and the Public Health Acts of 1875 was £84,762, and the loans which had been sanctioned but had not been taken up £23,990, giving a total of £108,752. He also pointed out that though the amount of loans taken up was only £85,000, they were entitled to borrow £213,714, and that the Council owned property to the value of £41,607. The loan of £2,200 which was now being applied for was for the purpose of providing electric light for the Council house, library, lecture halls, stabling, fire station, and the new technical schools. That light would render the Council house much more comfortable to those who attended there, particularly those who frequented the library. At the present time the heat from the gas in winter was almost unbearable, and there was also a considerable loss arising from the injury done to the books by the gas fumes. The new form of light would also be much better for the work of the technical school than gas would. Evidence as to the details of the buildings and plant was then given by Mr.

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Henman, the architect, and Mr. Vaudrey, M I.C.E. The engineer and inspector then visited the premises proposed to be lighted.

Glasgow.—The minutes of the Statute Labour Committee, which were read at the Town Council meeting, stated that at a meeting on May 21 the clerk submitted a copy of a communication addressed to the town clerk of the city by the principal clerk to the Commissioners of Sewers of the City of London, passed at a meeting of those Commissioners on May 11 regarding applications from the Post Office authorities to open the public ways of the city for telegraphic purposes. The committee, having considered the subject-matter of said communication and resolution, agreed to recommend that the Corporation resolve as follows: "That the Post Office authorities be informed that the Corporation of this city will not object to their opening the streets thereof, on conditions to be mutually arranged as to the extent of opening and the cost and manner of restoration for laying underground telegraph wires for their own public purposes, but that the Corporation will not give such consent for the laying of wires for the use or behoof of any private telephone or other company or firm, and that the Corporation will not allow any consent given to the Post Office authorities to be construed as authorising them to use, transfer, or delegate the same for the laying of such private wires." Mr. M'Farlane moved the approval of the minute. He remarked that it was now almost evident that there must be some understanding between the Post Office authorities and the Telephone Company with the view of obtaining the use of the public streets for the Telephone Company. If this was so, he had no hesitation in saying that the Government were going outside their authority and their duty, and it was for the Corporation to resist anything of the kind.

Weston-super-Mare.—A meeting of the committee of the whole Council has been held for the purpose of further considering "the desirability of the Council utilising the powers contained in the provisional order obtained by the late Local Board—and retained by the present authority—for the purposes of an installation of electric lighting for the town." Mr. J. Phillips (chairman of the Council) presided over a representative attendance of members. The minutes of the Lighting Committee were read, from which it appeared that the following letters had been received and considered by that body: (1) letter from electric light and power company, giving notice of their intention to apply in the next session of Parliament for a provisional order for the electric lighting of the district, and to ask the Board of Trade to revoke the Council's order, on the ground that they (the Council) had failed to carry the same into effect; (2) letter from Messrs. Capell and Melsome, stating that a syndicate had been formed "which would forthwith apply for, and, if obtained, exercise power for installing electric light in Weston-super-Mare," also enquiring whether the Council would be prepared to negotiate with the syndicate with a view to the latter acquiring the Council's powers. The syndicate—it appeared from a subsequent letter—comprised Captains J. L. Philp and E. M. Whitting, and Messrs. F. Blackmore, W. E. Perrett, J. Allen, F. Coleman, W. Beavan, A. E. Jefferies, and J. P. Capell. The following telegram was also received from the secretary to the Electrical Development and Finance Corporation, 39, Victoria-street, S.W.: "This corporation is prepared to carry out electric lighting at Weston-super-Mare for £23,000, and take a lease of undertaking on completion from the Council for 10 years, paying progressive rental of £1,100 for the first year, and £50 increase each year—public lighting 3d. per unit, private lighting 6d." After some discussion the committee unanimously resolved, "That this committee recommend to the Council that an electrical engineer be appointed to confer with a committee of the whole Council as to the best site, system, and plant to adopt, and the probable cost of carrying into effect the powers contained in the Council's provisional order for laying down an electric lighting installation." A special meeting of the Council was subsequently held, at which these minutes were confirmed *nem. con.*

Guildford.—At the Town Council meeting the Lighting Committee reported that they had considered the proposal made to light certain parts of the town by electricity. They were of opinion that unless considerable improvement in the quality of the gas now supplied was shortly effected, it would be necessary not only to consider the propriety of introducing the new light proposed into parts of the district, but that it would be necessary to consider whether the existing agreement with the gas company should not be terminated altogether; and that being so, the committee recommended the Council to defer the matter for a short period to see if any steps were taken by the company to bring about the desired improvement. The Mayor said the committee were not satisfied with the way in which they were treated by the gas company. Alderman Mason did not wish to see the town left in darkness, and thought that it was hardly necessary that the clause as to terminating the agreement should remain in the report. Alderman Allen did not see why the town should be left in darkness even if the agreement were terminated. Until lately Winchester was lighted by oil, and he believed Wimbledon still was. Mr. Bullen mentioned that only the Mayor and himself were present at the committee meeting, but they felt that there was no denying the fact that for years they had had a bad supply of gas. It was not the fault of the gas company, but of those who had the making of the gas and sending it out. There was somebody who apparently had control and did not choose to act. He questioned very much whether they got the pressure which they ought to have under the Act of Parliament. The light at a distance could not be seen. It was a dirty yellow, and the committee felt that if that state of things was going to continue when the company got their new appliances it would really become a very serious question with that Council whether they were doing right in supplying the town with the quality of gas they had at present. They might be obliged to go in for electricity even at a greater cost. Alderman Allen complained that every night at half-past eleven o'clock the pressure of the gas was reduced more than one-half, and he did not think that should be, seeing that it was at night time that the police required greater illumination for the protection of residents. The Mayor said the paragraph Alderman Mason had alluded to was put into the report for a purpose. The report was then adopted.

Manchester.—At the City Council meeting, Mr. Wilson, on the motion for the approval of the proceedings of the Electricity Committee, said that, while he admitted the popularity of the electric light, he desired to direct the attention of the chairman of the committee to the fact that there was great cause of complaint as to the charges for meter rents. Personal complaints had been made to himself with regard to this matter. The charge was, in fact, a serious item, there being nothing under 3s. 6d. a quarter, or 14s. a year. It seemed a ridiculous policy that, having abolished meter rents for gas, when another illuminant followed close upon its heels the committee should adopt that antediluvian system and charge a much higher meter rent for the supply of the electric light. The Corporation had, indeed, no more right to charge meter rent for electricity than they had to charge it for gas, in which case they had found out that it was a mistake. It very much militated against the popularity of the electric light, and he thought it was nearly time the committee took the matter into their serious consideration. Whilst he admitted that Manchester had the best installation possible, yet a little town like Bradford "beat them hollow" in the matter of the supply of electricity, the charges there being much less. The committee should reduce their charges and offer greater advantages. Mr. Alderman Higginbottom, in reply, said, with reference to meter rents, that the matter should be considered by the committee when the question of the reduction in the price was considered, in about a fortnight. He did not agree with Mr. Wilson in the statement he had made that the cost in Manchester was greater than at Bradford. At the latter place customers had to be obtained for the electric plant. Manchester, on the other hand, had not been in the position of being able to supply their customers. The plant was being taken up so rapidly that the committee were coming to the Council month after month and asking for money in order to increase it; and if a large amount of additional plant was not put down for the coming winter the committee would not be able to supply their customers. The average charge for the two years came to 4·7d. per unit, so that it was less than the 5d. charged at Bradford. The charges at Manchester, he believed, were lower than those of any town in England except Brighton, where they worked upon the principle that no profit should be made from the use of the electric current. In Manchester they were making a large profit, the profit this year being almost double the profit made last year. The committee would have to take the question of cost again into consideration, because they were exceeding the Board of Trade limit. The matter would come before the Council again in a short time. The proceedings of the committee were agreed to.

Torquay.—At the meeting of the Town Council, Mr. Appleton introduced a deputation of cab proprietors who presented a petition against the introduction of electric trams. Mr. Dale acted as spokesman, and said that, while they were acting to a great extent in their own interests, they also had the interests of the town at heart. They firmly believed that the introduction of electric trams would be detrimental to the town and to the majority of villa residents. They knew positively from the people they drove that this was a fact. The petition was signed by 244 cap proprietors and drivers. The trams would only cater for the tripper class, which would not do Torquay any good. Torquay ought not to be degraded to the level of a tripper town. The petition stated that between £40,000 and £50,000 was invested in horses and carriages in the town. If they included stables, etc., said Mr. Dale, the value of cab proprietors' property was not far short of £100,000. The Town Clerk reported the receipt of the draft order concerning the construction of an electric tramway along the Torbay-road to Paignton. Mr. W. Beavis moved that the Council oppose the order. After giving careful and impartial attention to the arguments in favour of the scheme, he was compelled to arrive at the conclusion that to permit the tramway would be detrimental to the best interests of the town. It appeared to be ignored by those who were in favour of the scheme that Torquay did not possess any self-supporting industry, and that the prosperity of the town was entirely dependent upon maintaining its reputation as a residential health resort. If a poll of the residents was taken, there would be an overwhelming majority against the construction of the line. The essence of the proposed agreement, suggested by the promoters, was nothing more nor less than a menace. If meant that if the Council did not assent to the scheme, they would do the thing they now promised not to do. Dr. Richardson seconded. The line would disgrace the town, and would be dangerous both to cabmen and cyclists. If tramways were to be introduced, they should be introduced by the Council. He predicted that the line would be a ghastly failure, and would soon be shut up. Then they would have to remake the roads. Trams were noisy, and the poles emitted sparks at night. He remarked that the Queen deserted Biarritz owing to the laying of a tramline in the principal street. Mr. Glanfield moved, and Alderman Mortimer seconded, the reference of the matter to a committee. By 12 votes to 8 the question was deferred to a meeting of the Council in committee. Mr. Garrett reported that the electric lighting

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works were in progress. The erection of the chimney and main flue through the centre of the Bath Saloon was being pushed forward rapidly. During the past month 350 tons of stone had been placed in position on the sea-wall, and 125 tons of concrete had been used. Mr. R. Crocker complained of the inconvenience near Tor Station, caused by the cutting up of the roads. Great complaint had been made concerning the interference with the traffic. The Town Clerk said the difficulty had now been obviated.

PROVISIONAL PATENTS, 1897.

MAY 24.

12758. **An improved form or construction of pipes for the reception of electric cables.** John Johnston Green and William Oates, Commercial-street, Halifax.

12784. **The searchlight electric lamp.** T. Sidney Hill and Peto and Radford, Limited, 57B, Hatton-garden, London.

12809. **Improvements in electric cables and in the manufacture of the same** Mervyn Joseph Pius O'Gorman, of the Fowler-Waring Cables Company, Limited, 24, Southampton-buildings, Chancery-lane, London.

12820. **Improvements in transforming continuous electric currents.** Adolph Müller and Henri Tudor, 4, South-street, Finsbury, London.

12827. **Improvements in electric primary and secondary batteries.** Victor Jeanty, 45, Southampton-buildings, Chancery-lane, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, November 19, 1896, being date of application in France.)

MAY 25.

12910. **Improvements in telephone-receiver supports.** Luis Duque and Francis McClellan Cosgrove, 111, Hatton-garden, London. (Complete specification.)

12933. **A general switch for groups of electric lamps.** Oliver Imray, 28, Southampton-buildings, Chancery-lane, London. (The firm of Rudolf Kissling and Sohn, Hungary.) (Complete specification.)

12935. **Improved apparatus for supporting and securing electrical conductors and for like purposes.** Herbert Tristman Marks, 21, Finsbury-pavement, London.

12936. **Improvements in electric furnaces.** Alfred Vincent Newton, 6, Bream's-buildings, Chancery-lane, London. (Alfred Hutchinson Cowles, United States.) (Complete specification.)

12944. **Improvements in electric tramways.** Henri Bersier, 53, Chancery-lane, London.

12945. **An improved electric arc lamp.** François Fesquet and John William Keys, 53, Chancery-lane, London.

12957. **Improvements in transforming alternating into continuous electric currents or vice versa.** Adolph Müller and Henri Tudor, 4, South-street, Finsbury, London.

12974. **Improvements in electrical telegraph systems and apparatus therefor.** Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Charles Goodwin Burke, United States.) (Complete specification.)

MAY 27.

13049. **Improvements in enclosed arc lamps.** Bernard Mervyn Drake and John Marshall Gorham, 66, Victoria-street, Westminster, London.

13100. **Improvements in or connected with primary or galvanic electric batteries.** Charles Nestor Gauzentés, 33, Chancery-lane, London.

13107. **Improvements in electric arc lamps.** Sigmund Bergmann, 28, Southampton-buildings, Chancery-lane, London. (Complete specification.)

13117. **Improvements in electric meters for alternating currents.** Granville Frederick Packard, 70, Chancery-lane, London. (Date applied for under Patents, etc., Act, 1883, Sec. 103, October 26, 1896, being date of application in United States.) (Complete specification.)

13154. **Improvements in attachments for operating telephone call-bells.** Hosea Waite Libbey, 45, Southampton-buildings, Chancery-lane, London.

13164. **Improvements in construction of dynamo-electric armatures.** Rookes Evelyn Bell Crompton, 55, Chancery-lane, London.

19455A. **Improvements in automatic switches and safe-guards for electric traction systems.** Silvanus Phillips Thompson and Miles Walker, 6, Lord-street, Liverpool. (Date claimed under Patents Rule 19, December 3, 1896)

MAY 28.

13212. **Improvements in or additions to the covers or casings of switches, cut-outs, ceiling roses, and other electrical fittings.** Thomas Taylor, 24, Temple-row, Birmingham.

13213. **Improvements in the tubes or cases of electric fuses.** Thomas Taylor, 24, Temple-row, Birmingham.

13221. **Improvements in electrical cut-outs.** Charles Mark Dorman and Reginald Arthur Smith, Ordsal Electrical Works, Salford, Lancs. (Complete specification.)

13236. **The Bolton improved incandescent electric glow lamp.** John Ignatius Bolton, 24A, Bramshill-gardens, Dartmouth park, London.

13268. **Improvements in electric mountain railways.** Emil Andre, 111, Hatton-garden, London. (Complete specification.)

13282. **An electric ignitor for gas-burners.** Ladislas Victor Lewitzki, 77, Chancery-lane, London.

MAY 29.

13346 **Improved means for obtaining phonographic sound in volume and in apparatus for developing the same.** William Speirs Simpson, 166, Fleet street, London.

SPECIFICATIONS PUBLISHED.

1896.

4910. **Electromagnetic regulating and actuating mechanism.** Niewerth.

9257. **Electric arc lamps.** Grabner.

9637. **Arc lamps.** Schonberg. (Administrator of Blahnik, deceased.)

9656. **Process for depositing metals on silver coatings.** The Improved Electric Glow Lamp Syndicate, Limited. (Schwabe.)

10781. **Apparatus for the application of electricity to vehicles driven by mechanical means.** Dowsing.

11058. **Motorcars or autocars applicable to launches.** Chibbe, Southey, and the Electric Motive Power Company, Limited.

14584. **Arrangement and attachments of electrolytic anodes.** Secrétan.

14613. **Telephonic transmitters.** Marr.

15303. **Method of and means for protecting electric lamp fittings from damp and corrosion, and for preventing short-circuiting.** Kendal.

1897.

902. **Automatic electric marine sounding apparatus.** Babcock.

6720. **Electrical apparatus for perforating designs.** Glorget.

8131. **Primary electric batteries or generators.** Essick.

8588. **Electrical resistance apparatus.** Mavor, Coulson, and Mavor.

8788. **Phonographs.** Lake. (Dickerson and Bettini.)

8885. **Hand-fed focussing electric lamp.** Barnard and Carver.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	9½-9¾
Brush Company, Ordinary	3	1¼-1⅜
—— Non. Cum., 6 per cent. Pref.	2	1⅛-1¼
—— 4½ per cent. Debenture Stock	100	104-106
—— 4½ per cent. 2nd Debenture Stock	100	96-99
Callender's Cable Company, Debentures	100	110-115
Central London Railway, Ordinary	10	9⅞-10⅛
——	6	5⅝-6⅛
Charing Cross and Strand	5	13⅞-14⅛
Chelsea Electricity Company	5	9⅞-10⅛
—— 4½ per cent. Debentures	100	112-115
City of London, Ordinary	10	23½-24½
—— 6 per cent. Cumulative Pref.	10	17-18
—— 5 per cent. Debenture Stock	100	131-136
City and South London Railway, Consolidated Ordinary	100	58-60
—— 4 per cent. Debenture Stock	100	137-139
—— 5 per cent. Pref. Shares	10	15½-16
County of London and Brush Provincial Co., Ordinary	10	12⅞-13⅛
—— 6 per cent. Cum. Pref.	10	15-15½
—— 4½ per cent. 2nd Debenture Stock	10	14⅞-15⅛
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	1⅞-2⅛
—— 5 per cent. Debentures	—	90-96
Edison and Swan United Ordinary	3	2-2⅛
—— 5 per cent. Debentures	5	3½-4⅛
—— 4½ per cent. Debentures	100	105-110
Electric Construction, Limited	2	1⅛-1⅞
—— 7 per cent. Cumulative Pref.	2	2⅝-3⅛
Elmore's Copper Depositing	1	¾-1
Elmore's Wire Company	2	1⅞-2
W. T. Henley's Telegraph Works, Ordinary	10	18-19
—— 7 per cent. Preference	10	18½-19½
—— 4½ per cent. Debentures	100	106-113
House-to-House Company, Ordinary	5	8⅞-9⅛
—— 7 per cent. Preference	5	9⅛-10⅛
India Rubber and Gutta Percha Works	10	20½-21½
—— 4½ per cent. Debentures	100	104-107
Kensington and Knightsbridge Ordinary	5	12⅞-13⅛
—— 6 per cent. Pref.	5	8-8½
London Electric Supply	5	2⅛-2⅝
Metropolitan Electric Supply	10	16½-17½
—— 4½ per cent. First Mortgage Debenture Stock	100	120-124
National Telephone, Ordinary	5	6⅝-6¾
—— 6 per cent. Cum. First Pref.	10	15-17
—— 6 per cent. Cum. Second Pref.	10	15-17
—— 5 per cent. Non. Cum. Third Pref.	5	6-6½
—— 3½ per cent. Deb. Stock	100	105-109
Notting Hill Company	10	15-16
Oriental, Limited, £1 shares	1	1½-2 xd
—— £5 Shares	5	8½-8⅞ xd
—— £4½ shares	4½	7½-7⅞ xd
Oriental Telephone and Electric Company	1	⅞-1
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	102-104
St. James's and Pall Mall, Ordinary	5	15½-16½
—— 7 per cent. Pref.	5	10-11
Telegraph Construction and Maintenance	12	35-38
—— 5 per cent. Bonds	100	103-106
Waterloo and City Railway, Ordinary	8	10⅜-11⅛
Westminster Electric Supply, Ordinary	5	15-16
Yorkshire House-to-House	5	8½-8⅝

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NOTES.

Interurban Telephones.—It may be worth note that Mr. Gavey's paper read last November at the Institution of Electrical Engineers on the trunk telephone system of Great Britain has been reprinted in the *Journal Télégraphique*, of Berne, which is published by the Bureau International. One notices that "jack" in its telephonic meaning has apparently become good French.

The Apostoloff Telephone Syndicate. — The interesting combination of a company meeting and a share auction in which the bidders are not altogether uninterested in getting the shares to a premium did not come off last Friday. There was the meeting all right, but after Mr. Margowski had made a speech the latter part of the programme was not carried out. It was considered better to appoint a committee to enquire into things, and meanwhile to adjourn for consideration. One can hardly doubt the wisdom of this decision.

Search-Lights at Sea.—They have been doing a good deal of work in connection with search-lights in the Italian navy, and are apparently not quite satisfied as to the certainty of always detecting with the light, and subsequently hitting with a gun, everything which tries to pass the beam of light. In the *Rivista Marittima* it is suggested that for shore batteries, at any rate, it would be better to keep the beam fixed so as to illuminate a given space and watch that for the passage of a vessel, instead of attempting in any way to sweep the surface of the water by shifting it.

Regulations in Spain.—There has been a great deal more in the *Revista de Obras Publicas* as to safety rules which are, will be, or, in the opinion of the authors, ought to be enforced in Spain. Some time ago we gave an abstract of the draft rules which seemed most likely to obtain official sanction. It can hardly be said that these erred on the side of severity, and meanwhile it would seem a safe course that what is good enough for France and Germany will be up to the standard of Spain. One has, however, of course, always to reckon with the ideas of the local authority.

Obituary.—Captain Charles William Earle was out riding a bicycle on Monday with his son, near Cobham, in Surrey, when the wheel of his machine caught in a rut and he fell with great force to the ground. He fell on his head and was killed on the spot. Captain Earle was 68 years of age, and joined the 60th Rifles in 1846. Since his retirement from the army, Captain Earle has been connected with several telegraph companies.—Lady Bessemer died on Tuesday at Denmark-hill in her eighty-fourth year. She was married in 1833 to Mr. Henry Bessemer, the inventor of Bessemer steel, who was knighted in 1879.

Personal.—On the occasion of the retirement of Prof. J. D. Everett from the Chair of Natural Philosophy in Queen's College, Belfast, a committee has been formed at Belfast to arrange for a presentation portrait, as a memorial of Dr. Everett's professorship, to be hung in Queen's College. Dr. Everett has occupied the Chair of Natural Philosophy at Queen's College for 30 years. Besides his proper work in physics, Dr. Everett is noteworthy for having made an incursion into the domains of shorthand. He invented a "system" which is rather nice until you begin to write fast with it, but then becomes very nearly as bad as all the other systems.

Electric Burglary.—Some time ago the American papers seriously discussed the possibility of the practical utilisation of electric heating to the opening of (other people's) safes. Scotland-yard is not to be beaten by Transatlantic amateurs, for there they have actually found—or it is said they have—an electric drill which is built to go about disguised as a race glass in a case. It is to be presumed that the burglar does not take his energy with him, but expects to find it in the mains on the premises. It is not stated whether the motor is a direct or alternating current one. It would be a pity for the enterprising investigator of a "crib" in the Strand to be disappointed by any little mistake of that kind. Altogether it is a very pretty tale. The *Daily Telegraph* says that "a great deal of interest, mingled perhaps with consternation, has been excited by the announcement of Scotland-yard's latest discovery." It does not, however, appear that in Victoria-street and other regions inhabited by electrical engineers who have safes worth burgling that there are any symptoms of serious alarm.

Safety Rules in Switzerland.—The prescriptions of the Société des Electriciens Suisse for electric installation and supply have been published in the annual report of that society, and have been reprinted in *L'Electricien* of May 29. The subject has been approached somewhat in the same spirit as by the Verband Deutscher Elektrotechniker, but the rules differ in several ways. There are fifty-one of the rules, but although they are considerably more concise than the German code, there has really been so much of this sort of thing of late that it is out of the question to devote the space to it necessary to give a reasonably full abstract. The naked hand test is preserved for heating, and, in general, the requirements are much the same as in the German society's rules. The formula for the minimum insulation resistance of a lighting installation is, however $(10{,}000 + 2{,}000{,}000/N)$ ohms, where N is the number of lamps, and every arc or motor is counted as though it were 10 lamps. The German rule is $(10{,}000 + 1{,}000{,}000/N)$ ohms. The novelty of the regulations is a provision for the periodic testing of instruments, meters, etc., and the logging of the results.

Refractivity of Water.—From the researches of Mr. Anton Lampa, published in *Wiedemann's Annalen*, it would appear that for electromagnetic waves water shows no signs of losing its high refractive index as the waves decrease in length, as it must do somewhere between the shortest electromagnetic waves and those of the visible spectrum. On the other hand, he has found that there is a falling off of the value of the index for alcohol, which indicates that the decrease across uninvestigated gap, though progressive, need not be absolutely discontinuous. But, then, alcohol does not behave altogether in the fashion of water, so far as conduction is concerned, which makes all the difference. There is nothing in the behaviour of water to the infra-red rays to lead one to suppose that there may not be a period of discontinuity. Some time ago Prof Mazzotto summarised the work of most previous observers, including Lampa, at the conclusion of a description of a series of careful experiments of his own on the refractive index of water, which were communicated to the Accademia dei Lincei. All methods agree so far as to give something between 8·9 and 9·0 for waves measured in decimetres. According to Lampa, the figure for smaller waves than these is higher instead of lower.

Greenwich.—The annual "visitation" of the Royal Observatory, Greenwich, took place last Saturday. Among the visitors were Prof. R. S. Ball, Prof. Adams, Lord Rayleigh, the Earl of Rosse, Prof. Rücker, Sir G. G. Stokes, Dr. Huggins, Prof. George Darwin, and Sir Henry Thompson. The annual report of the Astronomer Royal stated that the building of the north wing and central dome was completed in September last. Under this dome is erected the largest telescope in the world devoted to photography, the 26in. refractor, the

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gift of Sir Henry Thompson. This instrument, completed in April, is already in good working order. The magnetical observations have been made as usual. The mean deviation for the magnet for 1896 is 16° 56′ 5″ west, the result being affected to a certain extent by the iron in the new buildings and in the new altazimuth pavilion. The selection of a site in Greenwich Park for a new magnetic pavilion has caused a good deal of trouble owing to the difficulty of finding a suitable position free from any suspicion of disturbance from iron, and it has been found necessary to choose one at a greater distance from the observatory than was originally contemplated. During the year there were no days of great magnetic disturbances.

Cable Interruptions.—The official list of interruptions on "international" lines last month (up to the 25th), as published in the *Journal Télégraphique*, gives the following as not working at that date: the Assab-Massowah cable, which failed on the 21st, the Parà and Maranhao cable from May 5, the Konakry and Sierra Leone cable from April 28. The Ecuadorian land lines were, as usual, interrupted, but the last date of working was March 13, and also the Santa Catherina and Larissa line from April 7, and the Jamaica and Colon cable from February 5. This is really the list, as the others go back to last year. They are the Amazon cable beyond Obidos (December 7), the St. Croix and Trinidad cable (November 26), the Carthagena and Barranquilla line in Colombia (July 4), and the African Transcontinental beyond Mazoe, March 19, together with two cables whose date of failure goes back over a year and a-half. The repairs include the Assab-Massowah cable on May 5, after an interruption from April 24. As seen above, however, the cable soon failed again. The Benguela and Mossamedes cable, which failed on April 13, was repaired on May 1, and the Perim and Assab cable suffered a two days' interruption, ending on May 11. There are other interruptions in land lines listed, which were, however, repaired forthwith.

Luminous Discharge.—What appears to have been a case of the rather rare and very puzzling phenomenon known as ball lightning occurred at Sheringham, near Cromer, last week. The observers appear to have been too much alarmed to give very accurate accounts, but while a local thunderstorm was going on, according to a provincial contemporary, "the timekeeper at the Sheringham Hotel works had a basket containing a tin in his left hand, and, seeing a bluish light around him, was in the act of turning when he felt a strange sensation in his body, and his right arm became numb. At the same time there was a terrific crash of thunder." In connection with the luminous phenomena sometimes observed on mountains, *Nature* has directed attention to a series of observations of electrical storms on Pike's Peak, Colorado, contained in vol. xxii. of the Annals of the Astronomical Observatory of Harvard College. Luminous jets appeared very often along the telegraph wires for the length of an eighth of a mile, and the anemometer cups looked like revolving balls of fire. Upon touching the anemometer under these conditions, an observer found "his hands instantly become aflame. On raising them and spreading his fingers, each of them became tipped with one or more cones of light nearly 3in. in length." Many more striking effects of this character are described.

The Synchronograph.—What the Americans think of Messrs. Crehore and Squier's method of rapid telegraphing one cannot at present say, since reports of the discussion of the inventors' paper are not yet to hand. Meanwhile the New York *Electrical World* has dealt with its commercial practicability somewhat unfavourably. While it is true our contemporary thinks that such a system would result in a great increase in the capacity of many lines, yet it is doubtful if it would prove as flexible as the methods now in use, or would as readily adapt itself to the requirements of ordinary business conditions. It would seem that in America, when great haste in the transmission of intelligence is required, the long-distance telephone has come to be looked upon as the proper means, since a conversation with an interchange of questions and replies may be had by its agency in much less time than by the most improved machine telegraphic methods conceivable. Whether a rapid machine telegraph can find a field for itself intermediate between these two our contemporary will not prophesy, but it hardly seems likely that business men will be induced to use the rather cumbersome method indicated by the authors for the preparation of their letters, or will universely employ operators skilled in the preparation of such messages.

The Age of the Earth.—Lord Kelvin has been in considerable evidence in London of late. Not to mention publishing an entirely new theory of electricity in the pages of *Nature*, he has discoursed at the Royal Institution, spoken in the House of Lords, and addressed the Victoria Institute. They are serious people there, and would like to make up their minds about certain matters, though how Lord Kelvin's estimate of the age of the earth is going to help them much does not appear clear to outsiders. Lord Kelvin has been known for a long time to hold the opinion that our lady mother is not by any means as old as she looks. Indeed, if there is any virtue in the theory of heat and the integral calculus, she should not be very much over thirty—millions. It is impossible to impeach Lord Kelvin's mathematics, but, after all, the value of what comes out of the mathematical mill entirely depends on one being perfectly certain of having put into it exactly all that one ought, neither more nor less. When it gives warning that something is wrong somewhere by turning out arrangements in infinities or root-minus-ones, it more generally means that the right question has not been asked, or has not been asked in the right way, than that the laws of nature have been suspended. On the basis of Lord Kelvin, however, the Lord Chancellor trampled on the geologists and various other people, and the reporter of perhaps the steadiest and most reliable of our daily contemporaries came away so confused with it all that he mixed up Gallio and Galileo, and made the late Prof. Huxley accuse the latter of caring nothing for physics. What the Victorians thought of this when they came to read it can only be imagined.

Bimetallic Wire.—In reference to accidents from wires breaking, Mr. W. S. Eckert, in the New York *Electrical Engineer*, has taken occasion to again call attention to the possibilities of bimetallic wires. Put shortly, copper is weak in tensile strength and iron rusts. The problem is to combine the two so as to retain their merits and avoid their defects. Bimetallic wire, composed of a steel centre with solid copper surrounding it, seems, he declares, to meet the case, though at some expense of conductivity. "Bimetallic wire, like copper, does not corrode, neither does it stretch. It retains its electrical and mechanical qualities always, as shown by the experience of the Postal Telegraph Cable Company with wire of that description, put up in 1883, and which, according to reports of the officers of that company, tests as well to-day as it did 14 years ago. The conductivity of bimetallic for the transmission of direct current is, substantially, 65 per cent. of that of solid copper of equal diameter; its strength, practically four times its weight per mile." Telegraph, telephone, and other wires must necessarily be carried over tramway-

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wires at many points, and such wires are always liable to be broken in storms or by other wires or objects falling upon them. To minimise the danger of falling wires, it seems best to strengthen the wire. (The "object" that will break a wire at all is usually so heavy that it will break down any wire. Say, a tree, as at Coventry, or a post, or a chimney.) Lastly, bimetallic wire, possessing about 50 per cent. of copper, is cheaper than copper wire. And so the end of Mr. Eckert's eulogy.

The Mining Engineers.—The twenty-fourth genera meeting of the members of the Federated Institution of Mining Engineers opened at the Royal United Service Institution, Whitehall, last week, Mr. Lindsey Wood, the president, being in the chair. The Chairman delivered the presidential address, in the course of which he said that since the formation of the institution, eight years ago, the number of members had increased from 1,239 to 2,382. Mr. Wood drew a comparison between the cost of production of coal in 1865 and 1895, pointing out that in the latter year the increased cost of the above and below ground labour necessary to produce a similar quantity of coal to that raised in 1865 was £3,630,000. This increased cost was no doubt largely due to the legislation which had taken place with reference to mines as well as to the combination of workmen. The five special Acts of Parliament passed since 1851 for the regulation of mines had all been the means of increasing the cost of production of coal. He thought it would be well for the Government of this country to look carefully into what would be the future result of the continual increase of taxation on the future working of coal mines, on which the prosperity of our great manufactures so largely depended. Already, owing to the increased cost, many of the thin and hard seams of coal were having to be abandoned, and when once abandoned they would in all probability never be capable of being reopened on account of the incalculable injury done to them by the accumulation of water and the crushing they received during abandonment. Mining engineers of the present day were using great energy, perseverance, and determination to reduce the increased cost by greater scientific knowledge, the application of mechanical appliances, and improved machinery.

Electric Traction on the Railway.—The New York *Electrical World* says that the recent test of the third-rail system on the tracks of the New England and New York, New Haven and Hartford Railroads, between New Britain and Hartford, exhibits no new features and demonstrates nothing of electrical importance, but possesses great interest as the first serious attempt at the operation of trunk-line railways by electricity. The importance of the event in another way is not less great, for it shows that the management of a great system of railways in America has concluded that electric traction is likely to prove an advantageous way of working interurban trains on short runs. The experiment is really only a continuation of that begun at Nantasket Beach by the same railway company, but upon a larger scale and under more practical conditions. The New York *Electrical Engineer* goes further. "If merely for the sake of argument," says our contemporary, "we acquiesce in the opinion of steam railway managers, that through business will for an indefinite period continued to be performed by steam locomotives, we nevertheless believe that enough has already been demonstrated to show that local traffic is gradually but surely drifting in the direction of electric traction on present steam roads." The ready manner in which the change can be carried out by means of the third rail is self-evident, and it is argued that once the change is begun, a section or division of a railway electrically equipped for local traffic must by the sheer force of circumstances and economy in operation be finally forced to abandon the steam locomotive entirely, and that in reality the through electric trunk line is not so far off as railway managers honestly believe it to be. It would seem that in the experiments made on the newly-equipped line the speeds obtainable were as high as, if not higher than, those reached by means of steam locomotives.

The Marconi Telegraph.—Last Friday Mr. Preece discoursed at the Royal Institution before one of the largest audiences of the session, and the pretty little arrangement of coherer and relay in the box containing Mr. Marconi's receiver is no longer to be called even an open secret. Mr. Preece's discourse will be found in full elsewhere. When it came to the demonstrations, however, he naturally left the prepared lecture and discoursed at large. It was amusing, for instance, to see him assume the manner of a conjuror and assure the audience that there was no deception. He humorously defied Lord Kelvin, who was sitting immediately in front, as to the value of mathematics in making discoveries and as to the nature of electricity, and professed that his difficulty in reading and pronouncing Scottish names was optical and not linguistic. All this sort of thing would read but flatly in print. Behind the lecture table with Mr. Preece were two or three young gentlemen. About a third of the way through the lecture it came as a sort of surprise to the greater part of the audience to find that the most thoroughly English-looking of them was Mr. Marconi, of Italy. The mention of his name was the occasion for something more than the usual well-mannered applause of the Royal Institution theatre. Neither the transmitter nor the receiver are exactly the kind of apparatus that lend themselves to demonstration on the lecture table. One had, however, an opportunity of examining the transmitter in the library, and sparking it if one pleased. It is noticeable that the oil in the spark-gap acquires the odour that is familiar to some in connection with the lubrication of commutators. As to the receiver, it may be added that the proportion of nickel to silver is 96 : 4, with just a trace of mercury. Mr. Preece says he does not know at present how far he can signal with the apparatus. It is, however, to be tried forthwith for communication between the South Foreland, which gives a convenient elevation, and the light-ship at the south of the Goodwins, and it is also intended in this manner to put Sark into communication with the ordinary telegraphs of the country in the course of the present summer. Telegraphic communication with that island, which is desirable for several reasons, is indeed practically impossible in any other manner, for it is not big enough to carry the long induction line necessary to get signals by that method from Guernsey, and the cost of a cable would be simply prohibitive, even if it did not get chafed through on the rocky and current-swept shores about twice a fortnight. There are one or two purely theoretical points in connection with Mr. Preece's discourse, but these will be better by themselves in another note.

The Mechanical Equivalent of Heat. — Prof. Osborne Reynolds's Bakerian lecture read before the Royal Society dealt with the mechanical equivalent of heat, and was practically a description of the results of a new determination of it, in which the Reynolds hydraulic brake was used. The undertaking was the result of the occurrence of circumstances which afforded an opportunity such as might not again occur. This consisted in the facilities offered by the appliances which formed the original equipment of the Whitworth Engineering Laboratory, in 1888, the more essential of these being an engine of 100 h.p., working one of Prof. Reynolds's hydraulic brakes. This

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brake maintains any constant moment of resistance on the engine shaft, independent of the speed, all the work done being converted into heat, which appears in the rise of temperature of a steady stream of water flowing through the brake, the magnitude of which stream is independent of the load on the brake or the speed of the engine, and is under independent control. Besides this, in the Manchester town water there was an abundant supply of a purity expressed by three grains of salts to the gallon, conveniently distributed in the laboratory. If it is arranged that the water enters the brake at the temperature of melting ice, and leaves it at that of water boiling under the standard pressure, or very near it, since all that would be required of the thermometers would be the identification of these temperatures—and with a range of 180deg. the error in scale over one or two degrees would be comparatively of small importance—the usual difficulty of being certain of the correctness of the thermometer scales is eliminated. It would be impossible in any reasonable amount of space to give any details of the appliances or the precautions adopted. Not counting preliminary work, the research which was carried out by Mr. W. A. Moorby occupied about two years. In all 52 trials were included in the final result, and from these 25 separate determinations were made of the equivalent (subject to certain general corrections), which gave a mean value 777·91, and from this none of the separate determinations differed by as much as 0·2 per cent., and the greatest divergence from the mean was 0·05 per cent. It was found impracticable to eliminate entirely from each determination the losses of heat due to radiation, conduction, leakage of water, etc., and so it was found advisable to determine what these losses were. This information was given by the trials themselves, and the necessary corrections were applied to each separate determination, but on the mean value of the equivalent determined, without taking these errors into account, the error was only 0·0192 per cent. Eight final corrections, which had the same values for all trials, were made to the mean value of J, already given. Their total effect was to introduce a correction factor, which brings the mean corrected value of the specific heat of water between freezing and boiling points, as measured in mechanical units at Manchester, to 776·94. It may be remarked on this that since we emerged from the dark ages with 772, there has been a steady tendency to increase it. J is more than old enough by this time to have done growing. In practical work most of the quantities affected are not measured with such extreme accuracy that the existence of a small known error is of much importance, and when everybody is quite agreed as to what the precise figure should be, it will be time to consider what we are to do with our old tables. Meanwhile, 777 is a nice convenient figure to remember—which is something, anyway.

The Theory of Ions.—A couple of important papers by Mr. Holland Crompton relating to the theory of electrolysis and the ionic hypothesis generally have been read before the Chemical Society and published in abstract. Mr. Crompton finds that Van t'Hoff's law, that the osmotic pressure of the dissolved substance is the same as the theoretic pressure of the same volume if it were the gaseous state, is applicable when both the dissolved substance and the solvent form normal or monomolecular liquids. It may also apply if both liquids are associated; but if the dissolved substance is associated and the solvent is monomolecular the osmotic pressure is then smaller than the theoretical, and becomes inversely proportional to the factor of association, x_1, of the dissolved substance. If the solvent is associated and the dissolved compound is monomolecular, the osmotic pressure is greater than the theoretical, and is directly proportional to the factor of association, x, of the solvent. If the solvent has also an abnormal vapour density, the factor of association of the vapour being a, the osmotic pressure is directly proportional to x/a. Following out these conclusions it is shown that exceptions to Van t'Hoff's formula for the molecular reduction of the freezing point appear whenever association of either the dissolved substance or the solvent takes place, and that the exceptions observed in the case of electrolytes in aqueous solution are in keeping with the view that electrolytes are monomolecular compounds in solution in an associated solvent—*e.g.*, the water. It is contended that the hypothesis of electrolytic dissociation is not only unnecessary in explanation of these exceptions, but is inconsistent with what is now known of the molecular character of liquids. A connection is supposed to exist between the specific inductive capacity of a liquid and its power of promoting electrolytic dissociation. The author shows that it is only associated liquids that have high specific inductive capacities, and that the specific inductive capacity is approximately proportional to the cube of the factor of association of a liquid. It is, therefore, not on the degree of electrolytic dissociation of the dissolved substance, but on the degree of association of the solvent, that the conductivity depends, and the view is taken that electrolytes are salts in the monomolecular fluid state in solution in associated solvents. The second paper points out that the fact, which is usually quoted as strong evidence in favour of the hypothesis of electrolytic dissociation, that salts which contain a common optically active ion—either positive or negative—exhibit, in sufficiently dilute aqueous solution, the same equivalent rotatory power can have no bearing on the point because the same thing is exhibited by the amylic salts of certain organic acids, when these are examined in the free state and not in solution. As electrolytic dissociation is in this case entirely out of the question, the hypothesis becomes an unnecessary one in other instances. There was some discussion, in which Mr. Pickering, Mr. Whetham, and Dr. Shields took part. Mr. Whetham thought that while the theory that the ions were free from each other agreed with the observed fact that the conductivity of a dilute solution varied as the concentration, on the alternative supposition, that the ions worked their way through the solution by means of a continual series of interchanges between the opposite parts of molecules, the result would be different. The frequency of such collisions, and therefore the ionic velocities, would vary as the square of the concentration, and, since the conductivity depended on the product of the number of ions and their average velocity, it would be proportional to the cube of the concentration—a comment which is hardly as formidable in reality as it seems.

Wireless Telegraphy.—Apart from the subject itself, there are one or two points which come up incidentally in connection with the discourse at the Royal Institution last week which are interesting. The first is what may be for convenience called Mr. Preece's law (though it is probably not a law, but a rough general approximation to work to), that in induction signalling without resonance the parallel wires must be of not less length than the space to be signalled across. With two parallel wires of great length the effect should vary as the inverse of the distance (not the inverse square), and this obviously agrees with the condition that to maintain the strength of the signal, the length of the wires must be increased with the distance between them. The frequency is 260 per second, but "good signals depend more on the rapid rise and fall of the primary current than on the amount of energy thrown into the vibration."

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It would follow that if the successive impulses are to be treated as wave motions at all, it must be as practically analogous to "solitary" waves. The precise behaviour of these is hardly as yet to be considered common and familiar knowledge, but one of their most striking differences from the ordinary succession of short waves is that the diffraction is very large, and it is not very difficult to see that in such a case the original simplicity of the cylindrical wave front, and all that follows from it, cannot be maintained when the distance from the originating wire is considerable compared with its length. On the other hand, in the Marconi or any other Hertz wave system, where small waves are used, and plenty of them, the principle of resonance comes in to compensate for the more rapid decrease of the amplitude. The strength of the individual wave at the receiver may be unthinkably small, but the system, if properly "tuned," will accumulate the energy of a long succession of them, while as for the coherer it is incredibly sensitive but nobody at present pretends to have more than a rough general idea of the theory of it. Mr. Marconi's way of making that exasperatingly unreliable piece of goods run steadily in harness by never allowing it to have its head for a longer time than it takes the tongue of his relay to move, is beautiful in its simplicity. That and the Righi transmitter seem the secret of his success. As to the latter, Mr. Preece explained the double reason for taking the spark in oil. That the spheres should be better solid than hollow will appear most strange to those who are fondest of looking at things in the statical way. High frequency is fertile in pretty paradoxes as to the relative behaviour of conductors and dielectrics. Mr. Preece said that if he succeeded in making the receiver sound when he had enclosed it in a cubical iron tank with a close-fitting lid, all electricians would admit that there was something wrong somewhere, and that, therefore, there was something left for investigation. It must be remembered, however, that we have here neither very long nor very short waves. The wave-length was of the same order of magnitude as the tank itself, and much larger than the thickness of the conducting walls, while the receiver is a more sensitive affair altogether than the apparatus which are used to show the damping effect of a conducting plate on the induction in the case of the comparatively slow reversals of an ordinary alternating current. It is noteworthy that the signalling across the Bristol Channel was done in very bad weather, and was unaffected by rain. On the other hand, the higher up you get the better the signals go, which looks at first sight as though there was reflection from the surface of the sea or land. In moderation they will go through (or round) a hill. The secrecy of the signals, and the possibility of working several independent transmissions at once, depends on the accuracy with which the receivers should be "tuned." These and other matters, including the limit to which in practice the distance of signalling can be extended by simply increasing the size of the transmitting apparatus, are among the points which Mr. Preece spoke of as requiring to be threshed out by actual experiment.

Motorcarts.—It is exasperating to offer a thousand guineas or so as a reward of merit, only to find that of the particular kind of merit selected there is really so little in existence that it is quite impossible to give anybody a prize at all. Our contemporary the *Engineer* sums up the result of its competition in a long leader. One begins with high hopes and good intentions. "For a time all went well, no fewer than 72 entries were made." When it came to the point, five vehicles appeared, and the judges found none that they could anyhow give a prize to. The result shows that there is no such thing as a motorcar industry in this country, and "no such thing as a thoroughly satisfactory self-propelled vehicle." Then we come to particulars. The oil-engine is not suitable in its present form. Mr. Roots showed two vehicles propelled by "heavy" oil engines. Both produced a nuisance in the shape of petroleum fumes. A motorcar to be used in a large town must be absolutely inoffensive. It is in overlooking this truth that the sanguine inventor comes to grief. "The heavy-oil engine is impossible, and it is impossible because complete combustion cannot be effected by any expedient yet devised. But this is not all. The oil-engine is very uncertain in its action; it is intolerably noisy, and, in a word, quite unsuitable to the intended purpose so far as towns are concerned." The "spirit motor" is little better. "It works almost—not quite—without smell. But even if we overlook the circumstance that it uses an excessively dangerous liquid, we have to face the fact that the whole machine needs skilled attention, and that no van or vehicle capable of doing really heavy work on the system has yet been made, while the powers of the more or less ugly toys which have been turned out hitherto are so small that trifling hills cannot be surmounted with certainty." After remarking that Coventry sent no machines for the supplementary prize, we come to steam and electricity. Two vehicles were highly commended by the judges—namely, the electric tricycle car, shown by Mr. Blackburn, and the steam van of the Liquid Fuel Company. "The electric car is an ideal motor carriage; no dirt, no smell, no noise; steered by a pair of reins; its power adjusted by a slight motion of the seat beneath the driver. It was enough to see this vehicle running quietly about the grounds, up hill and down, without the smallest hesitation or trouble, to be convinced of its merits. In the details of its mechanism it is simplicity itself; but, alas! it has the fatal defect that it cannot store electricity enough for a run of more than about 20 miles. Yet even with this limitation it is difficult to believe that there is not a future for the electric motorcar." The steam van was beautifully made, "the workmanship is superb; but it has the great defect that it can only be driven and managed and kept in repair by a skilled man. The driver has no fewer than seven handles by him, all needing attention, to say nothing of several others which may be regarded as emergency cocks and valves." "So far as we can learn, it has hitherto always been driven by one man and steered by another sitting beside him. How far such conditions are likely to satisfy the desires of a draper or a grocer our readers must judge for themselves." Moreover, though, while this van is running it is fairly silent, but when standing there is the continual muffled roar of the petroleum flame going on, and when starting a dense cloud of steam is given off until the van is fairly under weigh. Such a vehicle might very readily be offensive in the streets. The final conclusion is that a new departure must be made by designers of motorcars. "The motorcar has yet to be made. It may be that it has not as yet been invented. . . . It must not be forgotten that what will satisfy our French neighbours will not at all satisfy public opinion in this country, which is much more exacting. And then after all comes the question—are motorcars wanted?" It is evident that the cold-fit stage of the motorcart fever is strong upon us. There is one more competition to take place besides the *Engineer's*, but the result does not seem to promise to be in any way different. In fact, only three entries have been received for the prizes offered by the Royal Agricultural Society for self-moving vehicles. The trials of these machines, if they go to trial, should now be taking place in the neighbourhood of Crewe.

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THE MECHANICAL CONSTRUCTION OF ELECTRICAL MACHINERY.

BY F. M. WEYMOUTH.

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THE DYNAMO.

(Continued from page 725.)

Bearings (continued).—In Figs. 216 to 219 herewith is shown a bearing containing features other than those on which we have already commented. This is a design by

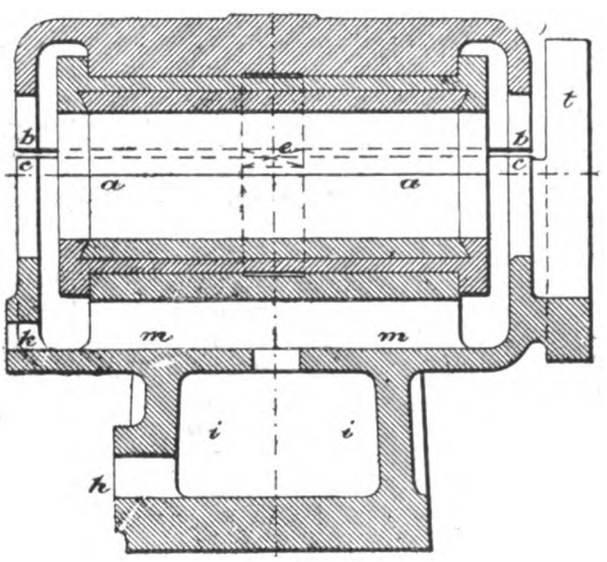

FIG. 216.

Messrs. Ernest Scott, Mountain, and Co., Limited, of Newcastle-on-Tyne, and we have to thank that firm very much for the drawings of which our present illustrations are a reproduction.

The most noticeable point here represented is perhaps the circular base, as indicated clearly in Figs. 217 and 219. Of these the latter shows the bearing fitted in the dynamo or motor bed-plate. This base, together with the rest of the machining of the bearing, is bored and turned concentric with the shaft axis, and thus the alignment of all

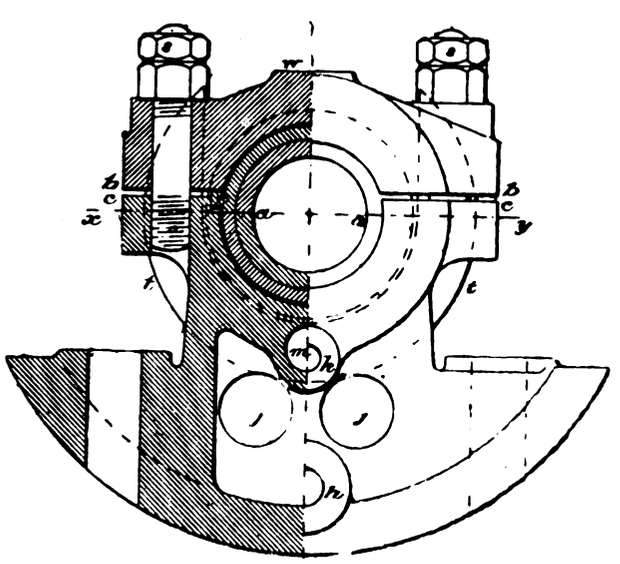

FIG. 217.

these parts is assured from the outset, and steady pins in the base are not needed. A tap-bolt on each side, screwing into the bed-plate, serves to hold the bearing in place, as shown.

Differing yet further from any previous bearing we have discussed, it will be observed that the opposing faces of the cap and the base, as at *b b* and *c c*, are formed right across at levels higher than the horizontal centre line, *x y*. The brasses being parted on the centre line, as at *a a*, the lower corners of the upper brass become engaged with the base, as in a plummer block, and the upper brass is thus steadied endways. To prevent the rotation of the brasses, snugs, as at *e*, are cast on each side of the upper brass, which are made to fit small recesses, as at *d*, in the base. The upper brass is also steadied sideways by the fact of the two jaws of the base rising above *x y*; and thus the cap has little to do beyond merely holding the upper brass down and retaining the shaft in place. The brasses, as may be observed, have a somewhat thick lining of anti-friction metal, which is carried all round the circle.

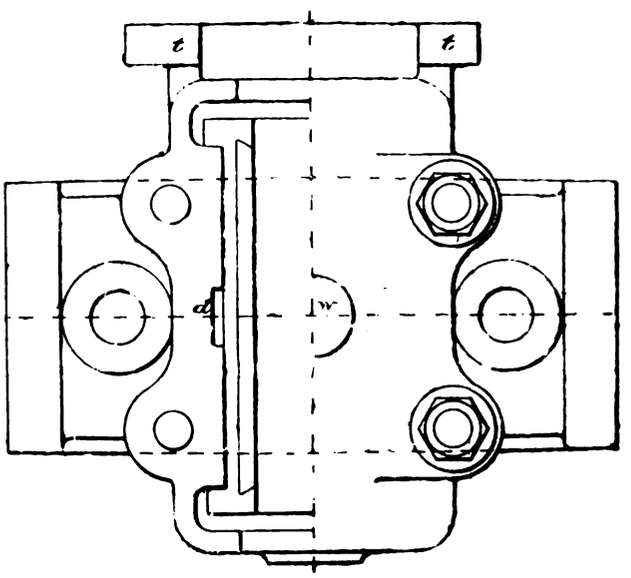

FIG. 218.

It would seem in this bearing that the hoods are turned or bored out on the inside, which is, of course, necessary so as to secure a fit for the flanges of the brasses, and it also affords clean surfaces whereon to catch the waste oil. This latter is drained away by a passage, *m m*, cored beneath, as in Fig. 205. It thence drips through a hole into the chamber, *i i*, below, from which it subsequently escapes by a bent pipe at *h*, and is caught in a trough or can, *n*, outside, as illustrated in Fig. 219. Apparently it is optional to effect the draining by the hole, *k*; but this hole will also facilitate the cleaning out when needful of the passage, *m m*, and will usually therefore be kept plugged. Other holes, *j j*, are required for extricating the core from the chamber, *i i*, after casting: and they also, requiring to be cored themselves, assist the support of the core of the

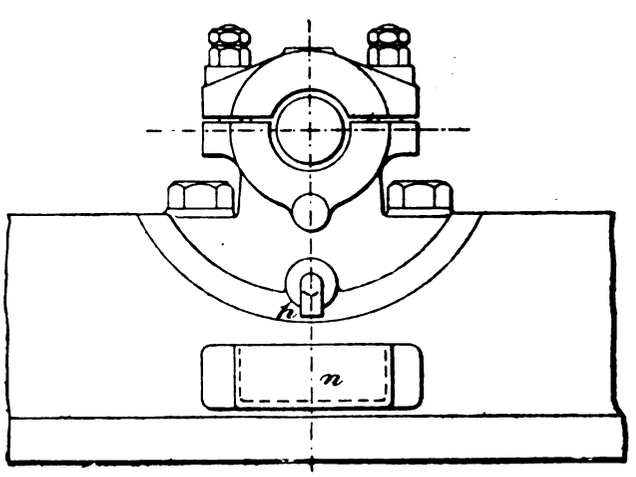

FIG. 219.

chamber, *i i*, in the mould; and the cores for these holes and the chamber may, in fact, be made all in one. The holes, *j j*, can then, of course, be closed permanently by hardwood plugs or other material driven in tight, and made flush on the outside so as not to show perceptibly when painted.

Means of lubricating are not represented in these drawings; but the facing, *w*, indicates sufficiently that this is

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carried out by a drilled tap-bolt, as was depicted in Fig. 200, or other such means.

This bearing is intended for the commutator end of the machine, and is thus required to carry the brush gear. We hence find here that instead of an annular groove being formed on the bearing, as was shown in Fig. 192, for this purpose, two horns, *t t*, rise from the base, the outer periphery of which form part of a circle, as shown. The base ring of the brush rocker, therefore, has to be made in two halves (as was the case with Fig. 192), but with a groove inside, so that it may fit on the outer periphery of the horns, *t t*, and be capable of rotation thereon round a centre in the axis of the shaft. It will be noted that the reason of the horns, *t t*, not being joined across the top, so as to complete the circle, is to facilitate the moving of the shaft in or out of the bearing: for with a complete ring at *t t*, the bearing would need to be passed over the shaft end, and much of the advantage of the cap would be lost.

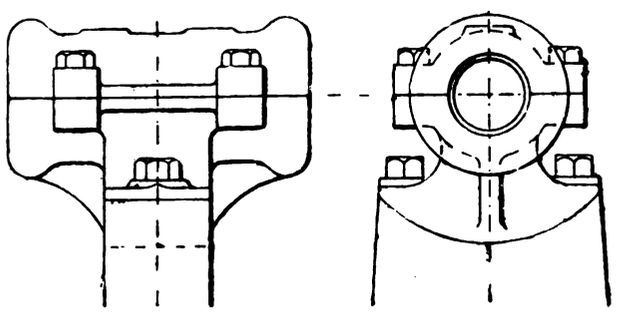

FIG. 220.

In the practical working of this bearing, the form of the cap, with the gap between *b b* and *c c*, and the use of lock-nuts, *s s*, indicate that this cap is not necessarily bolted hard down; but the nuts and cap may be adjusted so as to give the upper brass merely a requisite pressure on the journal, as was explained in connection with the plummer block, Fig. 200. The end of the shaft projects beyond the bearing, which is convenient for taking the speed by means of a small revolution counter pressed against the shaft centre.

Fig. 220 shows a bearing, similar to the foregoing as regards the circular base, fitted on the top of a pedestal. This is approximately a design by Messrs. F. H. Royce and Co., Manchester. It is also held by a tap-bolt each side.

Our purpose generally will be best served if we now glance at a variety of bearings, such as are subjected to ordinary methods of lubrication, before proceeding to those which are self-oiling. Thus Fig. 221 herewith is a design containing some further features of interest, and is taken

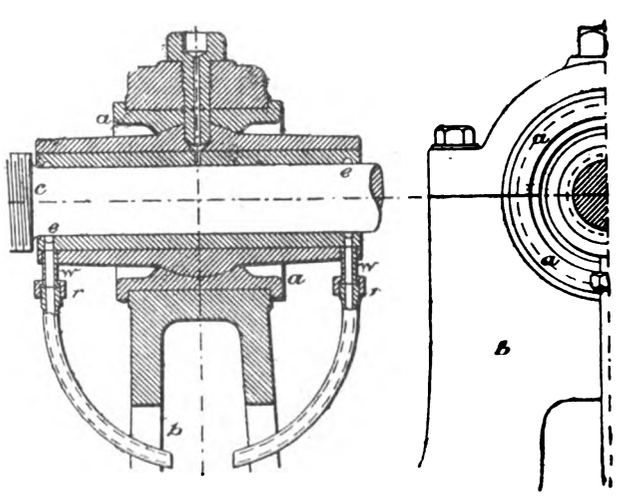

FIG. 221.

from a Blakey-Emmott machine illustrated in Prof. S. P. Thompson's "Dynamo-Electric Machinery," fourth edition. This will be observed in the first place to be a true spherical bearing, having a spherical seating for the sleeve, in contradistinction to the cylindrical seating shown Fig. 192. The seating is formed inside brasses, *a a*; and it will thus be noted that the making of the brasses forms extra work as compared with the mere boring of a cylindrical seating. At this juncture, however, it may be as well to reiterate that it is usual in practice, with the cylindrical seating, not to turn a true sphere on the sleeve, but to use flatter curves, as was shown and explained in connection with Fig. 197: it is also, then, not unusual to term such bearings "swivelling bearings," whereby they are distinguished from the true spherical bearing, although they retain its more important advantages. Referring still to Fig. 221, it will be perceived that the lower half, *b b*, of this bearing forms part of the pedestal cast on the bed-plate: in this respect, therefore, this arrangement is not comparable to a plummer block. It may doubtless save expense only to fit a cap, instead of having to make a complete bearing quite separate to stand on a low pedestal. But this question, as has been pointed out, affects the facility of removing the armature. In the present case the bearing forms part of an alternator with multipolar magnets, of which latter the upper half lifts off bodily, leaving the armature to be similarly dealt with if needful on the removal of the bearing caps. It is to be noted, however, that the metal about this bearing, forming as it does part of a large casting, becomes very thick and heavy.

In the swivelling bearing shown Fig. 192 there was no end thrust from the shaft, and the whole longitudinal steadiment of the shaft was assumed taken up by another bearing, such as that illustrated Fig. 205. Sometimes, however, in practice, the shaft is steadied between two bearings, a shoulder working against each. Such is the case in Fig. 221, where there is end thrust at *c* only, the bearing at the other end of the shaft doing duty in the opposite direction. This end thrust may thus seem to justify the spherical seating, inasmuch as this latter offers in some degree a direct horizontal abutment. This is a matter of judgment in particular cases: but we shall illustrate shortly a "swivelling" bearing designed to take the whole duty of steadying a shaft endways. Such thrust is, of course, usually only of a comparatively light and intermittent nature, and not a heavy positive load.

The oiling in Fig. 221 is effected by a drilled tap-bolt, whereof the hole may be drilled into the spherical parts, with the shaft temporarily in place to secure the alignment of the bush. A peculiar feature with regard to the waste oil is that in order to catch this, a groove, *e e*, is turned out near each end of the lining of the sleeve; and there are no specific means for throwing the oil off the shaft. The intent of the groove is to stop the superfluous oil before it reaches the end of the bush. It is thence led away by pipes as shown, from which it drips to the bottom of the pedestal. These pipes are detachable by means of union joints, *r r*, which permit of their easily being cleared inside if choked.

Enlarged detail views showing two varieties of such union joints are added herewith, Figs. 222 and 223. In the former the two tubes to be connected, *a* and *b*, have each a flange brazed on to them, that on *b* having some width, as shown, and a larger diameter than the other. This large flange is screwed to fit the nut *c*, which latter engages the small flange on *a*; and the nut rotates freely round *a*. The pipe *b* being held to prevent its rotation,

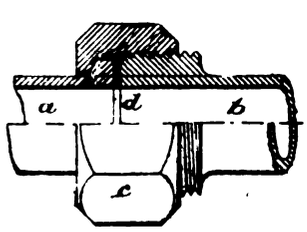

FIG. 222.

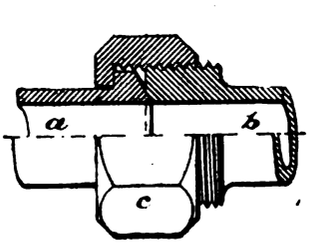

FIG. 223.

screwing the nut round will bring the flanges together; and with a spanner on the nut the joint may be made as tight as desired. In Fig. 222, a leather washer, *d*, shown solid black in section, is added as a further safeguard against leakage. The variation, Fig. 223, shows the pipes with their flanges cast on; and there is a coned joint, as depicted. This latter is used sometimes with small steam-pipes, and obviates the use of the leather washer, which is

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liable to wear with usage, or perhaps get lost under circumstances when not easily replaced. The methods may of course be mixed by uniting a copper or brass pipe with a brazed flange to a tube with the flange cast on. In any case the further end of the tube, *a*, must be left free for slipping on the nut. Thus in Fig. 221 the nuts will be put on the small tubes, *w w*, before these are fixed into the bush.

(To be continued.)

THE LOCAL DISTRIBUTION OF ELECTRIC POWER IN WORKSHOPS, ETC.

BY ERNEST KILBURN SCOTT.

PART II.

(Continued from page 719.)

Figs. 14, 15, 16, and 17 are curves showing the relative *speeds, prices, and weights of single-phase, polyphase, and continuous-current motors*, ranging from about 5 h.p. to 90 h.p. The plain dotted lines represent Messrs. Brown, Boveri, and Co.'s single-phase motors, and the full lines the same firm's two and three phase motors; whilst the black dots are values of the Oerlikon three-phase motors, as made by the General Electric Company of Manchester. To compare with these, the dot-and-dash curve gives the values of the Brush-Falcon continuous-current motors, a line of machines which the writer designed for the Brush Company about five years ago. The crosses are three-phase motors sold in this country by the Electrical Company, Limited; and the circles are multipolar continuous-current motors sold by the same firm.

Fig. 14 shows the *relative speed curves*, and it should be noted how the speeds of the alternate-current machines zigzag about. In getting out particulars of continuous-current plant, the designer need only know the voltage and number of amperes; but with alternate-current apparatus, it is also necessary that he should know the number of periods or cycles per second. With motors, the periodicity is of the primest importance, because, just as in the alternator the number of periods per second is calculated from the number of poles and the revolutions, so in the motor, the number of its revolutions is obtained from the number of poles and the periodicity. Inasmuch as a motor can only have an even number—2, 4, 6, 8, etc.—of poles, it follows that for a given periodicity only certain fixed speeds are possible. For example, with 50 periods per second, the speed would be

$$\text{revolutions per minute} = \frac{\text{alternations per second} \times 60}{\text{number of poles}};$$

$$\frac{50 \times 2 \times 60}{2} = 3{,}000 \text{ revolutions a minute for a two-pole}$$

motor, 1,500 for a four-pole, 1,000 for a six-pole, 750 for an eight-pole, and so on.

The curves are got out for 60 periods per second for the Brown motors, and 50 periods for the Oerlikon and the Electrical Company's machines. The higher periodicities of 83 and 100 per second, in common use in this country, would necessitate higher speeds than those shown, and the motors would be less efficient. Thus, in the Oerlikon list of 110-volt single-phase motors—at 42 cycles, a 9-h.p. machine runs at 1,200 revolutions, and absorbs 110 amperes; at 85 cycles it runs at 1,600 revolutions, and takes 120 amperes; whilst at 100 cycles the figures are 1,450 revolutions and 125 amperes, the starting current being 80 amperes.

Intermediate speeds can only be attained by alteration of the periodicity—that is, the speed of the generating unit. It will therefore be seen that for latitude in design, or where exact speeds are required, the continuous-current motor is by far the most convenient. This question of periodicity threatens to be a great bugbear in alternate-current work. Almost every manufacturing firm has a favourite periodicity, and it is sometimes amusing to hear the arguments why they adopted 66 periods instead of 50, or why 42 is preferable to 83, and so on, when anyone with half an eye can see they adopted it principally to be different to their neighbours. One thing is certain, that if ever alternate-current motors are put up for auction (begging any touchy reader's pardon for suggesting such a thing) the number of prospective buyers will be limited to those who are fortunate to own generating plant of the right periodicity.

Fig. 15 gives the *list prices* of the various machines, and it will be noticed that the prices of the Brown single-phase machines average about 28 per cent. higher than the same maker's two or three phase motors, whilst the latter almost corresponds with the continuous-current machines.

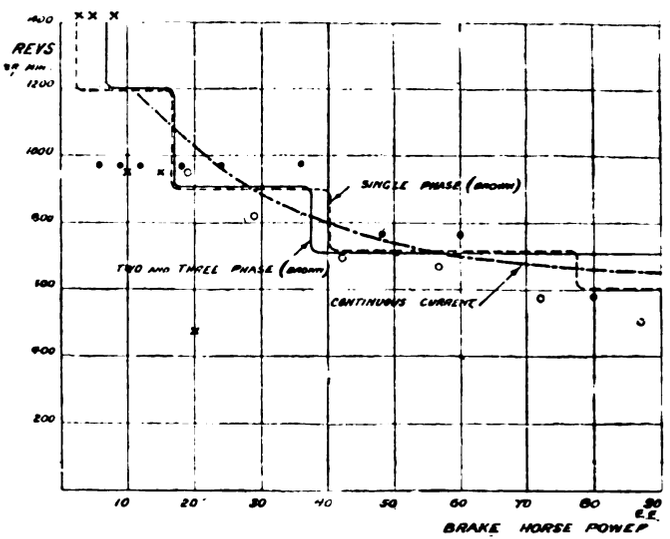

FIG. 14.—Revolutions per Minute of Continuous and Alternating Current Motors.

Messrs. Brown, Boveri, and Co. find that two and three phase machines give equally good results as regards output, power, and efficiency. In fact, they use exactly the same patterns in the two types for the same output, only varying the winding arrangements. When the same carcase is wound for single phase, it will only give about two-thirds of the output, and the efficiency, too, is considerably lower.

It will be noticed from Fig. 16 that the *prices of the starting apparatus* vary considerably, the prices for the larger sizes (above 24 h.p.) of the Oerlikon motors being too high to go on the paper. The prices of the continuous-current starting switch and resistance, and also a spare commutator, are about the same, so that the dot-and-dash curve is interesting as showing the relative cost of the commutator to the whole machine. In the smaller sizes, the cost of the commutator is about 7½ per cent. of the whole, whilst in the larger sizes it is only about 5 per cent.

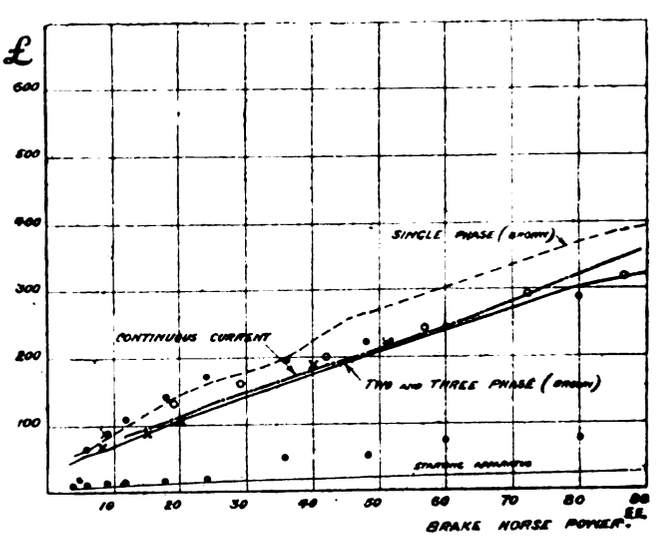

FIG. 15.—Prices of Continuous and Alternating Current Motors.

The last curve sheet, Fig. 17, gives the *respective weights* of the different machines; the top continuous-current curve being gross weight, whilst the others are net weights.

In practice, it is probable that the total amounts of wire in polyphase alternating and continuous-current motors for the same output and speed would be about equal; because, although in the alternate-current machine the winding is simpler, there not being so much dead or non-effective wire,

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yet the cross-section of copper is larger. The total amount of insulation is also greater, on account of the stress tending to break it down being higher for the same effective voltage.

There is, however, more *laminated iron* in the alternating motor, as both the stationary and rotating parts must be laminated; whilst in a continuous-current machine, the magnets, which form the greatest part of the weight, are of solid cast steel or wrought iron, and the rotating armature only is laminated. With regard to the other parts of the machines—the bearings

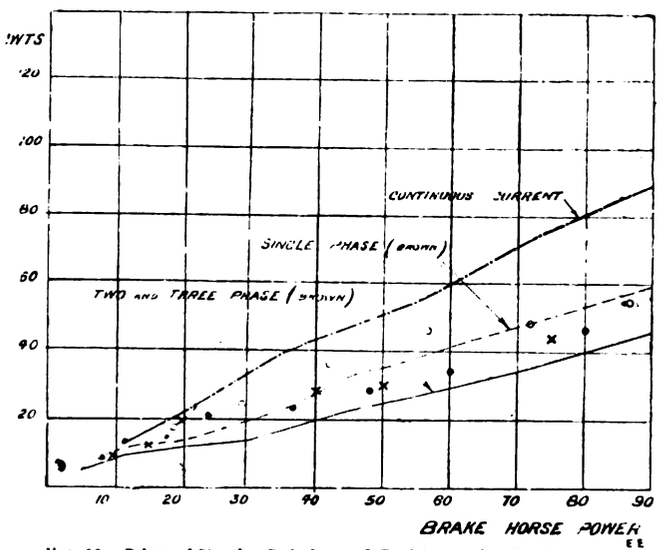

FIG. 16.—Prices of Starting Switches and Resistances for Continuous and Alternating Current Motors.

and bed-plates—it is almost impossible to make a comparison which is worth anything, because the practice of different makers and different countries varies so much in these matters. In England we go in for a much stronger construction than is customary on the Continent, and, therefore, a general statement that the weight of a polyphase motor is 50lb. per horse-power, whilst our English continuous-current machines average 80lb., is almost meaningless as a comparison. A 15-h.p. single-reduction, enclosed tramway motor, such as is made by, say, the General Electric Company of America, probably represents the most power in least room, and for least weight; and when makers of polyphase motors can turn out a motor which shall work as satisfactorily under exactly the same conditions, and yet weigh no more, then indeed will the advocate of continuous currents have to change his coat.

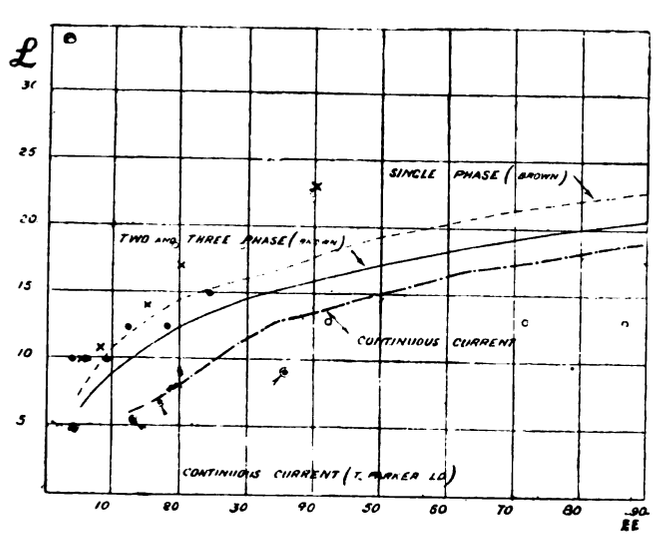

FIG. 17.—Weight of Alternating and Continuous Current Motors.

Mr. C. P. Steinmetz has designed what he calls the monocyclic system, by which it is sought to obtain the advantages of a polyphase system for motor purposes, combined with the ease of regulation of a single-phase system. Although called monocyclic, it is really a three-phase distribution: two of the phases being nearly in opposition, while the third phase, which is about at right angles to the other two, is used for starting the motors. If lamps as well as motors are used, no unbalancing can occur (as with the ordinary three-phase system), because they are both on the same circuit.

All the motors mentioned so far have been more or less of the Ferraris class, with rotating magnetic field, and by far the largest number of motors which are on the market have this feature; they include the Brown, Oerlikon, Tesla, Dobrowolsky, and Ganz.

There is another type of motor which differs radically from the above, in that there is no rotating field. Such a motor is the Stanley-Kelly-Chesney, and that designed by Rankin Kennedy. Not many of this type have been made, however.

(To be continued.)

ROLLER BEARINGS.*

BY WILLIAM BAYLEY MARSHALL, M.I.C.E.

The constantly increasing application of roller bearings to rolling-stock and other purposes, and the advantages claimed from such applications, have excited so much attention that the author feels no apology is needed for introducing this subject to the institution. It is certainly somewhat strange that although full knowledge of the advantages of rolling motion when applied to tractive purposes has existed for centuries, as illustrated by the use of wheels for transporting heavy loads, it is only within quite recent times that any serious attempt has been made to introduce the same movement between the axles or journals of such wheels and their bearings. To realise the importance of easy traction, it is only necessary to consider the vast sums of money which have been expended in producing surfaces favourable to traction by rolling motion, as exemplified by the railway, tramway, and road systems of this and other countries. It would therefore appear that, if by the introduction of roller bearings to the journals of the rolling-stock or to the axles of the vehicles running upon such surfaces, a further and considerable reduction in the tractive effort can be obtained, and this at a comparatively small additional expenditure, the application of such bearings would become general.

The following are the principal advantages claimed for rolling motion in bearings: reduction in starting effort, decreased tractive and revolving effort, economy in lubrication. If these theoretical advantages are accepted as arising from the application of rolling motion to bearings, the practical question is: Can such bearings be constructed to withstand the shocks of present railway loads and speeds, as also the heavy stresses connected with modern tools and machinery, at reasonable cost?

The requirements of satisfactory roller bearings may be summarised as follows: (1) that the proportions of their parts and the materials of which they are constructed are suitable to withstand the stresses imposed upon them; (2) that the bearing rollers must be kept parallel with their axle, or journal, and that they must not be allowed to touch each other; (3) that the bearings must be as simple and contain as few working parts as possible, and that they must be so designed that they can be applied and adjusted by any intelligent workman; (4) that they can be produced at reasonable cost. Simple as these requirements may appear, it is probable that only those who have tried to construct such bearings know how difficult they are to attain.

The reduction in starting effort in roller as compared with ordinary bearings, which reduction reliable experiments have proved to amount to from 50 per cent. to as much as 83 per cent., is of such importance in all cases of mechanical, electrical, or animal traction, that if this was the only advantage it would warrant, other things being equal, the adoption of these bearings. In the case of steam or other mechanical traction the reduction of starting effort allows of heavier trains or vehicles being controlled by the existing locomotives or other motors than can at present be dealt with. In railway vehicles the starting effort has been found in many cases to be as low as 3lb. per ton of load. The following are the results of careful experiments made to ascertain the relative starting effort

* Paper read at the engineering conference of the Institution of Civil Engineers.

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and running friction of tramcars fitted with ordinary and roller bearings:

Starting Effort.—Cars weighing 4 tons 15cwt.; ordinary bearings, 198lb., or 41·68lb. per ton; roller bearings, 30lb., or 6·53lb. per ton.

Running Friction.—Gravity test.

A car fitted with ordinary bearings and weighing 2 tons 15cwt. was let loose from a point 56ft. up an incline with 1ft. 6½in. rise. It ran down this incline and 57ft. along the level line at foot of same, or a total distance of 111ft. The force expended was, therefore, 6,160lb. falling through 1·521ft., or 9,364 foot-pounds. The average frictional resistance was 9,364 + 111, or 84lb., equal to 30·5lb. per ton. A similar car fitted with roller bearings, being let loose from the same point, ran the full length of the level line available—namely, 320ft.—and had not then quite come to rest, the total distance traversed being 376ft. The force expended was as above, 9,364 foot-pounds. The average frictional resistance was 9,364 + 376 = 29·4lb., or about 9lb. per ton of load. In the case of animal traction any reduction would not only be of great economical value by increasing the average life of the animals employed, but would also enable them to perform their duties with much less distress than under present conditions—a result much to be desired.

The following figures are of interest, and are founded on the results of actual experiments in tramway practice: Relative starting effort of a tramcar on a gradient of 1 in 20—ordinary bearings, 100; roller bearings, 77; saving, 23 per cent. On a gradient of 1 in 80—ordinary bearings, 100; roller bearings, 50; saving, 50 per cent. On a gradient of 1 in 140—ordinary bearings, 100; roller bearings, 39·6; saving, 60·4 per cent.—results which require no comment. As to decrease in tractive or revolving force, as the case may be, decrease in tractive force is of great consequence in railway, tramway, and road vehicles, as it reduces the constant or "fixed charge" upon the locomotive, motor, or animal; and similarly a reduction in the force necessary to revolve shafting and other machinery is of the greatest economical value, seeing that the amount of power expended in driving the main and counter shafts in workshops has been proved to amount to as much as from 50 to 80 per cent. of the total power employed. The reduction in the amount of lubrication required is purely an economical question. Experiments have, however, shown that at least 50 per cent. saving can be effected by the use of roller bearings. With a perfect roller bearing no lubricant is required, but oil must be used to prevent rusting.

As to the possibility of realising the theoretical advantages of roller bearings in practice, which is the question engineers have to consider, the results so far obtained are to the author's knowledge so satisfactory that his conviction is, that their adoption will be greatly increased in the immediate future. The following examples appear to prove that the experimental stage has been passed, and that roller bearings have now developed into practical realities. The Corporation of Blackpool have had some of their tramcars fitted with roller bearings, and these cars have been running on their electric tramway for over three years, and with results so satisfactory that they have applied similar bearings to all the new cars which have been constructed since the advantages of these bearings were established; and their consulting engineer some short time ago certified that at least 30 per cent. of energy is saved by the use of such bearings as compared with those in ordinary use. The Liverpool Overhead Railway made their first trials with roller bearings some two years ago, and are now gradually fitting them to the whole of their rolling-stock. Mr. Cottrell, the engineer and general manager, has been good enough to send examples of the bearings after they have performed a considerable mileage. The City and South London Electric Railway are now experimenting with roller bearings applied to their carriages. The engineers for the Waterloo and City Railway have specified roller bearings for the whole of the stock ordered for this line. A passenger train of six carriages fitted with roller bearings throughout has been running for two years (next month) between Brighton and Kemp Town, and has shown a saving of from 12½ to 15 per cent. in the consumption of fuel, which saving has been obtained under disadvantageous circumstances, inasmuch as the engine has to be kept in steam for about 16 hours, whilst its actual running time is under seven. The Western Railway of France are fitting a complete train with roller bearings for experimental purposes, and the report of their engineers will undoubtedly be of great value, as investigations of this kind are carried out with great care and skill by our Continental neighbours. Experiments are being made in some of our Colonies, as also on some of the principal railways in South America. Roller bearings have been fitted to many horse cars with results most beneficial to the animals employed, and it is estimated that the use of them would so prolong the life of the horses that the reduction in their depreciation alone would show a saving of considerably over £10 per car per annum. In general application, perhaps the most interesting is the fitting of roller bearings to the big bell of St. Paul's Cathedral, "Great Paul," which, with its headstock, weighs some 25 tons, and which gave considerable trouble when mounted on ordinary bearings.

It would also appear that there is a large field for the introduction of these bearings to the thrust and ordinary bearings of propeller shafts. The foregoing illustrations of actual application of roller bearings serve to show the importance of the question and the headway already made, and the author hopes that discussion will throw further light on this important subject.

SEPARATE CONDENSING PLANTS.*

BY HENRY DAVEY, M.I.C.E.

All steam-engine condensers since the time of Newcomen have been separate condensers, for the separate condenser was Watt's great invention, but what is generally known as a "separate condenser" is a condenser with separate mechanism. The author's special object is under this title to introduce the question of "economising condensing water." That is done by means of (1) cooling ponds; (2) evaporative condensers; (3) atmospheric condensers; (4) methods of cooling water to be used over and over again.

The condensers of the former class are now so numerous and so well understood, that condensers in which means are employed to economise condensing water, such as condensers in demand for electric lighting stations and for other places (especially in towns, because there condensing water is generally scarce), will be almost alone considered. As the use of such condensers becomes extended probably great improvements will be made, improvements which may be hastened by a free discussion of the subject.

The general principle by which the quantity of condensing water is lessened, is that of dissipating into the atmosphere heat, which would under other conditions be conveyed away entirely by the condensing water, and the problem to be considered is that of the best and most economical means by which the atmosphere may be made to take up or convey away the heat to be dissipated. The varying conditions of the atmosphere as regards temperature and humidity are factors to be calculated on; there is also the weight or volume of air made use of.

Cooling Ponds.—This method is the oldest and probably of the least importance, because the space required is so great as to preclude its general adoption. In proportioning cooling ponds, the general practice is very varied. The author has been accustomed to provide 2·5 square feet of water surface and 12·5 cubic feet of water for each pound of steam per hour.

Evaporative Condensers.—This is probably the most important type of condenser to be discussed, and one which is now being rapidly developed. The general principle is that of having a nest of tubes into which the steam from the engine is exhausted. Water is allowed to trickle down the outside of the tubes, and, becoming evaporated, the vapour thus formed rapidly carries away the heat from the tube, thereby condensing the steam inside. In still air the amount of heat thus dissipated is considerable, and it is obvious that if a stream of air be employed to carry away

* Paper read at the engineering conference of the Institution of Civil Engineers.

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the vapour as quickly as it is formed, the condensing effect will be greatly accelerated. That is the principle on which the modern evaporative condenser is constructed. A fan is employed to propel the air. The success of this type of condenser depends largely on mechanical details. The quantity of water used may be almost as little as that of the feed-water. The modern evaporative condenser is illustrated by the diagram which the author has placed on the screen. The water used for condensation is taken cold and first passed through a supplementary surface condenser close to the air-pump, through which condenser the vapour, coming from the evaporative condenser proper, is conveyed and further condensed. The water leaving the supplementary condenser passes along with the circulating water over the evaporating tubes; on leaving the evaporating tubes the heated water is caught in a tank, from which it is again circulated. From this tank the water for feeding the boilers is taken. In working evaporative condensers power is required, first, for forcing the water through the supplementary condenser; second, for circulating the water over the evaporating pipes; third, for working the air-pump; and fourth, for working a fan when a fan is employed.

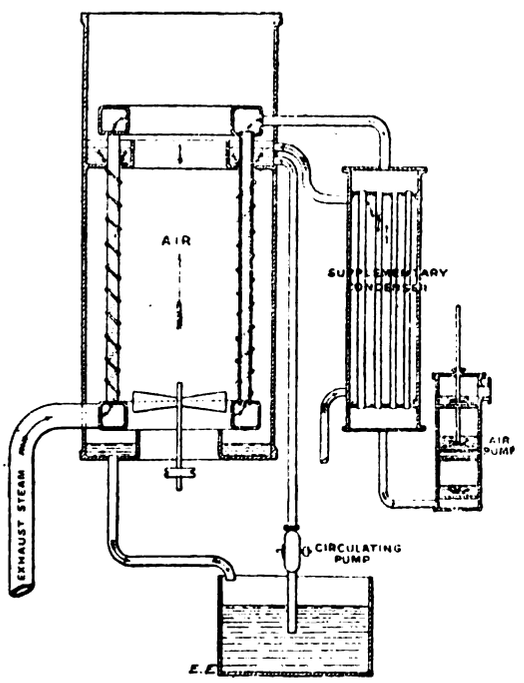

Diagram of Evaporative Condenser.

As regards the general practice in the proportioning of evaporative condensers of the class above described, the author has been favoured with some notes from Messrs. D. Stewart and Co., of Glasgow, who are makers of such condensers. The quantity of condensing water required per pound of steam is from 1lb. to 1½lb. of cold water, and the area of cooling surface in the evaporating tubes should be a minimum of one square foot per 10lb. of steam condensed per hour. The surface in the auxiliary condenser should be equal to one square foot per 55lb. of steam per hour. The quantity of water circulated should be 20 times the weight of steam. It has been the usual practice to place evaporative condensers on the roof of the building, although when a fan is employed it does not appear that that is necessary. It would occupy too much time to describe in detail the different forms of air-pump and the methods employed to ensure a good vacuum. This and other matters will be probably touched upon in the discussion.

Atmospheric Condensers.—The general form of atmospheric condenser is the same as that of the evaporative condenser. A supplementary surface condenser may be used in connection with the air-pump, and through which condenser the feed-water may be pumped on its way to the boiler, but the heat of the steam in the main condenser is dissipated by radiation and conduction into the atmosphere. The rate of dissipation of heat may, of course, be accelerated by the use of a fan. The surface required is great.

Methods of Cooling Condensing Water.—The oldest method is, of course, that of the cooling pond already mentioned; other obvious methods are those of spraying the water in a still atmosphere, trickling the water over surfaces in thin films, and spraying it in a current of air produced by fan or otherwise.

The author has not in the time allowed him been able to do more than mention the salient points in connection with his subject, and, in conclusion, he would point out the fact that methods of economising condensing water are growing in importance; therefore a full discussion could not fail to be of great interest and value to the profession.

IMPORTANT QUESTIONS IN THE ECONOMIC WORKING OF STEAM ENGINES AND BOILERS.*

BY BRYAN DONKIN, M.I.C.E.

The following are some of the chief points which during the last few years have occupied the attention of leading engineers and authorities, both here and on the Continent, with a view of obtaining the most economical working results.

Steam-Engines.—High pressures of steam, from 150lb. to 250lb., are now being used. Efficient steam-jacketing, not only on barrels, but especially to all covers of engine cylinders, except in high-speed engines, is essential for the best economy. The percentage of the internal surfaces really jacketed to the total surfaces touched by the steam should always be mentioned. The simple statement that a cylinder is steam-jacketed is misleading and insufficient. The clearance volumes and surfaces of cylinders should be reduced as much as possible. The extent of the clearance surfaces is very important, and they should be as flat and as smooth as possible. A greater number of revolutions per minute and higher piston speeds are now more used than formerly. Moderately superheated steam has long been employed on the Continent, but is coming in favour here very slowly. It greatly reduces condensation by raising the temperature of the cylinder walls. Balancing the rotary parts is now more attended to in high-speed engines. Steam-pipes should be well drained, to prevent water going into the cylinder, and well clothed, including their flanges. Workmanship is improved, and there is better automatic lubrication to all the external moving parts. To prevent oil passing through the surface condensers into the boilers, the cylinders and pistons are often not oiled at all. Discussion of this important point is suggested, with results obtained in practice. Greater facilities should be given for taking to pieces and putting together all the various parts of steam-engines, and more attention paid to mechanical efficiency, including piston-ring friction. Rotary turbine types of steam-engines are little used, but they have lately claimed much attention, and their economy is considerable. The importance of cylinder-wall temperatures and their relation to the temperature of the working steam is still not sufficiently appreciated. This is now recognised as the chief cause of condensation. The greater the difference of temperature between the working steam and the cylinder, the greater the condensation. Entropy diagrams are a most useful form of diagram, showing thermal units, and are now beginning to be used; but they should be more largely adopted. The subject has been ably treated by several good authorities, both English and foreign. Practical application of steam has also been lately made to road carriages, and specially for tramways. Some 70 to 100 steam tramways, with little engines and boilers placed at the end of the carriages, are now running in France, chiefly with superheated steam, and are doing good work. Accurate tests on all types of steam-engines are very useful and valuable. Steam-engine cylinders and covers are generally not sufficiently protected from radiation. A really economical steam feed or donkey pump is a great desideratum; as a rule they are very uneconomical. Some exact experiments have lately been made in France showing their waste of heat and steam. They should be worked continuously, if possible, and not intermittently; not stopped and started too often, leading to great waste

* Paper read at the engineering conference of the Institution of Civil Engineers.

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of steam. Comparative tests of different types is suggested. Single-acting engines seem to be on the increase for high speeds. The number of expansions has much increased of late years. Multi-cylinder engines, with 20 or 30 expansions, are very economical, and are often used, but this is only admissible where the barrels and covers are thoroughly steam-jacketed, or superheated steam is used, or both. A greater degree of compression than formerly, as conducing to economy, is desirable, and now often used. For comparison of experimental results of different steam-engines using different steam pressures, the terms should be in thermal units. The steam-engine efficiency committee reported quite lately that for all purposes it is desirable to state the economy in terms of thermal units per indicated horse-power hour, and also, if possible, in thermal units per brake horse-power, whether for saturated or superheated steam. Steam should not be allowed to escape at exhaust wet, as the loss of heat by evaporation to condenser from the internal walls is enormous.

Steam-Boilers.—Boiler efficiency, or the percentage of heat in the fuel, usefully employed in evaporating water, is now generally recognised as the best method of comparing experimental results in various types of steam-boilers with various fuels working under different conditions. The heating value of the fuel should always be given, and can easily be obtained by a fuel calorimeter. Forced and induced draught are now much more used than formerly, both on land and at sea, with excellent results. More attention is required to improve the combustion on grates, and to regulate the quantity of air admitted to ensure maximum boiler efficiency. The percentage of priming water in steam should be determined if possible. There are many instruments for this purpose. Suggestions are invited as to the best and most reliable. Analysis of the gases at the end of the boiler to determine the percentage of CO_2, CO, and O is most important, and can now be made cheaply and easily. No boiler experiments are complete without such gas analysis. The excess or deficiency of air in the exit gases can be calculated from such analysis. Automatic stoking generally leads to economy, as the grates are usually better covered with fuel, and there is usually less smoke. Steam-jets are often used under grates, but frequently they are found to consume a large amount of steam. Smoke is generally a sign of bad combustion. Black smoke is a disgrace to the boiler engineer or owner, and more attention should be paid to the combustion chamber, and to the admission of air in small streams, and in the right places and at the right times. Water-tube boilers have been more used the last 10 years than formerly, particularly those with small water-tubes, for very high pressures. Steam superheaters are often attached to the end of boilers, and they are sometimes separately fired. Feed-water heaters are much more employed, and with advantage, to reduce the temperature of the gases, the heat of which would otherwise be wasted, and go to increase the temperature of the feed-water. A feed-water heater should be considered as a distinct and separate apparatus, quite apart from the boiler. The efficiency of the boiler should be stated separately from that of the economiser. Much more attention should be paid to cleaning the surfaces, both internal and external, of boiler plates and economiser pipes, so as to facilitate the transmission of heat from the gases to the water. Soot and lime deposits are both very bad conductors of heat. Facility for repairs is very important, especially in water-tube boilers at sea. The variations in the endless types of boilers seem to have less effect on the general economic results than a sufficiency of heating surface and good combustion, with the right quantity of air for the fuel used. Higher furnace temperatures are desirable, but the products of combustion should not be allowed to escape at too high a temperature, and the best boiler efficiency is generally obtained with an evaporation of from 4lb. to 5lb. of water per square foot of heating surface per hour. Coal ground very fine is now being used on the Continent for steam-boilers, and the combustion is similar to that with gas firing. The powdered coal is burned with, or better without forced draught. Belleville and other water-tube boilers are now much employed in warships. It is surprising that automatic stokers are not used at sea, where it would seem that they are most required. Firing by hand on land is troublesome, but at sea, especially in tropical countries, it is exceedingly trying. Boilers should be much more carefully covered to diminish radiation. A good combustion chamber at the back of the grate for mixing the gases properly with the air and diminishing the smoke is very desirable, but care should be taken that the flames are chilled as little as possible. Introduction of live steam into boilers seems to produce economy by improving the circulation of the water. Filtration of air through the brickwork and smoke-box of land boilers should be carefully avoided. Air should only be admitted where and when it is really wanted, but this is seldom the case. The writer has lately collected a large number of reliable tests on steam-boilers of various types—stationary, marine, and locomotive, with heating value of the fuel, analysis of gases, boiler efficiency, temperatures, etc. Generally speaking, internally-fired boilers give a higher efficiency than those externally fired. The old and well-known locomotive type, with smoke-tubes and induced draught, stands high as a very economical steam generator. The term "nominal horse-power" of boilers should, if possible, be avoided. It is much better to give the total heating surface. A guarantee is often given of boiler efficiency with a given fuel and a given evaporation per square foot of heating surface per hour. The steam produced should be as dry as possible. Better circulation in land boilers is much wanted. Coal should be purchased, not by weight only, but by the heat it contains. On the Continent it is often bought with a guarantee that it will evaporate a certain quantity of water in a certain boiler.

Desirability of Reporting Results of Steam Engine and Boiler Experiments on a Uniform System.—It is very desirable that all steam engine and boiler results should be tabulated in a uniform manner. There is now much confusion, as experiments are published in various ways and under different headings by different authorities. The writer suggests that a small committee be appointed by the council of the Institution of Civil Engineers with a view of determining the best set of headings for the detailed statements of results. Such a standard method would be found very useful for a more rapid and accurate comparison of experiments. The proposed form should be as practical and simple as possible. In the United States, boiler experiments are now nearly always published in accordance with the uniform system of headings recommended and adopted by the American Institution of Mechanical Engineers. Any additions can be made by any experimenter at the end of the standard form to suit special requirements.

GAS FOR POWER PURPOSES.*

BY JOSEPH EMERSON DOWSON, M.I.C.E.

Gas-engines driven with ordinary town gas offer the following advantages compared with steam-engines: no ground space for a boiler is required, and no chimney; there is no boiler to clean and repair, and no boiler insurance; there are no clinkers and ashes to remove and no fireman to pay; the gas-engine can be stopped or started at will, and there is no loss of fuel during the stand-by hours. Besides all this, there is the important fact that there is always a large storage of power to fall back on in the gasholders at the gasworks. For intermittent work—such as hoisting, printing, etc., and for moderate powers working constantly—gas-engines driven by gas taken from the town mains have such manifest advantages that to a large extent they have superseded steam-engines, and will doubtless continue to do so. Almost the only drawback to the use of town gas is its cost, but in some places the day pressure in the mains is too low and gives trouble. It is generally admitted that when town gas costs more than 3s. per 1,000 cubic feet, the working cost of an engine indicating more than about 30 h.p. exceeds that of a steam-engine of the same power, under the usual conditions of regular working.

For larger powers it is now usual to work a gas-gene-

* Paper read at the engineering conference of the Institution of Civil Engineers.

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rating plant in connection with the engine, or there may be several engines served by one gas plant. In such cases the gas plant is to the gas-engine what the boiler is to the steam-engine. Approximately it occupies about the same ground space as a steam-boiler of the same horse-power, and the fireman is of the same type in each case. With the gas plant there is no need of a chimney stack, but in towns, or where there are adjoining houses, it is desirable to have a small waste-pipe from the generator carried up above the level of the roofs, so that when the fire in the generator is blown up after standing, the gases then formed may be blown off without nuisance. The repairs of a gas plant usually cost much less than the cleaning and repairs of a boiler for the same power. The first engine driven with generator gas was in 1879, and since then the adoption of this system of power has spread so rapidly in all countries that it is now quite impossible to estimate the numbers in use. The general outcome is that engines of good make (indicating 50 h.p. and upwards), driven by generator gas of average quality, consume about 1lb. of fuel, whereas good steam-engines require 2lb. to 3lb. per indicated horse-power hour. An engine indicating about 120 h.p. has been run on test for five hours, with an actual fuel consumption of only ¾lb per indicated horse-power. On another occasion, with an engine indicating under 33 h.p., the gas plant was placed on a weighing machine, so as to obtain a series of actual records of the weight of fuel converted into power, and even on this small scale of working the fuel consumed was only 1·2lb. per indicated horse-power hour.

It may be accepted that gas-engines of 50 i.h.p. and upwards may be worked, under usual conditions, with 1lb. fuel per indicated horse-power; but it is right to point out that these results cannot be obtained with all kinds of fuel. For heating furnaces and other such work, generator gas can be made with bituminous coal, but for engine work gas so made carries too much tar and other impurities. To avoid this trouble, the generator gas used for engines is made with anthracite coal or coke. The price of the small anthracite is 6s. to 7s. a ton at the pits in South Wales and near Glasgow, and for the South and West of England, and in most parts of Scotland the cost of this coal delivered is about the same as that of steam coal. In the Midlands and Northern Counties it costs more, and then local coke is used. Lately Dr. Mond has been working a gas plant with bituminous coal, and in his special treatment of the gas it can be used for engine work, but at present he can only work his process continuously, night and day, in a plant capable of serving not less than 2,000 i.h.p., so that for ordinary purposes it is not suitable. It is tolerably certain that sooner or later engines will be worked with bituminous coal; but without waiting for that particular result, the fact remained that great economy is already effected by using anthracite or coke.

Another important feature of gas is that it does not condense or lose power on its way to the engine; on the contrary, the more the gas is cooled, the better it is for the engine, as each charge of gas which enters the cylinder is more dense, and has consequently greater energy. With steam the reverse is the case; there is also trouble with leaks in the piping, but with gas there is no such trouble as the pressure is low. One result of being able to convey gas any distance in pipes, without deterioration, is that there can be a separate engine in each department of a large factory, with light shafting for each. It is no longer necessary to have heavy shafting to drive the whole of a mill or factory from engines placed near the boilers.

The electrical transmission of power in shipyards and other works covering a large area is now being adopted extensively, and in this way some of the loss from condensed steam is avoided. But the power for driving the dynamos still has to be provided, and the most economical is gas power. One of the leading firms on the Clyde is now putting in a large gas plant for this purpose. There are also several instances of gas power being used for electric lighting, as well as for pumping water, pumping sewage, etc. The stand-by loss of a steam-boiler is considerable, whereas that of a gas-generator, capable of serving 200 h.p., is only 3lb. to 5lb. per hour.

As to the fuel consumption of steam-engines, it is usual to say that non-condensing engines require 2lb. to 3lb. coal per indicated horse-power, but it may be well to remember the words of Sir F. Bramwell in his presidential address in 1885 concerning engines working under ordinary practical conditions: "In an investigation instituted last year by the Corporation of Birmingham, when considering whether they should approve of a proposal to lay down power-distributing mains throughout their streets, it was found on indicating some six non-condensing steam-engines taken indiscriminately from among users of power, and ranging from five nominal horse-power up to 30 nominal horse-power, that the consumption in one instance was as high as 27·5lb., while it never fell below 9·6lb., and the average of the whole was as much as 18lb."

SIGNALLING THROUGH SPACE WITHOUT WIRES.*

BY W. H. PREECE, C.B., F.R.S.

Science has conferred one great benefit on mankind. It has supplied us with a new sense. We can now see the invisible, hear the inaudible, and feel the intangible. We know that the universe is filled with a homogeneous continuous elastic medium which transmits heat, light, electricity, and other forms of energy from one point of space to another without loss. The discovery of the real existence of this "ether" is one of the great scientific events of the Victorian era. Its character and mechanism are not yet known to us. All attempts to "invent" a perfect ether have proved beyond the mental powers of the highest intellects. We can only say with Lord Salisbury that the ether is the nominative case to the verb "to undulate." We must be content with a knowledge of the fact that it was created in the beginning for the transmission of energy in all its forms, that it transmits these energies in definite waves and with a known velocity, that it is perfect of its kind, but that it still remains as inscrutable as gravity or life itself.

Any disturbance of the ether must originate with some disturbance of matter. An explosion, cyclone, or vibratory motion may occur in the photosphere of the sun. A disturbance or wave is impressed on the ether. It is propagated in straight lines through space. It falls on Jupiter, Venus, the Earth, and every other planet met with in its course, and any machine, human or mechanical, capable of responding to its undulations indicates its presence. Thus the eye supplies the sensation of light, the skin is sensitive to heat, the galvanometer indicates electricity, the magnetometer indicates disturbances in the earth's magnetic field. One of the greatest scientific achievements of our generation is the magnificent generalisation of Clerk Maxwell that all these disturbances are of precisely the same kind, and that they differ only in degree. Light is an electromagnetic phenomenon, and electricity in its progress through space follows the laws of optics. Hertz proved this experimentally, and few of us who heard it will forget the admirable lecture on "The Work of Hertz" given in this hall by Prof. Oliver Lodge three years ago.

By the kindness of Prof. Silvanus Thompson, I am able to illustrate wave transmission by a very beautiful apparatus devised by him. At one end we have the transmitter or oscillator, which is a heavy suspended mass to which a blow or impulse is given, and which, in consequence, vibrates a given number of times per minute. At the other end is the receiver, or resonator, timed to vibrate to the same period. Connecting the two together is a row of leaden balls suspended so that each ball gives a portion of its energy at each oscillation to the next in the series. Each ball vibrates at right angles to or athwart the line of propagation of the wave, and as they vibrate in different phases you will see that a wave is transmitted from the transmitter to the receiver. The receiver takes up these vibrations and responds in sympathy with the transmitter. Here we have a visible illustration of that which is absolutely invisible The wave you see differs from a wave of light or of electricity only in its length or in its

* Friday evening discourse delivered before the Royal Institution, June 4, 1897.

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frequency. Electromagnetic waves vary from units per second in long submarine cables to millions per second when excited by Hertz's method. Light waves vary per second between 400 billions in the red to 800 billions in the violet, and electric waves differ from them in no other respect. They are reflected, refracted, and polarised, they are subject to interference, and they move through the ether in straight lines with the same velocity—viz., 186,400 miles per second—a number easily recalled when we remember that it was in the year 1864 that Maxwell made his famous discovery of the identity of light and electric waves.

Electric waves, however, differ from light waves in this, that we have also to regard the direction at right angles to the line of propagation of the wave. The model gives an illustration of that which happens along a line of electric force; the other line of motion I speak of is a circle around the point of disturbance, and these lines are called lines of magnetic force. The animal eye is tuned to one series of waves, the "electric eye," as Lord Kelvin called Hertz's resonator, to another. If electric waves could be reduced in length to the forty-thousandth of an inch we should see them as colours.

One more definition, and our ground is cleared. When electricity is found stored up in a potential state in the molecules of a dielectric like air, glass, or guttapercha, the molecules are strained, it is called a charge, and it establishes in its neighbourhood an electric field. When it is active, or in its kinetic state in a circuit, it is called a current. It is found in both states, kinetic and potential, when a current is maintained in a conductor. The surrounding neighbourhood is then found in a state of stress, forming what is called a magnetic field. In the first case the charges can be made to rise and fall, and to surge to and fro with rhythmic regularity, exciting electric waves along each line of electric force, and in the second case the currents can rise or alternate in direction with the same regularity and originate electromagnetic waves whose wave fronts are propagated in the same direction. The first is the method of Hertz, which has recently been turned to practical account by Mr. Marconi, and the second is the method which I have been applying, and which for historical reasons I will describe to you first.

In 1884 messages sent through insulated wires buried in iron pipes in the streets of London were read upon telephone circuits erected on poles above the housetops, 80ft. away. Ordinary telegraph circuits were found in 1885 to produce disturbances 2,000ft. away. Distinct speech by telephone was carried on through one quarter of a mile, a distance that was increased to 1½ miles at a later date. Careful experiments were made in 1886 and 1887 to prove that these effects were due to pure electromagnetic waves, and were entirely free from any earth conduction. In 1892 distinct messages were sent across a portion of the Bristol Channel between Penarth and Flat Holm, a distance of 3·3 miles.

Early in 1895 the cable between Oban and the Isle of Mull broke down, and as no ship was available for repairing and restoring communication, communication was established by utilising parallel wires on each side of the channel and transmitting signals across this space by these electromagnetic waves.

The apparatus connected to each wire in this system of signalling consist of (*a*) a rheotome or make-and-brake wheel, causing about 260 undulations per second in the primary wire; (*b*) an ordinary battery of about 100 Leclanché cells, of the so-called dry and portable form; (*c*) a Morse telegraph key; (*d*) a telephone to act as receiver; (*e*) a switch to start and stop the rheotome.

Good signals depend more on the rapid rise and fall of the primary current than on the amount of energy thrown into vibration. Two hundred and sixty vibrations per second give a pleasant note to the ear, easily read when broken up by the key into dots and dashes.

In the electromagnetic system two parallel circuits are established, one on each side of a channel or bank of a river, each circuit becoming successively the primary and secondary of an induction system, according to the direction in which the signals are being sent. Strong alternating or vibrating currents of electricity are transmitted in the first circuit so as to form signals, letters, and words in Morse characters. The effects of the rise and fall of these currents are transmitted as electromagnetic waves through the intervening space, and if the secondary circuit is so situated as to be washed by these ethereal waves, their energy is transformed into secondary currents in the second circuit, which can be made to affect a telephone, and thus to reproduce the signals. Of course, their intensity is much reduced, but still their presence has been detected though five miles of clear space have separated the two circuits. Such effects have been known scientifically in the laboratory since the days of Faraday and of Henry, but it is only within the last few years that it has been possible to utilise them practically through considerable distances. This has been rendered possible through the introduction of the telephone.

Last year (August, 1896) an effort was made to establish communication with the North Sandhead (Goodwin) lightship. The apparatus used was manufactured by Messrs. Evershed and Vignoles, and a most ingenious relay to establish a call was invented by Mr. Evershed. One extremity of the cable was coiled in a ring on the bottom, embracing the whole area over which the lightship swept while swinging to the tide, and the other end was connected with the shore. The ship was surrounded above the water line with another coil. The two coils were separated by a mean distance of about 200 fathoms, but communication was found to be impracticable. The screening effect of the sea-water and the effect of the iron hull of the ship absorbed all the energy of the currents in the coiled cable, and the effects on board, though perceptible, were very trifling—too minute for signalling. Previous experiments had failed to show the extremely rapid rate at which energy is absorbed with the depth or thickness of water. The energy is absorbed in forming eddy currents. Although this experiment has failed through water, it is thoroughly practical through air to considerable distances where it is possible to insert wires of similar length on each side of the distance to be crossed. It is not always possible, however, to do this, nor to get the requisite height to secure the best effect. It is impossible on a lightship and on rock lighthouses. There are many small islands—Sark, for example—where it cannot be done.

In July last Mr. Marconi brought to England a new plan. My plan is based entirely on utilising electromagnetic waves of very low frequency. It depends essentially on the rise and fall of currents in the primary wire. Mr. Marconi utilises electric or Hertzian waves of very high frequency, and they depend upon the rise and fall of electric force in a sphere or spheres. He has invented a new relay, which for sensitiveness and delicacy exceeds all known electrical apparatus. The peculiarity of Mr. Marconi's system is that, apart from the ordinary connecting wires of the apparatus, conductors of very moderate length only are needed, and even these can be dispensed with if reflectors are used.

The Transmitter.—His transmitter is Prof. Righi's form of Hertz's radiator. Two spheres of solid brass 4in. in diameter are fixed in an oil-tight case of insulating material, so that a hemisphere of each is exposed, the other hemisphere being immersed in a bath of vaseline oil. The use of oil has several advantages. It maintains the surfaces of the spheres electrically clean, avoiding the frequent polishing required by Hertz's exposed balls. It impresses on the waves excited by these spheres a uniform and constant form. It tends to reduce the wave-lengths—Righi's waves are measured in centimetres, while Hertz's were measured in metres. For these reasons the distance at which effects are produced is increased. Mr. Marconi uses generally waves of about 120cm. long. Two small spheres are fixed close to the large spheres and connected each to one end of the secondary circuit of the "induction coil," the primary circuit of which is excited by a battery thrown in and out of circuit by the Morse key. Now, whenever the key is depressed, sparks pass across the three spark-gaps, and since the system contains capacity and electric inertia, oscillations are set up in it of extreme rapidity. The frequency of oscillation is probably about 250 millions per second. The distance at which effects are produced with such rapid oscillations depends chiefly on the energy in the discharge that passes. A 6in. spark coil has sufficed up to four miles, but for greater

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distances we have used a more powerful coil—one emitting sparks 20in. long. It may also be pointed out that this distance increases with the diameter of the large spheres, and it is nearly doubled by making the spheres solid instead of hollow.*

The Receiver.—Marconi's relay consists of a small glass tube 4cm. long, into which two silver pole-pieces are tightly fitted, separated from each other by about half a millimetre—a thin space which is filled up by a mixture of fine nickel and silver filings, mixed with a trace of mercury. The tube is exhausted to a vacuum of 4mm., and sealed. It forms part of a circuit containing a local cell and a sensitive telegraph relay. In its normal condition the metallic powder is virtually an insulator. The particles lie higgledy-piggledy, anyhow in disorder. They lightly touch each other in an irregular method, but when electric waves fall upon them they are "polarised," order is installed. They are marshalled in serried ranks, they are subject to pressure—in fact, as Prof. Oliver Lodge expresses it, they "cohere"—electrical contact ensues, and a current passes. The electric resistance of Marconi's relay—that is, the resistance of the thin disc of loose powder—is practically infinite when it is in its normal or disordered condition. It is then, in fact, an insulator. This resistance drops sometimes to five ohms, when the absorption of the electric waves by it is intense. It therefore becomes a conductor. It may be that we have in the measurement of the variable resistance of this instrument a means of determining the intensity of the energy falling upon it. This variation is being investigated both as regards the magnitude of the energy and the frequency of the incident waves. Now such electrical effects are well known. In 1866 Mr. S. A. Varley introduced a lightning protector constructed like the above tube, but made of boxwood and containing powdered carbon. It was fixed as a shunt to the instrument to be protected. It acted well, but it was subject to this coherence, which rendered the cure more troublesome than the disease, and its use had to be abandoned. The same action is very common in granulated carbon microphones like Hunning's, and shaking has to be resorted to to decohere the carbon particles to their normal state. Mons. E. Branly (1890) showed that copper, aluminium, and iron filings behaved in the same way. Prof. Oliver Lodge, who has done more than anyone else in England to illustrate and popularise the work of Hertz and his followers, has given the name "coherer" to this form of apparatus. He has much improved it. Marconi "decoheres" by making the local current very rapidly vibrate a small hammer head against the glass tube, which it does effectually, and in doing so makes such a sound that reading Morse characters is easy. The same current that decoheres can also record Morse signals on paper by ink. The exhausted tube has two wings which, by their size, tune the receiver to the transmitter. Choking coils prevent the energy escaping. The analogy to Prof. Silvanus Thompson's wave apparatus is evident. Oscillations set up in the transmitter fall upon the receiver tuned in sympathy with it, coherence follows, currents are excited, and signals made.

In open clear spaces within sight of each other nothing more is wanted, but when obstacles intervene and great distances are in question height is needed—tall masts, kites, and balloons have been used. Excellent signals have been transmitted between Penarth and Brean Down, near Weston-super-Mare, across the Bristol Channel, a distance of nearly nine miles. I must now show the system in operation. [Bell signals were made across the theatre, and signals were received from a transmitter which was carried away to various distant parts of the building.] Mirrors also assist and intensify the effects. They were used in the earlier experiments, but they have been laid aside for the present, for they are not only expensive to make, but they occupy much time in manufacture.

It is curious that hills and apparent obstructions fail to obstruct. The reason is probably the fact that the lines of force escape these hills. When the ether is entangled in matter of different degrees of inductivity the lines are curved, as, in fact, they are in light. A hill is virtually bridged over by these lines, and consequently some electric waves fall on the relay. Weather seems to have no influence; rain, fogs, snow, and wind avail nothing. The wings [attached to the receiver on which the electrical vibrations are excited] may be removed. One pole can be connected with earth and the other extended up to the top of the mast, or fastened to a balloon by means of a wire. The wire and balloon covered with tinfoil or kite becomes the wing. In this case one pole of the transmitter must also be connected with earth.

There are some apparent anomalies that have developed themselves during the experiments. Mr. Marconi finds that his relay acts even when it is placed in a perfectly closed metallic box. [The receiver was placed in a galvanised iron box and the lid put on. The bell was heard to sound when a signal was made in the transmitter.] This is the fact that has given rise to the rumour that he can blown up an ironclad ship. This might be true if he could plant his properly tuned receiver in the magazine of an enemy's ship. Many other funny things could be done if this were possible. I remember in my childhood that Captain Warner blew up a ship at a great distance off Brighton. How this was done was never known, for his secret died shortly afterwards with him. It certainly was not by means of Marconi's relay.

The distance to which signals have been sent is remarkable. On Salisbury Plain, Mr. Marconi covered a distance of four miles. In the Bristol Channel this has been extended to over eight miles, and we have by no means reached the limit. It is interesting to read the surmises of others. Half a mile was the wildest dream.*

It is easy to transmit many messages in any direction at the same time. It is only necessary to tune the transmitters and receivers to the same frequency or "note." I can show this here, but we are bothered by reflection from the walls. This does not happen in open space.

There are a great many practical points connected with this system that require to be thrashed out in a practical manner before it can be placed on the market, but enough has been done to prove its value, and to show that for shipping and lighthouse purposes it will be a great and valuable acquisition.

Forthcoming Events.—The last Friday evening discourse at the Royal Institution is given by Mr. Crookes to-night. There is the usual monthly meeting of members on June 14.—The conversazione of the Institution of Electrical Engineers takes place at the Natural History Museum on the 15th, and is followed by that of the Society of Arts on the 16th at the South Kensington Museum.—The Chemical Society have a meeting on their list for June 17, and the Society of Engineers for the 14th (at the United Services).—The Meteorological Society have a meeting on the 16th at the Royal Astronomical Society's rooms at Burlington House, at 4.30 p.m. There are papers by Mr. Harding and Mr. Mossman.—Lord Kelvin will preside at a dinner on June 14, which is to be given at the Whitehall Club to Mr. F. H. Webb, the retiring secretary of the Institution of Electrical Engineers.—The Chesterfield and Midland Counties Institution of Engineers announce an excursion to the "Dukeries." All desiring to attend should communicate with the secretary, at Chesterfield, at once.

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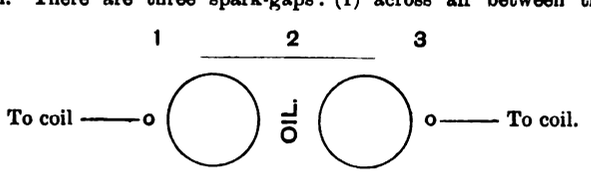
* Mr. Preece had the apparatus before him and a diagram on the wall. There are three spark-gaps: (1) across air between the



small sphere and the first large one; (2) across oil between the two large spheres; and (3) across air between the second large sphere and a small sphere, the same as (1), so that the apparatus is perfectly symmetrical.

* "Unfortunately at present we cannot detect the electro-magnetic waves more than 100ft. from their source."—Trowbridge, 1897, "What is Electricity," p. 256. "I mention 40 yards because that was one of the first out-of-door experiments, but I should think that something more half like a mile was nearer the limit of sensibility. However, this is a rash statement not at present verified."—Oliver Lodge, 1894, "The Work of Hertz," p. 18.

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"ELECTRICITY: ITS MEDICAL APPLICATIONS."

This is the title of a pamphlet written by Mr. G. R. Peers which has a double object—first, to aid in the restoration of public confidence in electricity as a curative agent; and, secondly, to doubly kill the slain, or, in other words, to expose electric quackery. The latter object being the easier, is better done than the former; but, indeed, this is following the general rule that destructive criticism is far more simple than is constructive criticism. It is no small wonder that electric or magnetic quacks have not yet excited the popular imagination by suggesting that a variation of position in the earth's field has curative properties. Why do they not suggest the going to the top of Eiffel towers, or to the bottom of deep shafts, to create minute currents in the conductor parts of the body, and that it is these currents which have a good or a bad effect upon the particular physical anatomy that experiences them. The quacks have little imagination as well as little knowledge, otherwise they would long since have made money, or attempted to have made money, by building high towers or digging deep wells, and sending their patients up and down. We are not quite sure as to the correct method of treating Mr. Peers, inasmuch as he undertakes to give "advice as to the application of electricity for the relief and cure of disease," mentioning, among other things, "irritability." Probably some of the regular practitioners would prescribe a dose of "rhubarb," or some other remedy for touching the liver, rather than electric current, even in small doses. Joking apart, we are somewhat incapable of appreciating the difference between an electrical expert and an electrical quack in matters concerning the cure of disease. The electrical expert probably has no better knowledge of physiology, anatomy, or cognate subjects forming the groundwork of all medical and surgical knowledge than the electric quack, and the aim of those who believe in the curative properties of electricity should be to give that subject a more prominent place in the hospital schools. It is the medical man who can appreciate and properly use electrical methods, and if his education is defective, say so—not attempt to supersede him with more defective knowledge. The idea conveyed by one or two passages in this pamphlet as regards the apathy of medical men to the progress of science, and especially electrical science, is misleading. Medical men are not so apathetic as is made out, and a constant examination of the technical journals, such as the *Lancet* or the *British Medical Journal*, will show there is rather an eagerness for information, not only as regards electricity, but in any direction which will enable the professional man to relieve pain and suffering. All possible praise may be given to pamphleteers when they simply and clearly explain electrical apparatus, and when they expose the trickeries of quacks. Mr. Peers does this, but, unfortunately, goes further. He also makes statements that must as yet be taken *cum grano salis*. The Tesla effect may or may not have the physical or physiological action stated. There is no reason, however, or, rather, there is no proof

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whatever that "it produces a profound effect upon nutrition, etc." Assume the correctness of rise "in temperature," does not a Turkish bath have a similar effect? We entirely disagree with such statements as "its use is indicated particularly in cases of bad nutrition, and such cases as rheumatism, neurasthenia, neuralgia, gout, hypochondria, melancholia, anæmia, chlorosis, neuritis, chronic synovitis, and chronic fibrous exudates about joints and tendons, readily yield to the treatment, producing satisfactory results." Not a single word of proof is advanced, no evidence is given, no authority adduced—the statement is to be taken on trust; and we contend this style of pamphleteering differs in no wise from that which the author condemns. Once again we emphatically say that the electrician without medical training is as bad as the medico without electrical training, and that the curative properties of electricity, be they what they may, will be best employed by the medical practitioner who has obtained electrical in addition to his ordinary medical training.

CORRESPONDENCE.

"One man's word is no man's word,
Justice needs that both be heard."

NEW EMPIRE THEATRE, GLASGOW.

SIR,—In your report of the installation at the above theatre published a few weeks back, you made it appear as if we had sub-let the contract for the work to a Mr. Bretherton. As this is likely to do us considerable harm, we hope that you will be able to make the necessary correction.

The installation was designed by our chief engineer, Mr. Archbutt, as also was that at the New Empire Theatre, Liverpool, and the whole of the work was carried out by our own staff to his instructions and under his personal supervision. The switchboards were manufactured for us, to our engineer's improved arrangement for theatres, by Messrs. Edison and Swan. The Mr. Bretherton mentioned was simply the foreman in charge of the works.—Yours, etc.,

Glasgow, June 9, 1897. BARCLAY AND SON.

THE BEST MEANS OF EFFECTUALLY PREVENTING THE LEAKAGE OF CURRENT TO "EARTH" IN ELECTRICAL INSTALLATIONS FROM GENERATING HEAT AND SETTING BUILDINGS ON FIRE.

BY SYDNEY F. WALKER.

It appears to the writer that in studying this question it will be best to consider: (1) what do we mean by earth? (2) how does leakage of current to earth occur in electrical installations? (3) how does this leakage current generate heat? and (4) what are the best means for its prevention?

"Earth," or "ground," as American electrical engineers term it, has very different meanings under different conditions. With the early experimenters, for instance, and those who at the present day use high-tension frictional electrical apparatus, the table, floor, the walls of the room, even the person of the operator himself, all form good "earth" unless carefully insulated. In high-tension electric light stations, also those using 2,000 volts and upwards, the floor of the building, even when of stone or concrete, also forms fairly good "earth," as many an incautious attendant has found to his cost.

On the other hand, with low-tension apparatus of all kinds it is often very difficult indeed to obtain good "earth" when required. In stony districts, for instance, especially during dry weather, it is often almost impossible to obtain a sufficiently good "earth" at each end of a line of telegraph or telephone to act as the return circuit. Those engineers, also, who have endeavoured to use "earth" as a return for low-tension electric light circuits know what a very large section of earth-plate they have been obliged to expose, and how troublesome the "earth" return always proves, even when it is obtained, unless one is fortunate enough to be able to make use of a large volume of water, common to the two ends of the circuit, for the purpose. Those engineers, also, who have had any experience of the arrangement of lightning conductors, and those who have studied the subject of lightning discharges, know how very difficult it often is to obtain "earth" of sufficiently low electrical resistance to ensure the safe discharge of the thundercloud; unless, again, they are fortunate enough to be able to make connection with a large mass of water, such as a large river or a canal.

A little consideration will show, the writer believes, that "earth" in all cases means the masses of metal embedded in the earth's crust, together with the water and other liquids present, in and on the earth's crust, supplemented in a few cases by the deposits of coal and metallic ores that are also present. The large masses of metal that are buried just below the surface of the ground in nearly every town of any consequence in the shape of the pipes used for the gas and water services, those used for pneumatic transmission, etc., together with the masses of metal situated on the surface of the ground to which they are connected, such as engines and boilers, gasometers, and other apparatus, and also together with the large masses of water in the reservoirs, rivers, etc., to which they are also connected, form an immense mass of electrical conductors in the neighbourhood of every town, and generally wherever an electrical installation is fixed; and it is to this mass of conducting material that leakage currents from electrical installations pass when they go to "earth." In addition to the conducting mass above referred to, moisture is also present in the soil of which the earth's crust is formed, in and on the bricks, stones, and wood of which our buildings are composed, and, except in very dry weather, on the metallic bodies used in the construction of our buildings, and this ever-present moisture forms a conducting path in direct connection with the large conducting masses referred to above.

As in most modern buildings gas is used in nearly every room, the water service often laid on to first and sometimes to higher floors, while tanks for the purpose of feeding the hot-water system are usually placed at the tops of the houses—these ramifications of pipes for the gas and water services, all more or less directly connected with the great conducting mass above referred, resident in and on the earth's crust, while moisture is present everywhere—"earth," or conductors in direct connection with the conducting mass described above as earth, meets us everywhere, to a greater or less degree, in every part of every building.

It may, perhaps, be as well to enquire, also, how "earth" behaves, what office it performs. In the early days of electrical science the earth was looked upon as a reservoir of infinite capacity, into which any quantity of electricity might be poured, and from which any quantity might be taken, by adopting suitable means. As the practical applications of the science developed, the reservoir theory was abandoned, and "earth" was looked upon merely as a conductor obeying the laws common to all conductors. More modern discoveries oblige us to modify this latter view, and to adopt one that is somewhat of a combination of the two. If we accept the latest views of the nature of electricity itself, that it is not only closely allied to heat and light, but that it also resembles those forces in being a form of molecular motion, it follows that "earth"—understanding by the term the definition given above—acts as a very large reservoir that is able to receive very large quantities of electricity; but it also acts as a conductor, and behaves as any other conductor, conveying electric currents between any two points at different electrical pressures.

The conducting mass we know as "earth" only acts as a reservoir on account of its large mass. It is able within certain limits to receive all the molecular vibrations that may be delivered to it by other conducting bodies in which the electrical pressure is higher. It also necessarily delivers

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current to other electrical conductors in which the pressure is lower than its own. "Earth," or the large mass of conducting matter referred to above, also acts as a conductor, just as it was imagined to by telegraph and telephone engineers of 15 to 20 years ago, but it acts as a conductor for any current that may require to pass, and between any two points between which an E.M.F.—a difference of electrical pressure—exists. Thus, to put the matter into practical shape, "earth" will receive current from any conductor in which an E.M.F. above its own exists, and it will either store the molecular vibrations so imparted to it, or it will pass them on to another conductor, or even to the same conductor, from which it received them, if a second connection is made to that conductor, and the pressure at the second connection is either lower than that at the first connection, or lower than that of "earth" at the point where the second is made. The "earth," of course, would assume the same electrical pressure as that of the first connection, less any charge that might be made on that pressure for the passage of any current that might pass through "earth" between the first and second connections; always supposing that another pressure had not been imposed upon it from another connection to another conductor.

In a large area, such as the neighbourhood of a large town, there will be many connections between conductors and earth, and between different points of the same conductor and earth at different pressures, so that there will be constant and ever-varying currents passing through "earth," which may be at ever-varying pressures throughout its area. That is to say, within the large conducting mass described as "earth," there will be currents constantly passing from points to points, obeying the same laws that currents in other conductors do, and arising from the same causes that currents always do arise—viz., the creation of differences of electrical pressures between different points in the immense conducting mass—and these differences of pressure will be caused in a great many instances by connections between various points in "earth" and various points in other conductors in which electric pressures exist.

Next, as to how leakage to earth arises. Leakage to "earth" takes place wherever there is an electrical installation, and from every part of the system; and the tendency to leakage is naturally greatest where the electrical pressure is highest. At the generator itself there is a leakage path through the insulation of both armature and field-magnet coils to the frame of the machine, and thence, by way of the foundations, or the moisture contained in them, to "earth." Where the generator is coupled directly to the driving engine, as in many modern central-station plants, the frame of the machine is itself in direct electrical connection with "earth" through the engine, steam-pipes, boiler, feed-pipes, etc. From the main cables also there is a leakage path, also through the insulation to the iron pipes, where these are used, and thence, by way of the moisture in the ground, to the gas and water services and "earth." At each transformer there is a leakage path, through the insulation of the coils, to the metal frame or containing box, and thence to "earth." At every junction box there is a leakage path, from the joint to the box, and thence to "earth." Within the consumers' premises there are leakage paths from each cable, through its insulation and through the moisture in the wood casing, the walls, etc., to the gas and water services. At every switch, ceiling rose, and lamp-holder there are leakage paths, by way of the moisture that is nearly always present on the cold porcelain surfaces of these apparatus, and thence by way of the moisture in the walls of the building to the gas and water services and "earth." In culverts where naked conductors are used there are leakage paths at every insulator by way of the moisture on the insulator, through the moisture in the walls and floor of the culvert, and so to "earth." In all these cases the leakage current will be very small, and such as will bring no danger of heating so long as the insulation resistance everywhere is well maintained—that is to say, so long as the cables are well covered with some form of insulator of a thickness in proportion to the E.M.F. opposed to it; and so long as the insulating envelope remains intact and its insulating properties good, the leakage current through the distributing cables will be small.

The same remarks apply to the leakage current from the generator, transformer, and consumers' cables. In dry situations also, and in dry houses, the leakage currents from switches, ceiling roses, etc., will be inappreciable. So long as culverts and junction-boxes can be kept dry, the leakage currents in them also will be small. But it is when the absence of all these requirements rules that the leakage currents begin to be troublesome. And it must be remembered that a leakage current which may do no harm at one particular point in a system may cause a leakage current at another part of the system to be more serious than it otherwise would be by creating a difference of pressure between the second point and the "earth" at that point, or by increasing an already existing difference of pressure. It is when the insulation of generators and transformers is not sufficiently high in proportion to the E.M.F. opposed to them; when the insulation of cables, both high and low tension, has not been made sufficiently high or of sufficient thickness, or has been damaged either in laying or in making; when culverts and junction-boxes reek with damp; when cables are fixed in new houses, with wet walls, without any additional precaution on account of the wet; when the insulation of cables has been stripped to make joints, and the envelope not properly made good, the partially bared cable lying perhaps in a trough of a damp casing, on a damp wall, not far from a gas-pipe—it is in all these cases that leakage currents of all kinds give trouble; and leakage to "earth" perhaps more than any other, because in many cases of the difficulty of locating it. And it should also be pointed out that, whatever the leakage current may be, it tends to improve the conductivity of its own path, very much as a stream of water does, though not in the same way. The leakage current through the insulation of the coils of generators and transformers, and through the insulating envelope of cables, and through the substance of the insulators used for naked conductors, switches, etc., gradually destroys the insulating properties of all the materials it passes through, so that the work it is doing and the trouble it may give is going on at a compound ratio. It has been already pointed out that the leakage current need not always be to earth; it may be, and often is, from "earth" to a cable or some portion of the system, the higher pressure at that portion of "earth" which enables it to send a current into the system being created by a leakage current from another part of the system, or even from an entirely independent system that is also connected to the same system of earth conductors.

Perhaps, however, the most dangerous form of leakage current is that which is set up between a cable carrying an electric light or power current and some conductor, such as a gas or water pipe, in direct connection with "earth," the leakage current being set up by reason of the insulated cable having been strained over the conductor. So long as the insulating envelope between the cable and the "earth" conductor is intact, and of sufficient resistance to prevent more than a very small current passing from one to the other, at that point all goes well; but the same process of deterioration that has been described above goes on there, and, in addition, there is a mechanical action, tending to gradually wear through the insulating envelope, or to squeeze it, till a serious current passes there. All buildings vibrate more or less, though the motion is imperceptible to us, and it is this vibration, causing friction between the earth conductor and the insulating envelope of the cable, that does the mischief. The greatest mischief, too, is often not complete till a second connection is made between some other part of the system at a higher pressure and another earth conductor, when, if the intervening conductor is of low resistance, and also, as may happen, of small section, very serious results follow.

Broadly, then, it may be taken that leakage to "earth" goes on from every part of an electric supply system, and that the quantity of the leakage current depends, as in other cases, directly on the difference of electrical pressure between various points of the system and earth, and inversely in proportion to the resistances to these differences of pressure offered at the several points. Leakage currents also take place from earth to points in every electric supply system, their strength being proportioned as with leakage

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currents to earth. Further, the strength of leakage currents tends to increase with time and use, both by reason of the deterioration of the insulator from causes other than the passage of the current, and also from the passage of the leakage current itself.

Next, how do leakage currents generate heat? There are three ways in which leakage currents to "earth" may generate heat. By conveying a very powerful current through a very small conductor; as when one connection to "earth" having been made at one part of the system a second connection is made to "earth" with another part of the system at a point at which there is considerable difference of electrical potential with the first point, and when in one of the paths to earth is included a short length of conductor of small section. If the connection to earth at the one point is of low resistance, and the resistance of the mass of conductors the writer has defined as "earth" is also very low, the electrical pressure at the "earth" where the second connection with the system is made is the same, or very nearly the same, as that at the point where the first connection is made, and consequently the short length of small conductor is exposed to the full E.M.F. present between the two points, and its resistance being small on account of its shortness, a powerful current will pass, which may heat the small conductor sufficiently to ignite combustible material in the neighbourhood. A case which came under the writer's notice some years since will, perhaps, illustrate this. An electric light installation had been put up in a small town, supplying a small number of houses within a limited area. Naked overhead copper wires were used for distribution between the generating station and the houses, very small and thinly-covered wires being used inside the buildings. The gas fittings were partially employed, flexible cords being led down from the ceiling plate to screwed attachments in the chandeliers. The small wires, where they were run in the floor, lay in a jumble under the floorboards, and over gas-pipes, attachments to gas chandeliers, etc. A connection was made with the gas service, and was known, though no effort was made to find out where it was. Some time after, a second connection was made with the gas service at one of the chandeliers in one of the houses, by one of the small wires lying in a jumble under the floorboard, and in such a manner that about 10ft. of No. 22 copper wire, thinly covered with guttapercha and cotton, formed a connection between the two points, and was exposed to an E.M.F. of 110 volts. The result was a very narrow escape of complete demolition of the house. The wire exposed to this voltage became white hot, melted, melted the guttapercha, and had ignited the woodwork, when, fortunately, it was stifled.

Remembering that the formula which rules the heating effect in these cases is

$$H = \frac{E^2}{R} t,$$

where H is the heat generated in time t, E is the E.M.F. present, and R the resistance opposed to it, it will be seen how serious these cases may become. In the present instance, the formula worked out—

$$H = \frac{110^2}{\cdot 1} = \frac{12{,}100}{\cdot 1} = 121{,}000 \text{ watts} = 160 \text{ h.p.}$$

Or, to put it in another form, the heat generated was sufficient, if maintained and properly applied, to boil three gallons of water in one minute. In the above instance the gas service had become connected to the two sides of the lighting circuit, with only the resistance of the small wire mentioned opposed to it; but it should be remembered that it is by no means necessary that the two sides of the circuit should come into connection with earth to produce dangerous heating effects. With an installation of arc lamps in series, for instance, or a system of high-tension distribution by transformers, the connection of two points in one cable to earth, if one of the connections be made through a short length of small wire, and in such a manner that a powerful current is caused to pass through the wire, will lead to dangerous heating effects.

It may, and does, frequently happen that a difference of electrical potential of 100 volts exists between two points in one cable of a high-tension distribution service—say, between the generating station and a point a mile distant. If that particular cable is "earthed" at the generating station, and a connection between it and earth be made at such a distant point, say, through some small piece of wire left in the neighbourhood of the high-tension cable, then when the second connection is made through the small wire a very dangerous amount of heat will be generated in that wire, and will ignite any inflammable material in its neighbourhood. In those cases also where it is the practice to "earth" one high-tension main at both ends, a similar result may arise if the earth connection at either end is not looked after; and in place of consisting of a large conductor connected both to "earth" and to the cable by large contact surfaces, the connection is allowed to become smaller and smaller, say, by wires of a strand breaking off, till at last the connection is only made by one or two small wires necessarily of short length. Then, if the resistance of the "earth" itself, of the body of metals, damp, etc., lying between the two points is small, and the connection at the other point is good, a dangerous heating current will pass the first time after the cross-section of the connection is so reduced that the E.M.F. between the two points rises above a certain figure. That is to say, probably the first time the working load is put on the cables.

(To be continued.)

INSTITUTION OF ELECTRICAL ENGINEERS, May 20.

On Dynamos.

BY W. M. MORDEY, MEMBER.

(Concluded from page 729.)

In endeavouring to obtain the same effect in a drum armature, the first and obvious course is to form an element, as in the

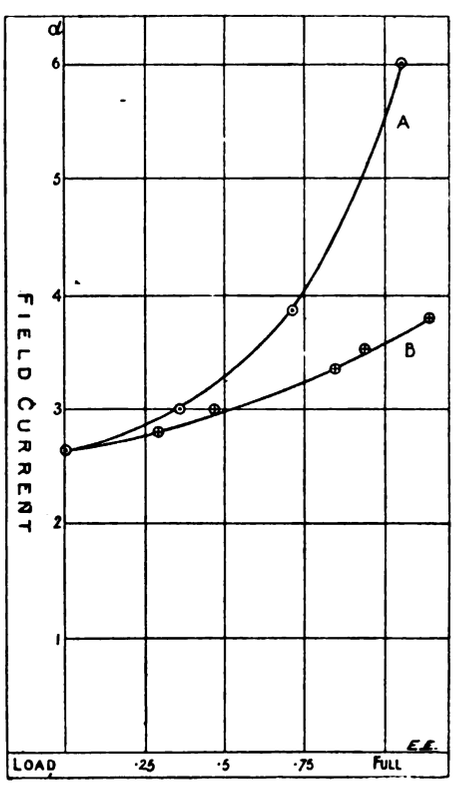

FIG. 9.

Gramme winding, of two turns joined in series, each turn wound as usual over a diameter, or an approximate diameter, but the two crossing one another at the required angle to give them the same relative positions on the core, or the same relative E.M.F.'s as in the Gramme. But since each turn has two separate and distinct E.M.F.'s, we at once observe that this procedure may be simplified by so disposing the two halves of each turn that the parts of a single turn will occupy the required

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relative positions and form a complete element—that is to say, we may wind the single turn, not across a diameter, as usual, but across such a chord that its two portions comply with the conditions stated in the preceding paragraph. And by so winding and so connecting the turns in the required order we get nearly all that is desired. Such a winding will give us conditions equivalent to those shown in Figs. 5 and 6. And if we wish to go further and to obtain conditions equivalent to Fig. 8, and we cannot find a chord capable of giving what we want, we may use a double turn of any combination of chords we desire. Fig. 10A shows such an "element."

But it may be said that chord windings have often been

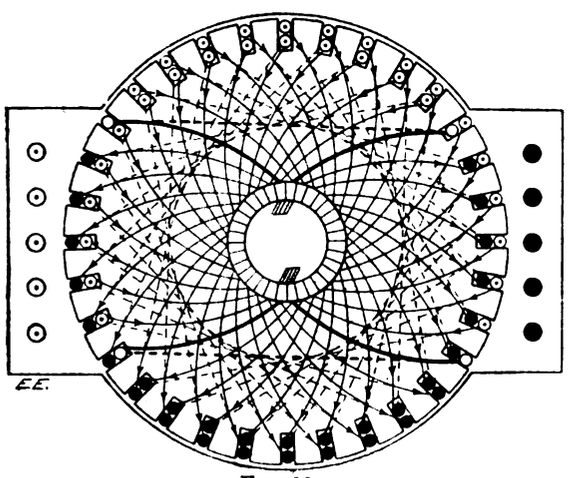

FIG. 10.

proposed—that Swinburne went into them pretty fully a good many years ago—that the very first elementary diagram of a drum in Thompson's book* shows a sort of chord winding; and, further, that toothed drums are well known and have long been used—that toothed armatures are indeed as old as the magneto machine. All this is granted. And it may be said that there can be no latent or undeveloped possibilities in the suitable combination of these two things, since the severe commercial competition of the past few years would have surely brought them to light. But it is possible that the complicated nature of the disease has prevented a simple remedy being sought for.

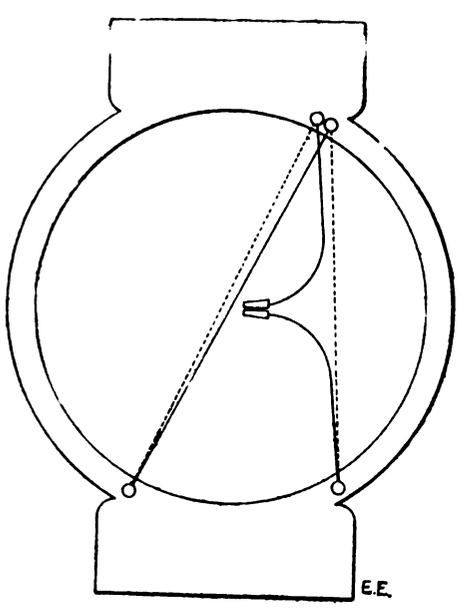

FIG. 10A.

This section may conclude by an account of results obtained by modifying a toothed drum dynamo on the lines explained. The machine was a new one, just turned out by a well-known firm of Continental manufacturers. It was supplied to do 15 kilowatts at 1,050 revolutions. As received, it gave the Curve A, Fig. 9, which shows the excitation at various loads, with constant volts and constant speed. The collection was not good even at small loads; it had no sparkless position, and the volts varied very much when the brushes were moved slightly. It was then rewound with a conductor of the same cross-section as before, and with the same number of turns. There were 32 slots and 32 sectors, four conductors in each slot. The actual winding diagram is given in Fig. 10, which is obviously a much more convenient and simple winding than the ordinary diametrical winding. Keeping the gap the same, it was re-tested, and gave Curve B, Fig. 9. The collection was now excellent; the excitation at full load was 72·5 per cent. in amperes, and 44 per cent. in watts, of the old excitation. The variation of volts for a given movement of the brushes was a quarter of what it was before; the full-load lead, which was originally 67·5deg., was now 12·5deg. The machine would now probably pass muster as a satisfactory one in every respect; previously it certainly could not have been considered a first-class machine, nor even a good example of an ordinary toothed-armature dynamo. Copper gauze brushes were used in both tests.

* "Dynamo-electric Machinery," p. 39 (1896).

BRUSHES AND COLLECTION.

The importance of good collection makes it worth while to carefully study, not only the main conditions, but any minor

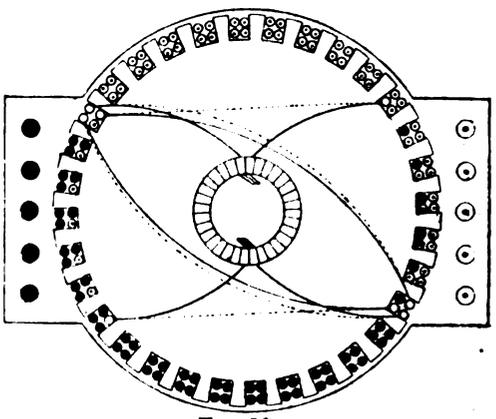

FIG. 10B.

effects that bear on it. Dynamos may be designed so liberally that they are almost incapable of sparking under any circumstances. But this is expensive, and we should try to develop less costly methods, and, if possible, find how to check tendencies to sparking. Prevention is not always better than cure. Many inexpensive dynamos, if cured of sparking, would be quite good and useful machines.

There are few matters of which our knowledge is less definite than the exact actions in the region of the neutral line, or even the precise causes of the movement of that line. This line of best collection is usually assumed to be definitely determined by conditions depending on the armature-turns and current, the strength of the field, and so forth—that in a given machine, with a given load, the angle of lead is quite definite, and only to be altered by structural modifications of the machine, such as increase of gap or change of polar surface. But, as a matter of fact, it is quite possible to shift the collecting line without any structural alterations—not merely to collect further back, but to get the best collection further back, and good collection no longer possible at the forward position, which previously was the best one.

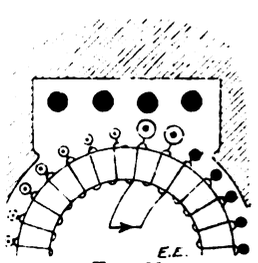

FIG. 11.

Among the numerous and complicated actions that take place under the brush, there is one that has an important influence on the angle of lead—that is, the amount of current flowing in the short-circuit. As the coils go successively under the brush and are short-circuited, the pre-existing direction of current is continued, then it falls to zero, and then, as the coil passes out from under the brush, it rises again in the opposite direction. It will be clear from Fig. 11 that this short-circuit current may quite perceptibly increase the armature reaction by adding to the demagnetising effect in the "magnetising space." The amount of this current may vary in different dynamos from very small values up to something considerably more than the working current. That is to say, when the coil goes under the brush the current may either fall quickly or slowly to zero, or it may rise to several times the working current before falling to zero. The large circles in Fig. 11 indicate the large short-circuit current, and show clearly how it may add to the demagnetising effect. Experiment has shown that by checking this current it is possible to considerably reduce the lead angle. In explaining this effect a preference may be felt for regarding the gain as due to the smaller reversing field required, and therefore smaller lead, resulting from the more rapid reduction of the existing current. This comes to pretty much the same thing.

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Even in a dynamo which works sparklessly and well, the short-circuit current may be serious in amount. It is harmful in many ways. It causes waste of power, both in the short-circuit itself and in the field winding, which must be increased to compensate for it. It reduces the output by lowering the sparking limit, by increasing the lead, by increasing the drop of volts, by requiring larger brushes and commutators than would otherwise be used. This short-circuit current may be checked by an opposing E.M.F. or by a resistance ; the former requires structural alterations.

Resistance in Commutator Leads.—The obvious way to check such short-circuit currents is by the insertion of resistance in the portion of the circuit under commutation ; as, for example, between the commutator and the collector. This is easy ; and, as the resistance is only in circuit as the coil passes the brush, and at no other time, an amount may be added large in proportion to the resistance of the coil short-circuited, but small as compared with the whole armature. But this plan, although it possibly has some effect on armature reaction, has no marked effect on sparking, for a very simple reason. To break a circuit without sparking, a resistance should be gradually introduced, and the circuit broken when the resistance is a maximum and the current a minimum. Unfortunately, this is not what happens in the case under consideration. The resistance is introduced and removed suddenly. Experiment has confirmed this explanation. Resistance was added to the commutator connections of an armature without any noticeable effect on the sparking. The amount was varied from something quite small to sufficient to increase the C R drop about 20 per cent.

Resistance in Brushes.—By a simple expedient the brushes themselves may easily be made to do what is wanted. An ordinary brush connects the adjacent sections by a path of very low resistance, allowing currents to circulate freely, checked by little more than the "contact resistance." The study of reactions leads naturally to the perception of the qualities a brush should possess. It should have a low resistance, so that it may easily carry large currents ; and it should have a high

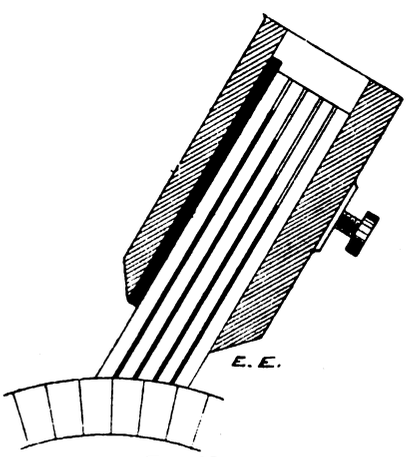

FIG. 12.

resistance, to prevent the circulation of large currents. Fortunately, this combination of opposite qualities is attainable by lamination across the path of the circulating currents. If a brush is slit or divided by insulating divisions (as in Fig. 12), although it is just as effective as before for the main current, it opposes a much longer path than usual to a short-circuit current, which, in consequence, is much reduced.

And the graduation of the resistance so that it is removed gradually from the circuit is not difficult. A little thought will make it clear that, as sparking does not occur when a contact is made, but does occur when it is broken, we should encourage the current to enter the brush at the back, where the brush is making contact with the sectors as they successively pass under it ; but we should discourage it from entering by the front, where the brush is breaking contact with the sectors as they successively pass away from it. Such a distribution of current is facilitated by making a good contact at the side of the brush for which the current should have a preference, and a bad contact, or none at all, at the front side, where it is desired that only a small part of the current should enter. Fig. 12 shows this arrangement.

Brushes of this sort are easily made—for example, by placing together a number of thin plates or layers of carbon, or metal gauze or foil, with an insulator between the layers except near the end where they are brought into contact. With carbon plates a good plan is to stick the plates together with an insulating cement except at one end, where tinfoil is put between them to ensure contact ; they then form solid blocks like ordinary carbon brushes. Such brushes applied in a particular case gave a better collection, and only half the lead of ordinary copper gauze brushes ; they were distinctly better than ordinary undivided carbon brushes.

Carbon brushes were originally proposed by Forbes. Their good effect was at one time attributed to small friction against the commutator, and to some peculiar property by virtue of which the current passed to them more easily than to better conductors. Their success, probably, is owing simply to their high resistance, by which they are enabled to check reactions after the manner described. One objection to carbon brushes is that, on account of their high resistance, they require to be of larger section than other brushes, a density of 75 to 100 amperes per square inch being as high as they should be worked. If this density is exceeded, they heat very much at the contact surface. Possibly they may be made to carry larger working currents when made so that the circulation of current through them is reduced. What the actual current density is at the contact face in any given case cannot easily be determined, as the circular effect so disturbs the distribution of the current at the face by increasing it at one part and opposing it at another. The action of heat in changing the conditions by varying the resistance may also be worth a passing notice.

DRAG ON BURIED CONDUCTORS.

Whether any mechanical pull is exerted directly on or by the conductors of armatures having sunk windings, has been repeatedly discussed. It has, of course, been freely acknowledged that, in slotted armatures, the support given to the conductors by the teeth makes such armatures mechanically superior to those having smooth cores. But many able persons hold that the advantage goes no further—that the teeth act only as so many "driving horns," the torque coming on the conductors, which are actually driven by the teeth through the insulation. If this is the case, the conductors ought to be as securely fixed in the slots as possible, in order that the racking and hammering of the insulating material may not affect the life of the windings.

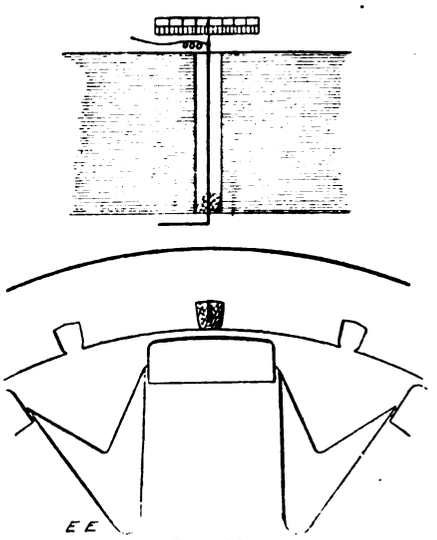

FIG. 13.

There is considerable importance in this matter, both theoretical and practical. The practical considerations are of the greatest possible importance, for on the answer to this question many vital things depend affecting the engineering aspects of electrical applications. Constructors of electrical machinery have laboured (or have often believed they laboured) under a very serious disability—one which often seemed to present an effectual bar to the thoroughly satisfactory solution of many electrical engineering problems. This disadvantage has been the use of very unmechanical materials for mechanical purposes. It is probable that every electrical engineer has respectfully watched a locomotive take a heavy train up an incline, or the passing of an express train at full speed, and has thought of what it would involve if this work had to be done by the medium of a pull exerted on cotton-covered copper conductors tied by piano wire to the surface of a smooth drum covered with shellaced paper and mica. The unmechanical character of insulators has always seemed to stand in the way.

But if there is no drag on a buried conductor, it changes all this. We need then no longer envy the mechanical engineer, for we, too, can put metal to metal and make sound mechanical joints, and take our strains on the iron and steel parts of the machine instead of on flimsy copper and flimsier insulation materials. The windings then present no mechanical problems, and the unmechanical character of paper and cotton ceases to trouble us.

It may be thought that this point has long been settled, but that there is still much uncertainty about it is evident from quite recent utterances. This arises, no doubt, from the absence of experimental proofs—definite trials do not seem to have been made. An account of some trials is therefore given here. An

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inductor alternator was used having a stationary slotted armature, the polar projection of the rotor being of one polarity only. The arrangement is shown diagrammatically by Fig. 13. One of the armature coils was removed, and in the empty slot was placed a conductor consisting of a copper strip 1in. by 0·1in., rigidly supported at one end and free at the other. A connection was made to the free end by a flexible conductor, and a pointer was attached moving over a fixed scale to show the deflection of the conductor. The strip was joined in series with four of the armature coils, a Siemens dynamometer, and a non-inductive external circuit.

The following experiments were made: (1) The machine was run at 25 ⌒ without any load except on the four coils and the strip (the whole armature contained 20 coils). The position of the pointer was noted on the scale. The circuit was then closed, and the current adjusted to 200 amperes. This caused a very perceptible vibration of the strip, the pointer showing a mean deflection of about 0·09in. The machine was stopped, and the conductor loaded by a weight applied in the middle of the free active portion (which was 10in. long), when it was found that a deflection of 0·09in. was produced by a weight of ½lb. The calculation given below shows that if the full drag came on the conductor it would correspond to about 4½lb., so that only about one-tenth of the full drag was borne by the conductor in this experiment. (2) With the machine standing and a pole-piece opposite the slot (as in Fig. 13) and the field excited as before, a direct current of 200 amperes was passed through the conductor: it was found that the steady deflection was rather more than before—viz., 0·12in.

From the data given by the tests of this alternator, 10in. of active conductor (the length used in the experiment) would give 1·38 volts at the periodicity used—viz., 25 ⌒. Assuming no phase displacement—

200 amperes × 1·38 volts = 276 watts = 12,170 ft.-lbs. per minute.

Surface speed at gap, 2,590ft. per minute. Hence, if the full drag came on the conductor,

$$\text{Drag} = \frac{12,170}{2,590} = 4{\cdot}7\text{lb.}$$

The comparison as to the effect of the drag and the weight is based on the assumption that the conductor was rigid and straight, instead of being slightly curved, as it would actually be; but the error produced by this assumption is unimportant. It may be explained that in actual work the winding is such that each conductor carries about 80 amperes, and the ampere-turns in each slot are about 12 times those produced by the single conductor.*

Armature Excitation.

With leading brushes the armature current opposes the field current. But with no load, leading brushes assist the field current under suitable conditions—that is to say, the effect with leading brushes is at no load the reverse of what it is at full load.

Consider a dynamo running without load. If the brushes are given a slight lead, as in Fig. 14A, a current flows through the short-circuited coils in such a direction as to assist the field. Further, if a brush is made to span a number of sectors, as in Fig. 14B, this assisting short-circuit current may be made to flow not only through the coils in advance of the neutral line, but through some of the coils behind the neutral line. To get this latter result, it is only necessary that the short-circuit should include a greater portion of the winding in front of the neutral line than behind it, then the E.M.F. of the forward coils will overcome that of the backward coils, and a current will be forced through the latter contrary to their E.M.F. It will also be obvious that if the coils behind the neutral line are short-circuited by a brush a demagnetising current will flow, which in a similar way may be made to extend to the front of the neutral line. The increase of excitation obtainable in this way is considerable. It was found quite easy to raise the volts of an ordinary dynamo 20 or 25 per cent. A much greater increase could be obtained momentarily, but excessive sparking made it undesirable to continue the experiment.

This effect is exactly the reverse of the short-circuit effect under the brushes referred to in the section of this paper headed "Brushes and Collection." But the two effects are not contradictory. In one case it is the working current in the armature behind the brush, and the continuance of the same direction of current under the brush, that opposes the field winding. The direction of current in front of the brush is always assisting. It is in this latter direction that the short-circuit current is set up under the conditions named, and the result is naturally to strengthen the field.

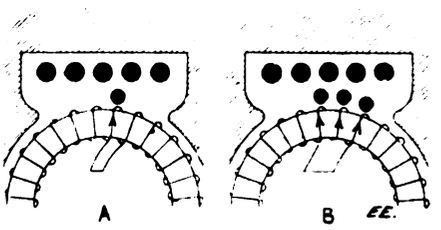

Fig. 14.

A rather interesting difference between the conditions of the magnetic circuit on the two sides of a dynamo may be referred to here. It was found by experiment with a single-magnet Gramme dynamo that, although the increase of volts was considerable when a wide brush was placed on the upper side, no further increase occurred when a similar brush was put on the lower side. Fig. 15 shows a single and double horseshoe form of magnet. In the former the armature current in the magnetising space on the upper side is acting on a magnetic circuit, shown by the line, L, which passes mostly through iron. On the lower side, however, the line, L′, passes mainly through air, and consequently the effect of the current is not so great. The difference will, of course, be most marked in small air-space dynamos. In a double horseshoe magnet, as shown dotted, the conditions on the two sides are similar. Effects of this kind are best studied with a Gramme armature, as the short-circuit caused by the brush is confined to the coils on a definite portion of the ring. In a drum, the short-circuited coils pass round the armature, and consequently the separate effects in the two magnetising spaces cannot be so well observed. This subject is referred to only as illustrating armature reaction,

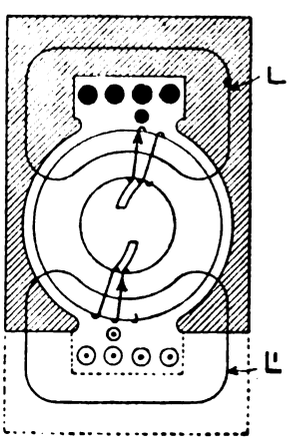

Fig. 15.

and not for any immediate purpose of practical utility. It may, however, suggest a useful result to some ingenious person.

Internal Fields.

The consideration of armature windings which reduce the amount of field winding required, and a recognition of the proper function of the field magnet, lead naturally to a revived interest in internal field magnets such as were introduced and advocated long ago by Profs. Ayrton and Perry.* There is now much to be said in favour of such arrangements. In those machines the armature and commutator were fixed, while the brushes and the internal shuttle-shaped magnet revolved. One only shrinks from recommending a return to such constructions because we have become accustomed to stationary brushes capable of adjustment while in use. But it would be unwise to sacrifice too much to retain this convenience. Our dislike to revolving brushes is to a great extent a legacy from the spark age. If machines can be made to work sparklessly with brushes in a fixed position relatively to the field, then the main objection to revolving the magnet and the brushes is removed. The

* On this subject the following interesting observations by Mr. Swinburne appeared in *Industries and Iron* of February 2, 1894: "Some electricians have difficulty in realising that in dynamos with notched armatures there is little or no force on the coils. They argue that as the conductors produce their full electrical pressure they must be cutting the field, and as they move uniformly and cut the field uniformly, they must be in a strong field, and must therefore have the same force acting on them as if they were on the outside of the armature. There is a fallacy here, however. The pressure depends on the rate of cutting lines, and the lines may be moving very rapidly in the opposite direction while they cut the wire, so that the actual field in which the wire finds itself may be very weak indeed. Imagine a notched armature and field. The lines will crowd into the teeth, and avoid the notches. Take any one line: as the armature moves, it cannot be imagined as being dragged round with it; it must therefore cross the notch to the next tooth. It will do this very quickly. To get an idea of what would be necessary to imagine the lines of induction, we can think of the appearance of iron railings seen through a carriage window with a knot or lump on the glass. There are practically no railings seen through the knot, and they are crowded on each side of it, and as the carriage moves they jump across the knot. The same number per second passes the knot as any other part of the window, but they are always less dense in the knot. The lines in a hole or notch-wound machine must be mentally pictured in this way."

* *Journal*, xii., p. 335, May 10, 1883.

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objection, even now, has not much force, as is evident from the common practice, as in tramcars, of running motors where they cannot, or do not, get any attention whatever when running.

Internal field magnets have been largely used on the Continent, the field magnets being fixed. Siemens and Halske and others have made very fine machines of this kind. Usually the outside of the armature is made to serve as commutator, but sometimes a commutator of ordinary form is used. As a type it is at present more especially suited to large sizes, because of the difficulty with small sizes of getting sufficient internal space for the magnet; but this difficulty disappears to some extent if we can reduce the amount of field winding and the cross-section of the field core.

If this paper has seemed needlessly long, indulgence is asked on the ground that the object has been to make the explanations clear, not to experts only, but to all who take an interest in and have a general knowledge of the subject. My thanks are due, amongst others, to Mr. L. Wilson and to Dr. Fleischmann, and in particular to Mr. A. G. Hansard, whose very able and willing assistance has been of great service to me in the preparation of this paper.

DISCUSSION.—May 27.

Sir HENRY MANCE (president) in the chair.

The ballot-list was given as usual last week. This being the last evening of the session, the following candidates were balloted for and elected at the close of the proceedings: as associates—Messrs. Robt. Campbell (Indo-European Telegraph Company), J. W. Fielding (Derby), W. Ramsay (Glasgow), and W. Routledge (South Shields).

The **Secretary** read the address to be presented by the Institution to the Queen on the occasion of attaining the sixtieth anniversary of her accession.

Mr. Mordey, before the discussion on his paper began, added some words of correction. These need not be further referred to, as the corrections are made in the paper given above.

Prof. Silvanus Thompson considered that the Institution was to be congratulated on getting a paper with the practical importance that Mr. Mordey's possessed. He (Prof. Thompson) had commented somewhat harshly on the want of patriotism displayed by some members of the Institution in giving the first description of novelties in papers read before other institutions. Though Mr. Mordey had made it exceedingly obvious in his diagram, it was not absolutely new to say that the problem of the magnetisation should be considered from the point of view of the armature and not of the field magnets. Prof. Forbes brought it out some years ago together with Mr. Eckemeyer, who used coils sunk in cavities. He (Prof. Thompson) had discussed formerly with Mr. Mordey the question of what was then called cross compounding—that is, there was a thick coil in series with the armature wound across both limbs of the magnet, so as to combat the cross magnetisation from the armature with another and opposing cross magnetisation. Mr. Mordey and himself went so far as to draw up a provisional specification, but then came out the discovery of cross-compound winding sunk in the channels of the pole-pieces, which left them very little to claim. There was, he thought, however, one thing of value which was left them, and that was that their method left it possible to them to fix the brushes in one place and regulate the line of magnetisation to suit the brushes by altering the current in the cross-compound winding—that is, they got an electrical instead of a mechanical adjustment. Mr. Sayers compounded on the armature instead of on the magnets, and now Mr. Mordey, operating upon the armature—that is, upon the very part of the machine which produces the distortion—had removed it by a very simple method. It was extremely interesting to see by what a small modification such great results were obtained. It was a thing which might have been done at any time since the Gramme ring was brought out in 1870, but though they had been all more or less trying to effect the object, no one had thought of this particular way till 1897. He would add a word on the experimental investigation Mr. Mordey had made into the fact that the drag which in solid armatures is upon the coil, in the toothed variety was removed from it to the core. If Mr. Mordey found that it was not completely removed, but about one-tenth remained on the coil, that only showed that the coil was not completely protected by the iron.

Mr. G. Adams read a written speech. It was to the effect that he did not agree with Mr. Mordey that the modern dynamo was an unsatisfactory machine. The paper was an indictment of smooth-core armatures. If these were bad, why were they almost universally made in English practice? The steel castings wanted were difficult to obtain in England. The need for ventilation in Mr. Mordey's machine should be less, not more, as with smaller field windings the C^2R loss would be less, and toothed armatures were better radiators than smooth.

Mr. Sayers would confine himself strictly to one or two points. He was unable to see that Mr. Mordey's arrangement of the winding would produce any advantage except for very small machines. A certain reversal of E.M.F. was necessary for sparkless commutation. Mr. Mordey said, by dividing the wire into two parts, he could get the opposed E.M.F. and have no sparking. So long as there was no current in the armature that was true, but the moment the load got on, the left-hand pole was strengthened (Fig. 4) and the right-hand pole was weakened. Now, the right-hand pole was the one Mr. Mordey must reverse with. If the coils were divided into two equal parts, the balance would be in the wrong direction. If the brushes were slid forward to get away from the trailing pole, the commuting power was seriously diminished. In Fig. 10 there was balance of current, but the expense at which it was attained was that there was only one bar to commute upon against three. From his experience in solid armatures—he spoke with the knowledge that humanity was fallible—he was nearly certain that that would not work. Mr. Mordey had gone a long way too far in estimating the gain from the possibility of a reduction in the air-gap. For mechanical reasons it was impracticable to work with a very small air-gap. The smallest he had been able to use was a gap of 1mm., and that was in a motor-generator with a comparatively weak field, and which would not have run for any time if the field had been a very strong one, because the slightest difference in the gap on either side would bring into play such an enormous force tending to strain the shaft that it would give, and the armature would go over entirely to one side and stick to the magnet. Working sizes were ·15in., ·275in., and ·375in.—in fact, ⅜in. Again, eddy currents in the poles were to be taken into consideration, and there must be some proportion between the air-gap and the pole distance, as it was, for commercial reasons, impossible to laminate the field. If the field iron was nearly continuous round the armature, a very slight alteration of the brushes produced a very great difference: the arrangement became delicate and easily upset, and a back E.M.F. was got where it was not wanted, with sparking as a result. He had found it advisable to make the sides of his slots parallel. Mr. Sayers illustrated on the blackboard various effects of magnetic leakage and induction on the bar in the slot, or of the bars on each other when there were several. With chord winding, machines with a number of conductor bar sections are very much more difficult to commutate owing to the different amount of induction in the succeeding bars. The self-induction effect increased as the square of the number of conductors or more. His plan to get over this was to distribute the coil over, say, three successive slots, so that the conductor took a different position in each. He, of course, thoroughly agreed with Mr. Mordey as to the drag being mostly taken off the coil in a toothed armature. Mr. Swinburne had explained it. What really happened was that the conductors traversed a weak field at a great relative velocity. He was glad Mr. Mordey had come round to his way of thinking as to cheapness, because most of the makers had maintained that the toothed armature was the more expensive. In reference to the question of a current generated in the short-circuited coils under the brush, he had concluded some time ago that there could not be any amount of current under the brush unless the machine was sparking. If the current was increasing when the coil came under the brush, there was no chance of reversing. With the brushes too forward or too backward there were opposite effects; but of the two possibilities he believed running out of circuit with the right current in, instead of a reversed one, was far the less damaging. It seemed, however, impossible to generate any great current under the brushes unless the machine was absolutely blazing.

Mr. Blathy, of Budapest, was called upon, but excused himself from speaking.

Mr. Esson was sorry Mr. Mordey had disfigured his paper by his way of spelling the title. Dynamoes spelled with an "e" seemed to have different characters from dynamos spelled in the ordinary way. Again, Mr. Mordey spoke of magnetising space. Magnetising coils could be understood, but what was magnetising space? Much of the paper was not new, and some of it was very ancient history. He (Mr. Esson) himself long ago in the *Electrical Review* had pointed out the advantage of toothed armatures which Mr. Mordey now mentioned. In fact, they were quite aware of the advantages of toothed armatures 10 years ago. The question was then why had they not been adopted. It was, so far as he was concerned, on the score of expense, because he did not see his way to construct toothed armatures cheaper than smooth ones. There was also a difficulty in stocking toothed-armature machines, because, in general every consulting engineer wanted something special, and to make a new armature was expensive. Mr. Swinburne and himself had in papers at one time or another discussed almost every suggestion in Mr. Mordey's paper. He (Mr. Esson) could not help admiring the way in which Mr. Mordey sprung his surprises on the Institution. He would come down and tell them that his alternator had no self-induction, and then next time that his transformer had no hysteresis—now it was that we were to have a small air gap and toothed armatures. He (Mr. Esson) imagined that there would be some difficulty in convincing them of it; for it really resolved itself into a question of cost. In small machines, cost of labour was everything and cost of material nothing. As a matter of fact, chord winding did not infallibly prevent sparking; it might even produce it, because it reduced the neutral line. It was said that all the molecules of the human body were replaced in seven years. Well, something more than seven years ago Mr. Mordey came down to the Institution in his best form, prepared to dispute everything put forward by Profs. Ayrton and Perry, and to say that by their heretical views they had retarded the progress of the industry. Seven years exactly marked the time it took Mr. Mordey to turn a mental somersault. He (Mr. Esson) was glad to find that Mr. Mordey had changed his ideas, but rather wondered where he would be in seven years more. He was glad Mr. Mordey had said something about the drag on the buried conductors, and that it was not anything like what it would be in a conductor on the outside of the core. The thanks of the Institution were due to Mr. Mordey for bringing before them so large an amount of matter in so small a compass. It was like old times to have these things threshed out anew at largely attended meetings.

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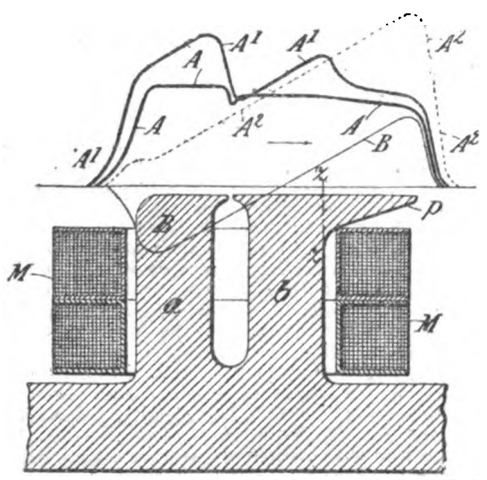
Mr. Raworth said the only reason why Mr. Esson could say that part of the paper was ancient history was because Mr. Mordey took the thing as it existed, and by one touch of a master hand had converted it to better use. Two weeks ago he saw an armature made by the Gramme Company with pole-pieces coming close to the armature. On looking close, however, he found that the pole-piece was hollowed out 1in. to 1¼in. Unless the Gramme people were behind the times, that it had proved necessary to do that showed that Mr. Mordey had not been talking ancient history. Most of Mr. Sayers's arguments would appear to hold water for small machines as well as large ones. But the machine constructed in Mr. Mordey's way did actually run sparkless up to 15 kilowatts. Mr. Sayers must therefore show that his arguments were not merely theoretical objections which did not obtain in practice. The Brush Company had taken out a license under Mr. Mordey's patent, and he hoped they would reap much benefit from it.



Enlarged Section of Differential Pole, with Diagram of Air-gap Induction.

Mr. Ernest Scott, from an inspection of the diagrams, had come to the conclusion that in Mr. Mordey's winding there would be more dead wire than in the ordinary way, and therefore a greater C^2R loss. The difference, of course, was not serious. Mr. Scott further remarked on the cost of increasing the number of "sweated" joints. There was a considerable saving in the form of machine with the internal field. It was only in the larger sizes that one got cut in the space for field copper, and not, as one would have thought, in the small ones. With an internal field a collector was required to get the current into the field winding. Prof. Thompson had suggested laminating the field. It seemed possible to carry the laminations across at right angles to those of the armature.

Mr. Mavor said Mr. Mordey deserved great credit for obtaining a result which was got in another way by Mr. Sayers. The latter was perhaps the better way. If the machine had a very falling characteristic, and was driven by an engine with a throttle governor, the engine would have to run at faster speed for full load than for light load, which was an advantage. He strongly agreed with the speakers who said it was not sparking or heating that limited the air-gap, but the strain on the shaft or bearings when there was any asymmetry. The winding of Mr. Mordey would not be applicable to machines with one conductor for each plate, and it was with these that the difficulties occurred.

Mr. R. E. B. Crompton said dynamo construction was not such a simple thing as the discussions on it in that Institution might lead one to suppose, and he did not think those discussions had taught them very much or had led to any useful result. Mr. Sayers spoke in the tone of a man who in the course of carrying out his ideas had met with difficulties which he did not expect. In his own firm, Mr. Brown had begun upon somewhat similar lines. The results obtained by Mr. Mordey had been obtained by others for small machines, but could not be obtained for large ones. The life of the builders of large dynamos was not an easy one. Experiments might be carried out on small machines which gave every promise of success. Everything might seem correct, but when it was attempted to repeat them on large machines it was entirely different, and a thousand pounds was gone before one could turn round. He thought he could claim to belong to a firm which turned out machines which worked sparklessly; but that was only by the observation of a number of conditions, and not by any royal road such as that suggested in the paper. He thought, however, that the winding suggested by Mr. Mordey would prove of great service to them in many cases, but not in all. It had always been a tempting thing to turn the machine round and make the field revolve. He himself had attempted the problem. It was all very well to say that we live in a sparkless age. That was only true in so far that by little adjustments they could turn out a machine which would run sparklessly, and these adjustments would last some considerable time before they required attention again. But with a revolving field one came to the absolute impossibility of adjusting revolving brushes, that is, if it was to be done at the time when they should be adjusted—namely, when they were taking current. The problem seemed insoluble unless someone would produce an absolutely non-sparking machine without adjustment. Neither Mr. Sayers, nor Mr. Mordey, nor Mr. Brown had done that yet, although they had done a great deal.

Mr. Hawkins said in Mr. Mordey's plan there was no automatic readjustment, which was the charm of Mr. Sayers's device. If Mr. Mordey's machine ran sparkless at no load, it would not at full load without altering the brushes. He had to emphasise the remarks of previous speakers as to the enormous force brought into play in the armature by any asymmetry if the air-gap was made very small. He was surprised at the affection of Mr. Mordey for the Gramme-ring method of winding.

Prof. Ayrton being called upon said it was too late in the evening to speak at any length.

Prof. Jamieson said, as he had not had an opportunity to read the paper before coming, he would communicate anything he might have to say. He was afraid Mr. Esson's speech betrayed him as coming from Aberdeen, where everybody opposes everybody else. That was the only reason he could find for his disagreeing with Mr. Mordey.

Mr. R. W. Weekes doubted the application of Mr. Mordey's idea to large-sized dynamos, as these had only a single turn per commutator section. He then described with a sketch the Lundell arrangement of reducing the effect of the armature reaction by utilising approach to saturation to make the shape of the poles act on the distribution of the magnetic flux. [The details of this method were given in our columns of February 26, from which the adjoining block is taken.]

Mr. Gadsby remarked that a counter E.M.F. might be obtained by varying the windings in other ways than that suggested by Mr. Mordey. For instance, it would seem that slanting the conductor in reference to the axis of the armature would give it [*i.e.*, so that the coils go like the thick bar of an N, but Mr. Gadsby drew it on the board to slope the other way]. Or it might be done by retaining the winding parallel to the axis and skewing the pole-pieces.

Communications had been sent by **Lord Kelvin** and **Mr. Gisbert Kapp**, but it being already much beyond the usual time of rising they were not read.

Mr. Mordey said he would confine his reply to the principal points. He had to thank Mr. Sayers for making the paper possible. He (Mr. Mordey) had never said there was no lead given to the brushes, or that they were in the same position at no load and full load. The object was to reduce the lead, and it would be found that in one machine rewound on his plan the lead was reduced to one-fifth. The proportion in which the sparking was reduced was not so easily expressed, since it disappeared altogether. He regretted that Mr. Blathy had not been prevailed on to speak. Mr. Esson complained that there was little new in the paper. He (Mr. Mordey) agreed, and consequently had hesitated to offer it to the Institution. Mr. Esson further made it a matter of complaint that something he had written in 1886 had not been referred to. The literature of dynamos was extensive. Mr. Esson had certainly tried his hand at making toothed armatures which did not spark, but he never succeeded; so he should now let the other fellows have a chance. Mr. Swinburne had written him (Mr. Mordey) a letter, in which he treated his work in quite another spirit. He (Mr. Mordey) wished fully to acknowledge the importance of the work of Mr. Swinburne, Mr. Sayers, and Dr. Hopkinson on the subject. Mr. Esson threw it in his teeth that he once had said that the hysteresis loss of a transformer got less at full load. At the time he said so, that was generally supposed to be quite wrong. Some investigations of Mr. Wilson were published in the *Electrician* some time afterwards. These were so extremely scientific that few people read them at all, and fewer still of those that read them understood what they meant. But the conclusion of them showed that what he had said was right. In reply to Mr. Scott, he might say that as a matter of fact there were no soldered joints in his armature at all. In fact, soldered joints, which were the curse of the dynamo shop, were got rid of altogether. It was never claimed in the paper that an enormous revolution was to be produced in dynamo construction. That statement must be in some unpublished postscript. Mr. Crompton had also referred to the Ayrton and Perry internal magnet, and said the difficulty was adjusting the brushes. Now there were hundreds and hundreds of machines running on tramcars under circumstances where the brushes were not and could not be adjusted.

Mr. Blathy: Those are motors. There is a great difference.

Mr. Mordey, continuing, said that if chord winding was a thoroughly known thing, and its advantages appreciated, would someone point out to him a manufacturer who was making solid chord-wound armatures? With reference to diagonal winding, Mr. Sayers had shown him an armature wound so at Birmingham many years ago. It was tried, and abandoned.

The **President** regretted that the paper had not been read earlier in the session, so that they could have given another night to its discussion. It was not the fault of the Council that they could not persuade Mr. Mordey to let them have a paper before.

This meeting finishes the session.

KINGSTON-UPON-HULL.

The electric lighting accounts of the borough of Kingston-upon-Hull show a total expenditure on the electric light undertaking up to date of £47,585. 6s. 3d. Herewith we give the revenue account, general balance-sheet, and statement of electricity generated, sold, etc., each account being for the 15 months from January 1, 1896, to March 31, 1897.

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Dr.	Revenue Account.			£	s.	d.
Coal or other fuel, including dues, carriage, unloading, storing, and all other expenses	£1,014	6	6			
Oil, waste, water, and engine-room stores	171	15	3			
Wages at generating station	864	2	6			
Repairs and maintenance, as follows: buildings, £17. 2s. 6d.; engines and boilers, £138 6s. 6d.; dynamos, exciters, transformers, motors, etc., £24. 5s. 10d.; other machinery, instruments, and tools, £253. 2s. 9d.; accumulators and accessories, £102. 19s. 4d.	535	16	11			
				2,586	1	2
Wages and other remuneration to linesmen, fitters, labourers	96	3	6			
Repairs, maintenance, and renewals of mains of all classes, including materials and laying the same	264	16	4			
Repairs, maintenance, and renewals of transformers, meters, switches, fuses, and other apparatus on consumers' premises, together with cost of materials and lamps sold	7	19	0			
Repairs, maintenance, and renewals of apparatus at distributing stations	--					
				368	18	10
Rents payable	157	19	6			
Rates and taxes	183	15	0			
				341	14	6
Salaries (engineer's department)	625	6	7			
Printing and stationery	130	6	5			
General establishment charges	191	19	1			
				947	12	1
Law expenses				54	4	10
Insurance, etc.				53	13	0
				4,352	4	5
Amount carried to net revenue account				6,675	6	11
				£11,027	11	4

Cr.	£	s.	d.
Sale of current per meter, 4d. and 5½d. per B.T.U.	10,549	17	0
Rental of meters, etc., on consumers' premises	337	11	7
Other items, miscellaneous	73	19	5
Premium	30	0	0
Stores on hand, March 31, 1897	37	3	4
	£11,027	11	4

General Balance Sheet.

Dr. Liabilities.	£	s.	d.
Net revenue account—Balance at credit thereof, December 31, 1893	13	2	4
Ditto, December 31, 1894	996	2	2
Ditto, December 31, 1895	1,263	0	4
Ditto, March 31, 1897	1,981	9	10
	4 253	14	8
Amount due to treasurer and sundry stockholders—capital account	47,585	6	3
	£51,839	0	11

Cr. Assets.	£	s.	d
Capital account—amount expended for works	47,309	14	5
Stores on hand at March 31, 1897—coal, oil, waste, etc., £37. 3s. 4d.; general, £275 11s. 10d.	312	15	2
Sundry debtors for current supplied to March 31, 1897, £2,878. 1s. 1d.; other debtors, £7. 17s. 5d.	2,885	18	6
Treasurer, amount in hand	1,330	12	10
	£51,839	0	11

Statement of Electricity Generated, Sold, etc., Jan. 1.

Quantity generated in B.T. units	525,066
Quantity sold to private consumers by meter	463,796
Quantity used on works	38,097
Total quantity accounted for	501,893
Quantity not accounted for	23,173
Total maximum supply demanded (kilowatts)	542

COMPANIES' MEETINGS AND REPORTS.

CONSOLIDATED TELEPHONE CONSTRUCTION COMPANY.

The report of the directors of the Consolidated Telephone Construction and Manufacturing Company, Limited, for the year ending March 31 last stated that the total receipts for the year on revenue account amounted to £4,405, including £1,000 paid by the Edison Gower-Bell Telephone Company of Europe, Limited, on account of dividends already declared. Deducting the usual expenses, amounting to £2,122, and including the amount brought forward, a balance was left of £3,685, against which the directors have decided to write off £507, leaving a net sum available of £3,178, out of which the Board proposed a dividend of £2 per cent., less income tax, carrying a balance forward of £1,004. The removal of the works to the provinces had proved a success in the saving of manufacturing charges, though it is hoped that the saving in wages will be more pronounced when the demand for labour in the bicycle trade has slackened. The total amount of sales exceeded that for some years past. The enlargement of the Company's powers, as approved by the shareholders in 1895, had enabled other work to be undertaken with satisfactory results, and the directors are hopeful that these new demands will increase. The rentals from private telephone lines increased, and the highest paying point of the lines already built and leased had not yet been reached. The lawsuit in Belgium carried on by the Edison Gower-Bell Telephone Company of Europe was showing satisfactory progress, and certain of the infringing companies seemed disposed to compromise matters. The Anglo-Portuguese Telephone Company for the year ending March 31 showed an increase of 43 in subscribers, and of £455 in rental.

The general meeting was held on Thursday afternoon at Winchester House, E.C.

Mr. C. L. W. Fitzgerald, who presided, in moving the adoption of the report, congratulated the shareholders on having had the works removed to Coventry, which saved them a considerable amount. They had also had a very acceptable profit on their tradings. Travelling, etc., expenses had been £100, but this had got them some very good orders, so it was not entirely lost. The enlargement of the Company's powers had enabled them to take some good orders in different sorts of work—electric motors, electric lighting, bicycle parts, etc. The rentals from private telephone lines had increased and further increase was expected. The directors recommended a dividend of 2 per cent. less income tax.

The report was seconded by **Sir Alexander Armstrong, K.C.B.,** and carried unanimously.

Mr. Stoop wished to move a resolution, advising the directors to move the voluntary liquidation of the Company, but he was ruled out of order.

After the re-election of a director and the auditors the meeting ended.

APOSTOLOFF AUTOMATIC TELEPHONE SYNDICATE.

An extraordinary general meeting of the Apostoloff Automatic Telephone Parent Syndicate, Limited, was held last Friday at Winchester House, E.C., Mr. Max Margowski presiding, for the purpose of considering a proposal to transfer the assets and business of the syndicate to a new company.

The **Chairman** said the Board had thought it advisable to specially request the shareholders to attend to discuss the development and progress of the Company. When Mr. Apostoloff introduced his invention to him, he (the Chairman) thought it a sufficiently good speculation to provide the necessary capital without asking outside people to subscribe. There were eight signatories to the articles of association, two of whom provided the entire working capital—viz., the Honduras Government Banking and Trading Company and himself. He found the major part of it, and the company named subscribed £500. Of course, no human being could produce anything entirely perfect, and it would have been wrong on his part to expect that any man could produce anything which would work successfully at the outset. The invention was at first only on paper, but when a model was completed they gave a demonstration, and invited experts to examine the invention, among these being a representative of a certain great European monopoly, who was sent over with a view to purchasing it. The price they were asking for one patent alone was no less than £500,000, and they were bound to substantiate the claims they made as to the merits of the invention. They arrived at the figure of £500,000 upon the basis of 30 per cent. of the economy their invention would produce to the monopoly. The monopoly referred to was, he believed, the only one in the world working with an underground system, and in order to substantiate the claims they made for the invention they asked the inventor to solve a certain problem which presented itself in underground working. The inventor examined the monopoly's system and found a technical solution of the problem. They, however, wanted something more practical so as to simplify the application of the invention, and they found it necessary to call in a gentleman for this purpose who was a well-known engineer, occupying a high position in the telephonic department of a European Government. So satisfied was he of the value of the invention that he was prepared to resign his position and forfeit his claim to a substantial pension which would have been due to him in a few years. In order to secure his services, it became necessary to reconstruct the syndicate with a liability upon all the shares, or to form a new company with a larger capital, which would take over the syndicate. As the former course would necessitate the creation of a liability upon the shares issued to the inventor as fully paid—a liability that was never contemplated when the shares were issued—it was decided to adopt the second course. They were not selling the invention to an outside company for a mere £75,000 in fully-paid shares, but were selling their syndicate to themselves. It simply amounted to an extension of their operations. He was himself the largest holder in the syndicate. A discussion followed, in the course of which several shareholders expressed the opinion that the circular setting forth the proposed scheme was couched in ambiguous terms, and that more time should be given to the shareholders to consider the matter now they had the details before them, and it was ultimately decided that a committee of three shareholders be appointed to confer with the directors as to their proposals, and that the meeting be adjourned.

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CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Bucharest.—Tenders will be received at Bucharest on June 25 by the Roumanian State Railway Departmental Authorities for the supply of Morse telegraphic paper strips.

Louvain (Belgium).—Tenders will shortly be receivable at the office of the Postmaster, Louvain-Centre, for the completion and maintenance of a post, telegraph, and telephone building.

Wigan.—The Baths Committee require tenders for repairing and renewing the electric bells at the public baths. Particulars may be obtained from Mr. J. J. Charnock, town clerk, Wigan.

Lyons.—Tenders will be received on June 23, at the Prefecture of the Rhone, Lyons, for the installation of the electric light at the lunatic asylum at Bron. There are two contracts of about £4,000 each (estimate).

Ghent.—The city of Ghent has put out for competition the electric tramway service. Particulars are obtainable on application to le secretariat de la ville de Ghent, Belgium, and tenders must be in by July 2.

Mouscron (Belgium).—The Municipality announce that the lighting of the town is open for tender from 1900. It is not specified whether preference will be given to any particular method of illumination, electric or otherwise.

Paris.—The French Postal and Telegraphic Authorities will receive tenders for paper strip for telegraph instruments on June 22, but previous application for permission to tender must be applied for at Paris, Rue de Grenelle, 103, by June 12.

London, E.C.—Tenders are required for the supply, delivery, and erection of four separate duplicate electric lighting plants. Lighting capacity, 2,000, 4,000, and 5,000 lights. Delivered at Sydney, N.S.W., Australia. Apply to Mr. Henry Goodwin, Anderton's Hotel, Fleet-street, E.C.

Blackpool.—The Tramways Committee require tenders for supplying two bogie tramcars. Specifications can be obtained, and cars of the type required can be seen, on application to Mr. John Lancaster, manager, Tramway Depôt, Blundell-street, Blackpool. Tenders to be sent in, addressed to the Chairman, Tramways Committee, by June 21.

Neath.—The Corporation invite tenders of rental for the working by horse or mechanical traction of the existing line of tramways about to be reconstructed by the Corporation, extending from Skewen to Briton Ferry, through the market town of Neath, a distance of about 4¼ miles. Tenders, marked "Working of Neath Tramways," are to be delivered by 28th inst. to Mr. Edwin C. Curtis, town clerk.

Rio de Janeiro.—The Secretary of State for Foreign Affairs has received a despatch from H.M. Consul-General at Rio de Janeiro enclosing a translation of an official notice setting forth the conditions under which tenders are invited for the telephonic service of that city and its suburbs. The tenders are to be presented by June 30, and the conditions may be inspected at the Commercial Department of the Foreign Office any day between 11 and 6.

Brighton.—Tenders are required by the Council for the completion of the electric light wiring, etc., of the Municipal School of Science and Technology, Richmond-terrace. Drawings may be seen at the office of the borough engineer, Mr. F. J. C. May, C.E., Town Hall, Brighton, and specifications and forms of tender may be obtained after 5th inst. at the office of Mr. Francis J. Tillstone, town clerk, Town Hall, Brighton, on payment of £1. 1s., which amount will be returned on receipt of a bona fide tender. Sealed tenders, addressed to the Town Clerk, and endorsed "Tender for Electric Lighting, Municipal School of Science and Technology," must be left at his office before 10 a.m. on June 14.

Treeton (near Rotherham).—The following contracts are advertised by the Treeton Parish Council: (1) a contract for the supplying and fixing plant, apparatus, and materials for lighting certain streets and roads in the parish of Treeton by means of electricity; and (2) a contract for the supplying electricity for 1,000 hours per annum, and working, repairing, and renewing the plant for 30 years. Any persons or companies willing to undertake the said contracts, or either of them, may make proposals for that purpose, which will be considered by the Parish Council on 24th inst. The proposals should be delivered or sent in writing to Mr. S. Fiske, clerk, Treeton, near Rotherham, before 24th inst.

Hull.—Tenders are required by the Corporation for the following works in connection with the electric lighting extension—viz., (Contract No. 10) foundations and buildings; (11) steel roofs, tanks, etc. The weight of steel in roofs is about 20 tons, and the capacity of tank (which is of steel plates) is 30,000 gallons. Forms of tender, specification, and quantities may be obtained of Mr. A. E. White, borough engineer, Town Hall, Hull. A limited number of blue prints of the three contract plans for Contract No. 11 will be supplied on payment of 10s. (not returnable). The prints will not be ready before 12th inst. Tenders, endorsed as directed on the form of tender, are to be addressed to the Chairman of the Electric Lighting Committee, and delivered at the Town Clerk's Office before 10 a.m. on 24th inst.

Inverness.—The Highland Railway Company require tenders for the following among other articles, in such quantities as they may require, from July 1, 1897, to June 30, 1898, delivered free of all charges, viâ Dunkeld, at the company's storehouses, Inverness: galvanised telegraph wire, telegraph instruments and fittings, and telegraph construction material. Forms of tender may be obtained on application to Mr. J. G. Bulmer, stores superintendent, Inverness. Tenders, properly endorsed, sealed, and addressed to the Directors, must be lodged with Mr. Wm. Gowenlock, secretary, Inverness, by 19th inst. Separate forms of tender will be provided for each contract; parties are therefore requested to specify the particular contract or contracts in respect of which they propose to submit tenders. Patterns can be seen at the stores warehouses, Inverness, but cannot be sent away for inspection.

Blackpool.—The Corporation invite tenders for the supply and delivery carriage paid at the Corporation Electricity Works, as and when required up to March 31, 1898, of about 20,000 cored carbons 13mm. 12in. long, solid carbons 13mm. 7in. long, 10,000 cored carbons, 13mm. 12in. long, and 10,000 solid carbons 9mm. 12in. long. Samples for testing purposes should be sent free of charge to Mr. Robt. C. Quin, borough electrical engineer, Corporation Electricity Works, Blackpool, by 12th inst. Each sample must be labelled with a nom-de-plume, and bear no evidence of the sender's name or address, otherwise it will be ignored. The successful tenderer will be required to enter into a contract for the maintenance of the qualities according to sample and for deliveries within seven days from the date of orders. Tenders, endorsed "Carbons," should reach the Borough Electrical Engineer by 18th inst.

London, S.W.—The Metropolitan Asylums Board require tenders for lighting the Grove Hospital, Tooting-grove, Lower Tooting, S.W., by means of electricity, according to drawings, specification, and conditions of contract prepared by Mr. A. Hessell Tiltman, architect, of 6, John-street, Bedford-row, W.C., where the drawings may be seen, and a copy of the specification and form of tender obtained, on and after 12th inst., between 10 a.m. and 5 p.m., upon payment of a deposit of £10 in gold or Bank of England notes, which amount will be returned to persons sending in bona fide tenders and returning the specifications. Tenders, sealed and endorsed "Tender for Electric Lighting, Grove Hospital," must be delivered at the Chief Offices of the Board, Norfolk House, Norfolk-street, Strand, W.C., by 10 a.m. on 23rd inst. Mr. T. Duncombe Mann, clerk, Norfolk House, Norfolk-street, Strand, W.C.

Southampton.—The Corporation invite tenders for the supply and erection of water-tube boilers, mechanical stokers, coal-conveyor, pumps, steam and water mains, water-tank, water-purifier, fuel economiser, and ironwork. Specifications and forms of tender can be obtained at the Municipal Offices, Southampton, or at the offices of the engineers, Messrs. Kincaid, Waller, and Manville, 29 Great George-street, Westminster, on payment of a fee of £3. 3s., which sum will be returned on receipt of a bona fide tender. The contractor will be required to pay not less than the minimum standard rate of wages for the time being in each branch of the trade. The Corporation do not bind themselves to accept the lowest or any tender, and the contractor whose tender is accepted shall enter into a formal agreement, under seal, with sufficient sureties, for the due performance of his contract. Sealed tenders, endorsed "Electricity Supply, Tender for Contract No. 3," must be sent to Mr. George B. Nalder, town clerk, Municipal Offices, Southampton, at or before 4 p.m. on June 16.

RESULTS OF TENDERS.

Monmouth.—The Town Council have accepted the tender of Mr. H. Weldon, Union Temple-chambers, Birmingham, for buildings in connection with the electric light, at £4,847.

Leeds.—For painting the overhead electric tramway poles and brackets on the Kirkstall and Roundhay tramway route, for the Corporation, the tender of Mr. A. E. Collett, Leeds (poles 9s. 9d. each, posts 1s. 6d.) has been accepted.

Derry.—The Lighting Committee having advertised for tenders for the supply of from 350 to 400 tons of coal for the generating station, received the following: No. 1, 15s. 6d. per ton; No. 2, 14s. 9d. per ton; No. 3, 15s. 3d. per ton; No. 4, 14s. 3d, per ton. It was decided to accept tender No. 2, which came from the firm of Messrs. Morrison and Co., Derry.

Belfast.—The Corporation have accepted the tenders of Messrs. Victor Coates and Co., Limited, to supply and erect boiler and economiser; that of the Electric Power Storage Company, for storage battery, maintenance of same, and exchange of the battery in the present station for one of another type; that of Messrs. Doulton and Co., for earthenware conduits and junction blocks; and those of Messrs. Callender and Co., for cables, laying of cables, and roadwork; that of Messrs. John Shaw and Co., for cast ironwork; also that of Messrs. J. and. W. Steward, for piling the site of the proposed station.

BUSINESS NOTES.

The Belfast Trams.—The Corporation have decided to rescind their resolution not to extend the term of the tramway company's lease.

Kirkby-in-Ashfield.—At the Urban District Council meeting the report of Mr. W. J. Furse as to lighting the parish with electricity was referred to the special meeting.

Tonbridge.—The Clerk reported at the Urban District Council that the Tonbridge Electric Lighting Bill had been read a third time in the House of Commons and for the first time in the House of Lords.

Colwyn Bay.—At the Urban District Council meeting it was decided to consider the question of opposing the proposed new Colwyn Bay and Llandudno light railway at an early meeting of the Council.

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Fulham.—Mr. A. Cook has been appointed chairman, and Mr. Cranfield vice-chairman, of the Lighting, Electric Lighting, and Destructor Committee of the Vestry.

Telegraph Extension.—Major Nerazzini announces from Irma, which is situated at two days' march from Harrar, that he is laying a telegraph line which in three or four months will be completed as far as the Shoan capital.

Bristol Tramways and Carriage Company, Limited.—The traffic returns for the week ended June 4 were £2 461. 14s. 7d., compared with £2,322. 13s. 1d. for the corresponding period of last year, being an increase of £139. 1s 6d.

Taunton.—The Town Council have adopted a recommendation of the Electric Lighting Committee that six months' notice should be given to all customers that they would be supplied on the demand indicator system after December 31 next.

Dudley.—Councillor Brooks asked at the Town Council meeting whether it was the intention of the Council to go on with the electric lighting now they had got the order. The Town Clerk replied it had not passed the House of Lords yet.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended June 6 (including Whit Sunday) amounted to £1,324, as compared with £1,152 in the corresponding week of the previous year, being an increase of £172.

Accident.—John Swarback, 38 years of age, of Woodhouse, employed at the new generating station in the Calls, Leeds, was stepping aside to allow another man to pass on a plank on Saturday, when he fell a distance of 5ft , and was badly injured.

Torquay.—The Town Council having resumed the consideration of the draft order with regard to the proposed electric tram have decided to appeal to the burgesses for guidance in the matter. A public meeting is to be convened by the Mayor to consider the question.

Ceylon. — *Indian Engineering* says that the Colombo Gas Company's tender for the lighting of Kandy with electricity has been adopted, and when the scheme is carried out, Kandy will be ahead of its big brother, Colombo, which has only a few electric street lamps in the fort.

City and South London Railway.—The returns for the week ended June 6 were £945 compared with £930 for the corresponding period of last year, being an increase of £15. The total receipts for the half-year 1897 were £23,335, compared with £21,465 last year, being an increase of £1,870.

Wilne.—The parish church has recently, through the generosity of Mr. Marcus J. Astle, been very effectively fitted up with electric light from Wilne Mills. The work has been very tastefully executed, and will form a very suitable permanent memorial of the year of the Queen's Diamond Jubilee.

Catalogue.—We have received a copy of the June leaflet of the General Electric Company's catalogue. It contains illustrations and particulars of wiremen's sundries, motors, medical and scientific supplies, and of the "General" intercommunication telephone system for use in works, offices, warehouses, etc.

Yorkshire Motorcar Company, Limited.—This Company has been registered, with a capital of £2 500 in £1 shares, to acquire the business carried on by J. E. Tuke at Bradford and Harrogate, Yorkshire, to enter into a certain agreement, and to carry on the business of motorcar factors and agents, cycle manufacturers and dealers, engineers, machinists, etc.

Hampshire Light Railways (Electric) Company, Limited — This Company has been registered with a capital of £1,000, in £10 shares, to promote and obtain the necessary authority to make and maintain railways and tramways in the county of Hampshire or elsewhere, and to acquire, maintain, and work tramway, omnibus, railway, and electrical undertakings.

National Motor Carriage Syndicate, Limited.—This Company has been registered, with a capital of £30 000 in £1 shares, to adopt an agreement with H F. Joel; to acquire, develop, and turn to account any inventions relating to electricity ; and to carry on the business of motor and cycle manufacturers and electricians. Registered office: 37, Walbrook, E.C.

Bakewell.—Some conversation took place at the Urban District Council meeting as to the feasibility of utilising the water power in the river for the purpose of lighting the town by electricity. Mr. Brown said he had been making some enquiries into the matter, but the result as yet was not of a very definite character. The idea, he said, had been started, and it would grow.

Nelson.—The General Purposes Sub-Committee reported at the Town Council meeting that they had again had under consideration the question of electric lighting of main thoroughfares, but resolved that no action be taken in the matter at present. An application by the trustees of the Baptist Chapel, Carr-road, for a supply of electric light to their new school in Every-street was acceded to.

Acton.—A letter was read at the District Council meeting from Mr. F. J. Warden-Stevens offering to advise the Council on the subject of the establishment of electric lighting and refuse destructor works. Mr. Warden-Stevens offered to prepare and supply a full report on the subject for £15 It was decided to thank Mr. Warden-Stevens for his letter and to file it for future reference.

Bury.—It was reported at the Town Council meeting that the Electricity Committee had decided that the price of the electric current should be reduced as follows: for lighting purposes, 6d. per Board of Trade unit for the first hour for each day in the year, and 3d. for each succeeding hour ; and for motive power, 2½d. per Board of Trade unit. The reductions will take effect from July. The minutes were confirmed.

Norwich.—The Town Council having applied to the Local Government Board for sanction to borrow £200 for purposes of electric lighting, an enquiry has been held by Colonel C. H. Luard, R.E. The application to the Local Government Board was made last February, and as the committee were unable to wait any longer the lamps were erected and lighted with great success in time for the first entertainment in Chapel Field Gardens

Remember Mitchelstown!—It is announced that the scheme of electric lighting for Mitchelstown, which has been in abeyance for some time past, is about to be revived. The Board of Guardians on June 11, 1895, decided to have the provisions of the Act put in force, and adopted a scheme of electric lighting submitted by a local committee, and also an area of taxation for the project. An application will again be made to the Guardians a few weeks hence to readopt it.

Islington.—At the meeting of the Vestry, the Electric Lighting Committee was appointed as follows: Messrs. F. T. Bailey, E. J. Chant, J. T. Johnson, A. Walkley, G. T. Wilson, F. Chatterton, F. W. Hales, A. G. Wylie, J. A. C. Cameron, E. Fitzgerald, R. Gordon, J. E. Quayle, J. Fletcher, F. H. Varley, A. J. Fearnhead, J. Jackson W. T. Stainton, S. Lambert, T. Andrew, T. W. Vine, A. S. Dobito, H. W. Callender, W. Elliott, J. W. Smyth, and Bowman.

Appointments Vacant.—The Corporation of Edinburgh are prepared to receive applications for the post of assistant engineer for the central electric light station. The salary is £100 per annum, and applications are to be sent in by June 19. Further particulars are given in our advertisement columns.—An advertisement will also be seen from the Northampton Institute, Clerkenwell, inviting applications for the appointments of demonstrators, lecturers, and instructors.

A Japanese Pacific Cable.—News from Hawaii comes by San Francisco. "According to advices" received there from Honolulu, Mr. Ishikawa, the representative of a Japanese syndicate, has been conferring with the Hawaiian Government upon the proposal to lay a cable between San Francisco and Yokohama, touching at Hawaii. Details are given as to what the cable is to cost and where the syndicate is going to place the capital. The English investor is not to be asked to contribute.

Personal.—Mr. F. J. Warden-Stevens has been appointed the consulting engineer to the Poplar Guardians in connection with their important workhouse and offices, and to prepare a complete scheme for the workhouse, embracing electric lighting, a system of steam supply for the laundry, engines, disinfectors, and heating, a water supply from subsoil for fire, flushing, and cleaning purposes, and also a power system for laundry and bakehouse, together with a separate lighting system for the offices.

Cheltenham.—The Electrical Engineer reported at the Town Council meeting that in accordance with instructions he had estimated the costs of providing and running electric incandescence lamps for the lighting of St. George's-road, etc., and he recommended scheme No. 1, which involved a capital expenditure of £700, and an annual charge of £5. 2s. 6d. per lamp for the 29 lamps. Application is to be made to the Local Government Board for sanction to borrow £750 to carry out the proposed lighting.

Illuminating St. Paul's.—The idea of illuminating the dome of St. Paul's Cathedral with incandescent electric lights on Jubilee night has been abandoned, as the result of the communications that have passed between the Dean of St. Paul's and Colonel Sir Vivian Majendie, chief inspector of explosives. Experiments have, however, been made with searchlights upon the dome from the neighbouring premises, and it is understood that the dome will be illuminated by means of these. As many as 25 searchlights will be employed.

Glasgow Corporation Tramways.—At the meeting of the Corporation Tramways Committee it was stated that 99 million passengers had been carried during the past year, showing an increase of 13 million as compared with the previous year. A large sub-committee was appointed to carry out all the arrangements for proceeding at once with the construction of the new electric line between Springburn and Mitchell-street. They will also consider a proposal made to them by a deputation from the Electricity Committee to utilise the power station in John-street in working the new line.

Sunderland.—The Electric Lighting Sub-Committee of the Corporation have decided to send a deputation to Leeds and Bristol with a view to ascertaining the best form of standard for use in the town, and one which could be adapted to supplying electric power to tramways. The committee also signed the contract with the gas company for the lighting of the town during the ensuing six months ; £2. 5s. 6d., an increase of 1s., is to be paid for each lamp ; compensation at the rate of 10s. per lamp is also to be paid to the company for all lamps displaced by the new scheme of electric lighting which the committee have in hand.

Blackburn.—A motion was submitted at the Town Council meeting appointing Mr. E. M. Lacey, of Westminster, as consulting and electrical engineer to the Corporation, to prepare plans and specification of the machinery and apparatus required for the proposed electric lighting installation. Councillor Cunliffe asked if the remuneration had been fixed. Alderman Topper asked if the engineer had previously had experience in Lancashire towns. Councillor S. Turner said the amount of remuneration had not yet been fixed. The engineer had had experience in Blackburn—where the installation was for traction purposes as well as for lighting purposes—and at Bury. The aim of the committee was to have works adapted for the supply of electricity for traction purposes as well as for lighting. The motion was carried.

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Cardiff.—At a meeting of the Lighting and Electrical Committee of the Corporation it was reported by Mr. Appelbee that he had received an application from Mr. Seward for the supply of current to work motors for driving the ventilating fans in the Central Arcade. It was decided that a cable should be laid through the arcade for the purpose of supplying the necessary current for this purpose, and also for the lighting of the shops as required. Mr. Appelbee also reported that he had quoted a price for the supply of current to the buildings in the Cathays Park in the latter part of the month. The meter rent now being charged to consumers was considered to be too high, and it was decided that it should be reduced from 20s. to 10s.

The Leeds Tramways.—The extension of the Kirkstall section of the Leeds tramways to the Abbey has been completed, and was recently inspected by Mr. Hannam (chairman of the Leeds Highways Committee), Mr. Boston (chairman of the Corporate Property Committee), Mr. Scott (deputy-chairman of the Corporate Property Committee), Mr. Wharam (tramways manager), and Mr. C. A. Prince (surveyor of highways), and declared satisfactory. It is intended that a service of cars to the Abbey shall be commenced forthwith. The work of relaying the lines in Boar-lane is progressing rapidly. The only remaining permanent way that will be disturbed in connection with the preparations for the running of the proposed Roundhay and Kirkstall electric tramways is that portion of North-street between Meanwood-road and the dispensary.

Electric Heating and Cooking Apparatus.—In the natural order of things the idea of using electricity for purposes of heating and cooking was laughed at in its beginning by the laity, and even now there does not seem to be a boom in this direction. Possibly this is the result of ignorance on the part of the public; if so, the sooner they are informed the better. Unless a good article is put right under their noses, they are too busy to stop to look for it. The Electrical Company, Limited, of 122 and 124, Charing Cross-road, London, W.C., have issued a very useful catalogue of heating and cooking apparatus for direct and alternating currents. Various specimens are illustrated and explained, and full details are given of their capabilities and prices. The metric system has also been chosen for the weights and dimensions throughout the catalogue, of which we advise everyone to obtain a copy.

Great Yarmouth.—A revolving observation tower is being erected here in honour of the Queen's Jubilee. The design comprises a strong hexagonal steel tower 150ft. high by 14ft. in diameter, surrounded by a circular structure or elevator. This elevator is raised and lowered by four strong cables, each of which is capable of performing the work alone. On this elevator is a circular platform fitted with rollers, and intended to revolve upon the elevator. This platform is provided with revolving chairs accommodating upwards of 150 persons. While the elevator ascends and descends the tower the platform revolves around it, thus affording an uninterrupted and unsurpassed view of the surrounding country. The elevator is operated by powerful engines, and the platform is propelled by an an electric motor. Mr. T. Warwick, Leamington-road-villas, Bayswater, is the patentee of the tower.

Water Power in Ireland.—Mr. T. Healy has written a long letter to the *Times* protesting against the Irish Industries Bill being dropped. This measure proposes to enable water power to be taken (compulsorily) for industries, subject to only the following restrictions: (*a*) that such water is intended to be used for producing electricity, and that its employment for such purpose would not injure the water power then used for any existing mill, or the water supply of any city, town, district, or locality; (*b*) that the proposed industry is not of a nature to cause pollution to any stream or river; (*c*) that any land to be taken is principally barren, uncultivated, or mountainous; (*d*) that no fishery of any substantial value would be injured by the undertaking; (*e*) and that the establishment of such industry would be of general or local advantage. Mr. Healy's letter, however, is hardly framed in a spirit which will conciliate opposition on the part of the owners of the water power.

South African Cable Subsidies.—A letter from Mr. J. A. Ellis to the *Times*, on the subject of Dr. Leyds and the South African Cable Company, gives incidentally some particulars as to the subsidies paid to that company. There is at the present time an agreement with the cable company which has been in existence since 1879, and which expires on December 31, 1899; under that agreement the company receives the following annual subsidies: Great Britain, £35,000; Cape Colony, £15,000; Natal, £5,000; Portugal, £5,000. In 1895 the Transvaal Government entered into an agreement with the cable company, under which they undertook to give an annual subsidy of £10 000 for a period of 15 years; and, under a further agreement made in 1895, the Imperial Government, Cape Colony, Natal, and the Chartered Company agree to contribute the following amounts for a period of 10 years from the expiry of the existing agreement on December 31, 1899: Great Britain, £8,750; Cape Colony, £6,000; Natal, £1,650; Chartered Company, £600.

National Telephone Company, Limited.—The directors are issuing 130,766 (balance of 250,000 authorised) 5 per cent. non-cumulative third preference shares of £5 each, subscriptions for which are invited by tender, the minimum price having been fixed at £5. 15s. per share. The total authorised capital of the Company is £6,000,000, of which £4,648,626 is already issued—namely, £150,000 6 per cent. first preference and £150,000 6 per cent. second preference £10 shares, £596,170 third preference £5 shares, £2,422,985 £5 ordinary shares, and £1,329,471 in 3½ per cent. debenture stock. The prospectus states that the new issue is made to provide the necessary capital required to meet the extension of the business. The profits of the Company for 1896 amounted to £321,506, and after payment of debenture interest and the full preference dividend there was a surplus of £202,354. Tenders must be sent to Messrs. Robarts, Lubbock, and Co., 15, Lombard-street, E.C., or the National Bank of Scotland, 37, Nicholas-lane, E.C., on or before 19th inst.

Poplar.—At the meeting of the Board of Guardians, the General Purposes Committee, reporting with reference to electric lighting, stated as follows: "Your committee have under consideration a letter from Mr. F. J. Warden-Stevens, A.M.I.E.E., in which he states that upon inspecting the workhouse, with a view to the preparation of a report upon the question of electric lighting for that establishment, he found that the steam and hot-water arrangements were very scattered, and were, in his opinion, capable of improvement. Mr. Warden-Stevens enquires whether, under the circumstances, the Guardians would not wish to have a comprehensive report dealing with these matters as well as the electric lighting. As it appears that the cost of such a report would only involve an additional outlay of £10. 10s., your committee strongly recommend that Mr. Warden-Stevens be asked to go fully into the question of electric light, power, steam, and water supply, in combination, and to advise the Guardians thereon." The report and recommendation was adopted.

Electricity Instead of Steam.—The proposition of the Illinois Central Railroad to use electricity for running its suburban trains is attracting a great deal of attention from railroad men, says the *American Manufacturer*, as it will be the first practical attempt to substitute electricity for steam in railway operations. It will be tried on eight miles of road, the suburban business of which is supposed to be the heaviest of any one railroad in the world. Railroad authorities state that it is hardly expected that the change will result in any great cutting down of expense, but it is thought that the train service will be more flexible and frequent, as it is proposed to do away with the regular train schedule entirely, running the cars or trains so often that passengers will do very little waiting at the stations. Those practically interested in railroading are anxious to see this idea worked out. They hold that without definite figures it is impossible to estimate what the relative economy would be, but for a service of the kind contemplated they admit that there will be at least a great convenience in the use of electricity.

Larne.—The Town Commissioners at their meeting considered the question of the lighting of the town, the three years' contract with the Larne Electric Light Works, Limited, London, having expired on April 30 last. Mr. Picken considered that the price asked for the lighting and proposed extensions, which when totted up would amount to about £435, was too high, considering the quantity of the light. He was of opinion that the time had come for them to take over the gasworks, markets, and apply for separation from the county. Directors of those private companies had to be paid, and it was the ratepayers who were paying them. They (the Board) received no pay, and would look after the interests of the ratepayers, being accountable to them for their every action. Mr. M'Gregor agreed with Mr. Picken, and was strongly in favour of purchasing the gasworks. Mr. Foster said that unfortunately by the acts of their predecessors they could not bring in any other electric light company, but it was open to them to obtain powers for lighting with electricity. In the end it was agreed to advertise in the meantime for tenders for the lighting of the town for the ensuing three years.

Glasgow.—At the meeting of the Corporation, Mr. Gray said he wished to call attention to the fact that there seemed to be a difference of opinion between the Tramway Committee and the Electricity Committee as to the carrying out of the arrangements in connection with the overhead line to Springburn. He wanted the offer contained in the letter to be remitted to the Tramway Committee for their consideration. It was a new oil-motor which would enable cars to be run at a cost of a halfpenny per car mile on the present rails. Mr. Paton rose to order. The Lord Provost said Mr. Gray was not in order in bringing this matter forward at that time. If Mr. Gray had any communication to make he had only to send it to the Tramway Committee, and he had no doubt Mr. Paton would be delighted to receive it. Mr. Gray said he was not a member of the Tramway Committee, and he wished the authority of the Town Council to have the document sent to the committee. Mr. Paton said that if the matter was sent to the town clerk in the usual way it would reach the committee. That was the proper plan to adopt. Mr. Gray said there seemed to be a terrible amount of feeling in this matter. He would hand the document to the Press.

Canterbury.—The following report of the Lighting Committee was received at the Town Council meeting. A letter was read from the gas company to the effect that the directors would not be prepared to accept the conditions mentioned in the town clerk's letter of May 10 unless the contract was for three years, but that they were willing to allow the three years to commence from December 31 last. The committee recommend that a reply be sent to the effect that the terms of the minute of April 26 last would be adhered to, and that unless the company would take a contract for two years the Council would have no alternative but to go on with an annual contract. The surveyor was instructed to report as to the incandescent lighting on the Dane John and Lady Wootton's Green, and as to the cost of the standards. Alderman Mason, in moving the adoption of the report, said the committee felt that they could not recommend the Council to enter into a contract with the gas company for three years, as it would be tying their hands too much. Hitherto they had had an annual

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contract, but seeing that the company had made certain concessions they thought it would only be fair to accept the contract for a period of two years. Alderman Cross seconded and the motion was carried.

Morley.—The following report of the Electric Lighting Committee was adopted at the Town Council meeting: "That in consequence of it being arranged to bring the cables down Fountain-street, and the other sub-stations be rearranged as shown on plan submitted by Mr. Hammond, that all house-service cable be laid in bitumen between the street cables and the houses, and be armoured; that Councillor Hirst having applied for a supply of electricity for lighting and motive power, it was resolved that the main be extended to his premises in South Queen-street; that electricity supplied for motive power be supplied at the rate of 3d. per unit for the first 10,000 units, and 2½d. for the next 10,000 units, and after that 2d. per unit per annum; that Alderman Johnson and Alderman Stockdale be empowered to take the necessary steps to make arrangements to transfer the charge of the town hall electric lighting station to Mr. Claydon; that 11 electric arc lamps be fixed in Queen-street, in the following positions—viz., one at the Bottoms, one at Scatcherd-hill, one at the bottom of Queen's-promenade, one at the junction of Troy-road and Scatcherd-hill, one opposite the bottom of Princess-street, one near the bottom of Wellington-street, one near the bottom of Albion-street, one opposite the market, one opposite Peel street, one midway between Peel-street and Fountain-street, and one at the junction of Queen-street and Fountain-street."

Halifax.—Colonel C. H. Luard, R.E., an inspector from the Local Government Board, has held an enquiry in respect to an application from the Corporation for sanction to borrow a sum of £9.300 for purposes connected with the electric tramway scheme, and £1,633 for the purposes of street improvements. The Town Clerk said the sanction of the Department had already been obtained, apart from the tramways, to borrow £59,950 in connection with the electric works. Of the £59,950 they had already borrowed a sum of £46,433, and that left a balance of £13,517 for electric lighting purposes. They proposed to work the tramways by electricity. The Bill, which bore the title of the "Halifax Corporation Tramways Act, 1897," had passed through Parliament, and they were expecting the Royal assent any day. That Act gave them power to borrow £20,000, and such other powers as the Board of Trade might think proper. The powers of the Electric Lighting Act were to be exercised under the sanction of the Local Government Board, and the tramways would be dealt with by the Board of Trade. The area of supply was within the borough. Mr. Wilmshurst, the electrical engineer, submitted plans showing the route of the mains which it is proposed to lay up Horton-street from the railway station, Ward's End, Commercial-street, George street, Bull-green, King Cross-road, King Cross-street, Silver-street, a portion of Crown-street, Swine-market Gibbet-street, and up to Highwood Well. There was no opposition.

N. Y., N. H., and H. Railroad, Conn.—The New York, New Haven, and Hartford Railway directorate has made another advance in the application of electricity in the operation of its road, in the electrical equipment of its line running from Berlin to New Britain on New Haven system, Hartford division, and from New Britain to Hartford, on the New England system, Springfield division. The first electric car was officially run over the electrically equipped track by Colonel N. H. Heft, the chief of the electrical department of the N. Y., N. H., and H. R. R. in the presence of the president, C. P. Clark, Vice-Presidents Hall and Mellen, the directors, and other prominent officials of the New Haven and New England systems. The Americans make the guarded claim that this section is the longest section of any railway in the world hitherto exclusively operated by steam locomotives to be equipped for electric traction. The total distance is 12·3 miles, divided in two parts. The first runs from the power-house at Berlin, and the second extends from New Britain to Hartford. The road from Berlin to New Britain is single track; from New Britain to Hartford double track, one track only being devoted to electric service. In the operation of this road the electric trains will run from Berlin to New Britain and back. The trains from New Britain to Hartford and back run as a separate service, the change of cars being made at New Britain The system differs in its electrical equipment from that at Nantasket in that the trolley contact is abandoned in favour of the third-rail system, the conductor or third rail being laid along the centre of the track between the running rails.

Wimbledon.—At the Urban District Council meeting, Mr. Crimp moved: "That the question of electric lighting be referred to an eminent expert for his opinion, the fee not to exceed 100 guineas, and that the Road and Drainage Committee be authorised to formulate a series of questions to the expert to be selected by them." His reason for moving the resolution was that he had heard on the very best authority that within the next few weeks they would receive the sanction of the Local Government Board to the borrowing of the necessary money for carrying out their electric lighting scheme. They were all agreed upon one thing, and that was that they wanted the very best scheme they could get, and they were also agreed that in engineering matters, as in all others, two heads were better than one. He had the fullest confidence in Mr. Preece, and he thought every member of the Council would agree that he was deserving of that confidence. He had had a very great deal of experience, but they must not forget that he was a comparatively young man, and they must also bear in mind the line which the opposition took at the enquiry. He submitted that in obtaining the opinion of a second expert they would be spending the ratepayers' money, not only in a perfectly justifiable manner, but in a manner that they would entirely approve of themselves. Mr. Donaldson seconded the resolution. He thought, without in any way reflecting on the special ability of the organiser of the scheme, that in so large an undertaking they should obtain the very best advice they could. The resolution was defeated by seven votes to five.

Hull.—Under the auspices of the Hull Farriers' branch of the Amalgamated Association of Tramway, Hackney Carriage Employés and Horsemen in General, a public meeting was held last week to protest against the Town Council adopting the electric tram scheme. The following resolution was carried unanimously: "That having regard to the fact that the existing accommodation for the travelling public of Hull is not only ample, but also far more convenient than any purely tramway system, and also to the fact that the proposed scheme will not only deprive numbers of workers connected with the present system of their livelihood, but will also throw out of employment thousands of working-men, the proposed extravagant scheme for the adoption of the electric tramway system in Hull be condemned, in the hope of inducing the Town Council to reconsider their proposal." At the meeting of the Town Council, Mr. Holder asked why the charge for electricity should not be reduced at once to users by at least one penny per unit. He pointed out that upon the present charge of 5½d. per unit the committee, according to their annual report, had made a profit of £3,031. Other towns had reduced the charge, and there was no reason why they should not do so. If they took a penny off they would still have £1,099. 7s., after paying off the sinking fund and interest on borrowed money. He would not move a resolution, but he hoped the chairman and members of the committee would soon see their way to make a reduction. Mr. Skinner said he was very much obliged to Mr. Holder for his suggestion, but it was not a new one. The matter was discussed at the last meeting of the committee, and he then said that no one would be better pleased to see a reduction than himself when the proper time came.

Derby.—At the meeting of the Town Council the Highways Committee reported as follows: "An application has been made to the Light Railways Commissioners by a company for an order to enable them to construct a light railway from Derby to Ashbourne. The notice, plans, estimate, and draft order have been deposited with the town clerk. The committee have considered the matter, and are of opinion that the project is one which should be encouraged, provided proper clauses are inserted in the proposed order protecting the interests of the public and the Corporation. The committee have been informed that the mode of traction will be by means of electricity conveyed by overhead wires supported by posts not less than 20ft. high fixed in the pavement. The portion of the borough affected will be from the boundary of the borough on the Ashbourne-road, down Ashbourne-road and Friargate to George-street, with a branch into the Great Northern Railway yard. A letter has been received from the Light Railways Commission stating that the Commissioners would be glad to be informed of any opinion which the Derby Corporation may form in the matter." Alderman Doherty proposed the adoption of the report, and some discussion arose, Mr. Gandy objecting to the railway coming any farther into the borough than the tram terminus. Mr. Russell and other gentlemen thought that the scheme would be an excellent one, and would prove of great benefit to the town. Alderman Doherty explained that the town clerk would safeguard the interests of the borough in every respect, and an amendment that the matter be referred back to the committee was defeated by a large majority. The report was then adopted. The celebration fund now amounts to £1,020, and it has been decided to illuminate the town hall by electricity.

Income Tax and Machinery.—In reply to a memorial from the Association of Chambers of Commerce in reference to the present state of the law as to allowances made in income-tax assessments for depreciation of machinery and for obsolete machinery, the Chancellor of the Exchequer has directed the following letter to be written: "The chief points raised in the memorial are as follows: (1) that the allowances in respect of repairs and depreciation of machinery are insufficient, and the methods of calculating such depreciations are unsatisfactory; (2) that no allowance is made for the cost of replacing machinery which has become obsolete. As to the first point, I am to say that, as the law now stands, deductions are allowed both in respect of expenditure incurred in repairs of alterations of machinery according to an average of the three years preceding the year of assessment, and also in respect of the diminished value of machinery by reason of wear and tear during the year. The allowance of these deductions is in the hands of the district or special commissioners, as the case may be, and they have to decide in each case, as it arises, the adequacy of the deductions allowed. As to the second point, I am to say that the Board of Inland Revenue have given instruction to their surveyor at Leicester, which is particularly referred to in the memorial, that where a claim is made in respect of the introduction of more modern machinery in a factory, no objection is to be taken to the allowance, as a deduction from the assessable profits of the year, of so much of the cost of replacement as is represented by the existing value of the machinery replaced. Any excess in the cost of the new machinery over the actual present value of the old is an addition to the capital of the business, and cannot properly be regarded as a charge upon revenue for the purposes of income-tax assessment. I am to add that similar instructions will be given to surveyors in other districts when this question arises there."

Birmingham Tramways.—A further meeting of the Public Works Committee has been held with reference to the arrangements with the tramway company in respect to their Bill now before Parliament. It will be remembered that when the Bill of

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the company was deposited the City Council resolved not to oppose it in its preliminary stage, in the hope that before it reached the House of Lords an agreement would be come to respecting the system of traction to be substituted for the present steam locomotives. The decision of the committee not to allow overhead electric wires has given rise to great difficulty between them and the promoters of the Bill, the latter not seeing their way to provide an entirely underground system under the conditions of the lease as originally agreed to. As a result of a conference between the engineers retained by the Corporation and those of the tramway company, the estimate of the latter as to the cost of the underground system has been materially reduced, the figure being now placed at £11,000 per mile. When the committee adjourned a fortnight ago, it was understood that Mr. Ross would attend at this meeting on behalf of the tramway company and be prepared either to assent or to reject a modification of terms which a majority of the members of the committee were stated to be willing to recommend the Council to concede, and if these were rejected to announce that the company would withdraw their Bill. Mr. Ross, however, was not present, having, it was stated, been called to London to consult with others connected with the financing of the undertaking. Under these circumstances no progress was made, and the committee will meet again on the 14th inst., when they will formulate a report to be presented to a special meeting of the City Council to be held on the 18th. In view of the greater cost of a complete conduit or underground system over and above what was anticipated when the agreement for the new lease was come to, the committee, it is believed, will recommend the Council to modify to some extent the terms imposed on the company. The modifications are understood to include a slight extension of the lease and a substantial reduction in the amount charged for rent, as well as some alterations as to the length of conduit to be purchased by the Corporation at the end of the lease. A rough estimate mentioned gives the total value of these concessions as equivalent to a capital sum of between £120,000 and £130,000. The committee, it is stated, are by no means unanimous in these recommendations, and the course of procedure adopted is to throw the responsibility upon the City Council as a whole.

Hastings.—The Public Lighting Committee reported at the Town Council meeting that they had received from the engineer of the gas company a letter, from which it appeared that the company were not prepared to purchase and fix the new incandescent lamps and brackets required for the improved lighting of High-street and George-street in accordance with the order made at the last Council meeting, unless terms for the supply of lamps and columns, etc, generally were arranged with the company in accordance with one of the alternatives suggested by the company in a letter from their engineer of October 8 last, which was referred by the committee to a sub-committee for consideration and report. The committee, under the circumstances, recommended that so much of the order made at the quarterly meeting held on May 7 as related to the substituting of incandescent lamps, etc, for the existing lamps in High-street and George-street be rescinded, and having regard to the fact that the Council would, within a short period, be in a position to light the streets named by means of electricity, further recommended that it be referred back to them to consider the matter of so lighting such streets, and to report in due course. Councillor Idenden moved and Councillor Tuppenney seconded the adoption of the report. Councillor Shoesmith moved an amendment, that in the third line from the bottom of the report they insert the words, "Will be in a position to light these streets by the end of August with electricity." The Town Clerk asked if it would not be better for the matter to go back to committee as proposed, and Councillor Shoesmith said he would be satisfied with that course. Councillor Coleman said he was quite prepared to second the amendment, but he quite agreed to the matter being reconsidered by the committee. They had been told they would be able to get the electric light up in the Old Town by that time, and he hoped they would do so. The Deputy-Mayor said he had had an interview with the borough engineer, and Mr. Palmer assured him that considerably before the end of August he would be able to light up George-street and High-street with electricity. He (the deputy-mayor) fully recognised that, those streets being so narrow, they required a better light even than they had in wider streets. The assurance of the borough engineer was so very pronounced that they need not fear but that the light would be up by the end of August. Councillor Ransom asked if he was right in taking it that the object of this resolution was to rescind *in toto* what had been proposed and adopted, and to refer back to the committee only that part of it that related to the possibility of lighting these streets with electricity? Did they do away altogether with the original motion to have better gas lamps? The Town Clerk said that was so, for the reasons stated in the earlier part of the report, because the gas company would not do what the Council wanted them to. The report was adopted.

Croydon.—The Croydon County Borough Council have adopted the following report in regard to electric light from Prof. Kennedy with regard to the extension of plant and station: "The number of lamps connected at present is equivalent to about 6 600 of 8 c.p., and there are about 4,000 further applications, making a total of 10,600. Judging from the station records, which I have examined in detail, I think that by December next, when your heaviest load for this year will occur, you will have about 12,000 lamps connected, and these lamps, together with the arc lamps in the streets, will be practically full load for two of the machines in the stations, leaving the third machine as a reserve. The plant, therefore, is sufficient, but not more than sufficient, to take you through the coming winter. At the rate, however, at which lamps are coming on to your mains, and applications for further supply coming in, I do not doubt that the end of 1898 will see you with about 10,000 more lamps to supply than you will have at the end of this year. It will therefore be necessary, to meet the wants of 1898, that you should have more plant. The manufacturers of engines and dynamos of the highest class suitable for electric lighting are so extremely busy just now, that I doubt very much whether you can make certain of delivery of such machinery in less than 12 months from the date of order. I think, therefore, that it would be wise if your committee would seriously take into consideration as soon as possible the question of providing for extensions, for I am sure that that the plant ought to be ordered, if possible, before the summer holidays in order to make quite sure of good delivery. I should advise that you place in the station one steam alternator having an output of about 250 kilowatts—that is to say, twice the size of your present machines. This machine will be sufficient along with one of your present machines, leaving the other two as stand-by, to supply about 12,000 lamps alight at once, or, say, 24,000 connected, and therefore will be sufficient for all your wants during 1898. The total cost of such a set, with all the corresponding pipes, instruments, and connections to switchboard, etc., would be about £3,600. The three existing boilers would be quite sufficient to supply steam for this increased power, but would not give you any reserve. It would therefore be wisest to put down also one additional boiler, in order that you might make sure of always having one boiler standing by. The cost of this boiler, with its seating, mountings, and pipes, would be about £750. The two rectifiers put down in the station, with all their gear, switches, etc., have cost us about £450 each. I think we ought to get a third at a somewhat less price. In Edinburgh, similar machines have cost me about £400, ordering four at a time." The sub-committee having the matter in hand recommended at the Council meeting that they should be authorised to order the plant and extension of buildings as recommended by Prof. Kennedy at an estimated cost of £5,500, and that the British Thomson-Houston Company, Limited, be asked to guarantee sinking fund and interest on this additional capital, and that the application be made to the Local Government Board for sanction to the necessary loan. The committee further recommended that application be made to the Local Government Board for sanction to borrow £5,550 for electric lighting purposes. The recommendations were adopted.

Blackpool.—In proposing the adoption of the Electric Lighting, etc., Committee's minutes at the Town Council meeting, Councillor Brodie said, as regarded the electric lighting department, the Council had heard with pleasure that the year's working showed a profit of over of over £800, after paying all interest and sinking fund charges. This result was gratifying in view of the many difficulties which beset the department during the last year especially. If a profit like this could be made when everything appeared to be against success, the profit when everything got in thorough working order would be substantial and satisfactory. He regretted he could not give as good a report of the electrical tramway. They expected to give £2,200 towards the rates, but although the receipts were £13,300, they could only give £300 towards the rates. Some three or four months ago the committee went thoroughly into this matter, and they found some extravagant expenditure, and they made a change. The estimated expenditure on the centre channel was £250, but the actual expenditure was £1,295, an excess of £1,045. The receipts for Sunday traffic on 33 Sundays were £906. 9s. 3d., and the wages for the same £500. Certain old dynamos and wheels had been put in as good stock by the late manager, which had now been wiped off to the extent of £400 or £500. The estimated expenditure on motors and gearing was £700, but the actual expenditure was £1,429. The difference between the actual and estimated expenditure, exclusive of the cost of repairing the culvert, was £1,501 on the wrong side. This amount was made up by £729 on motors and gearing account and £322 on coal and water account. About £100 was due to Sunday working, which was not anticipated when the estimates were made up, but he believed the excess was mainly the result of bad fittings of the motors and gearing of the cars; for the electrical portion of the cars, when thoroughly overhauled, were found to be in a lamentable condition. By these bad fittings the motors were compelled, in some cases, to do double or treble their proper share of work, and it was, therefore, not surprising that they continually broke down. The cost of electrical repairs to cars was at all times heavy, but these repairs, instead of being carried out thoroughly, so as to make the cars run well, appeared to have been only half done, and consequently had to be done over and over again, so that in the end they cost an enormous amount of money. Thus was the excess of £729 accounted for. In regard to the excess of £322 on coal and water account, the same reason which applied to the motors and gearing applied to this—viz., to a small extent to Sunday running and to a large extent to the bad fittings mentioned. If the motors were compelled to do more than their proper share of work they would require more current and more steam and energy, and consequently more coal, water, etc., all of which swelled the total cost abnormally. In the estimate for the current year £2,000 had been set aside for repairs to motors and other repairs. This seemed a very large sum, but he was assured it would all be required, but not exceeded. All the electrical portion of the cars was being thoroughly overhauled, and though this was a costly matter it would soon repay itself by more efficient, steady, and satisfactory running of the cars. The committee were doing everything possible to ensure a satisfactory service and to place the department on a more profitable basis. In answer to Councillor Howarth, he stated that the amount mentioned allowed for depreciation.

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Reading.—The General Purposes Committee reported at the Town Council meeting that they had considered the report dated April, 1897, which was submitted to them by the borough engineer and surveyor on the subject of the tramways, whereupon it was resolved that the committee do recommend to the Council as follows—namely: "That with a view to improving and extending the tramway service in the borough, steps be taken for the purchase by the Corporation of the undertaking of the Reading Tramways Company, Limited, by agreement, and that the town clerk do apply to the company to state the terms upon which they would be willing to sell their undertaking to the Corporation; that the borough engineer and surveyor be and is hereby authorised and directed in consultation with the Mayor, the Deputy-Mayor, and the chairman of the committee, to make arrangements with a competent valuer to value the undertaking of the company, if a valuation should appear to be necessary, in order that the Council may be in a position to arrange satisfactory terms with the company, or failing a purchase by agreement to proceed in the year 1899 to the compulsory purchase of the undertaking under Section 43 of the Tramways Act, 1870. That the borough engineer and surveyor be and is hereby also authorised and directed to watch the various systems referred to in his report, and to report from time to time to the committee as to the success or otherwise of the several systems which may be in operation." Alderman Monck, in moving the adoption of the report, said that perhaps he might, in a few words, say what their position would be. If this resolution was passed they would have power to approach the tramway company, and by an agreement with them purchase the tramways at a valuation that was satisfactory to both parties. If they could not come to terms with them, then it gave them power to purchase the tramways compulsorily, but that power could not be exercised till after the month of August, 1899. They had to do it within six months after August, 1899, and therefore they would see that if they purchased by compulsion there would be no object and no necessity for their obtaining an Act of Parliament next year. It would give them till 1899 to obtain either a provisional order or an Act of Parliament, which either might seem necessary. He thought it was really for the benefit of the town that they should postpone this question till 1899. It was certain that the Council did not know—certainly it was not unanimous—what extensions they wanted in the town, and they certainly did not know what system of traction they wanted. They were very much indebted to Mr. Bowen for his report; it was a very exhaustive report, and one, he thought, which would make them use their eyes in going about to see these other systems, and especially abroad. There were numerous corporations that were in the present session of Parliament obtaining provisional orders to work their trams for themselves or lease them, and no doubt they would try various systems of traction. It was much better for them in this case not to be a pioneer company, but let somebody else try the experiment, and let them get the benefit of these experiments. He thought they would see that the committee did not wish to put the matter off indefinitely, but merely to have a little time for consideration, and then bring it again before the Council for their final decision. Alderman Hill seconded the adoption of the report, and it was carried unanimously.

Ramsgate.—At the Town Council meeting, Councillor Bear, in accordance with notice, proposed "That this Council approve and support the application of the Isle of Thanet Light Railways (Electric) Company, Limited, for an order authorising the construction of the proposed light railway from Pegwell through Ramsgate, Broadstairs, and Margate, subject to the insertion in such order of the new clauses and amended clauses agreed upon by counsel for the Corporation (Mr. Low) and counsel for the promoters (Mr. Bower), and that the town clerk take the necessary steps for giving effect to this resolution." In the course of his observations he said all the objectionable clauses in the order had been eliminated by the promoters since it was first before them, and they had agreed to various restrictions, not only as to the kind of pole for the wires, but also as to there being no trailer cars, and they gave the local authorities full power over various matters, so that in many particulars the Bill as it now stood was quite a different thing to what it was at the outset. Councillor Bear proceeded to refer to the need of such communication in the Isle of Thanet, as it would tend to develop the island. He had ascertained that one of the terms upon which the promoters would meet the Council was to contribute a sum of £3,500. He thought, on the whole, they had met the Council in an extremely liberal spirit. Councillor Hodgson seconded. The Mayor strongly opposed the resolution. He said he had given the matter great consideration, and nothing had induced him to alter his opinion. Councillor Poole also opposed, remarking that he was under the impression that the modifications agreed upon would have come up for the consideration and approval of the Council before they took any further steps, and he thought that would be the proper course to adopt. They ought to have the modified order before them before passing such a resolution, or they would be giving themselves away completely. Councillor Gwyn agreed with the last speaker. Of course they were not blind to the advantages offered by the tramway, but it would be the greatest folly imaginable to have it along the front, which was the one charm of Ramsgate. Councillor Hawkes agreed with Councillor Poole that the document of the concessions proposed should be placed before the Council. He had been in Brussels, Antwerp, and one or two other places recently, and found that the poles were ornamental and were in no way a disfigurement, whilst the travelling was certainly most luxurious in every way. Aldermen Wood and Green opposed the resolution, and Councillor Cook spoke in favour of it. Alderman Emett thought they should have the terms and discuss them at some future time. Councillor Barnett suggested that the meeting should be adjourned so that the town clerk could prepare the terms of the proposed agreement for their consideration. If it was true the promoters offered £3,500, he thought it was well worth considering in the interests of the ratepayers, for this year they would have to spend something like £10,000 in making up roads. He believed, too, the company had agreed to pay 2s. per ton for coal dues, and that would bring in something like £200 a year. Some discussion ensued as to whether the Council should adjourn, and eventually Councillor Barnett proposed, and Alderman Sykes seconded, that the question be adjourned for a fortnight, in the meantime the members to be furnished with printed copies of the proposed terms of agreement. This amendment was carried by 17 votes to 3, and the question will therefore come up for consideration on June 17.

Manchester.—The Corporation having applied to the Local Government Board for sanction to borrow £130,000 for the purpose of extending the electric lighting works and system, Colonel J. T. Marsh, R.E., recently held an enquiry. According to the opening statement of Mr. Hudson (the assistant town clerk), the present demand for the electric light in Manchester far exceeds the supply. The capacity of the plant was equivalent to the supply of current represented by 128,000 lamps of 8 c.p., but the demand for the current down to a very recent date was represented by 161,594 lamps, showing a deficiency of 33 594 lamps. The principal new works proposed to be constructed consisted of two direct-driven electric generators of 2,500 h.p., six Lancashire boilers, similar to those already provided, and five tubular boilers; also two economisers, each having 480 tubes. In addition to these works a very large outlay upon additional mains would be necessary. On March 31 last the total outlay on electric lighting was £309,190. 19s. 10d., and the estimated cost of works which were included in previous applications for loans, and which had not yet been executed, was £40,809. 0s. 2d. The further estimated outlay was £130,000, making a total of £480,000. In conclusion, Mr. Hudson said that the Corporation desired the loan for the same term of years as was granted previously—namely, 25 years. Alderman Higginbottom (chairman of the Electricity Committee) then explained the electric lighting scheme in detail, mentioning that Manchester was the first city of the United Kingdom to adopt the five-wire system. The area of supply had gradually increased, and provisional arrangements for the supply of the current to Moss Side and Levenshulme had now been made. In order to cope with the increased demand for electricity for lighting and motive power, it was absolutely necessary that the plant should be enlarged at once. He gave details showing how the £40 809 already sanctioned would be expended, and explained how the amount of £130,000 required for the proposed extensions was arrived at. Upon buildings it was estimated the expenditure would be £13,000; upon machinery, £55,800; upon transformer stations, £15,300; upon mains, £33,500; meters, £2,500; instruments, £500; sundries and contingencies, £9 400. Dealing with the varying capacity of the plant, he said that in 1893 it was 40,000 eight-candle lamps, that in 1894 it was increased by 16,000 lamps, and that in 1895, and 1896, up to March, 1897, it was increased by 72,000 lamps, making a total of 128,000 lamps. Another side of the progress was shown as follows: In 1893 there were 289 consumers and 32,716 lamps; in December, 1894, the consumers were 624 and the lamps 60,298; in December, 1895, the consumers were 1,018 and the lamps connected 93,290; in December, 1896, the consumers were 1,466 and the lamps 133,504; and in May of this year the consumers were 1,620 and the lamps connected 147,068. There were also awaiting connection 52 consumers and 14,526 lamps, making the total number of consumers connected and awaiting connection 1,676, and the number of lamps connected and awaiting connection was 161,594. If by any possible chance the whole of the lamps were lit at once, the plant would not at present be able to supply the demand. The percentage of lamps lit at the same time was 65, but should a fog come on rapidly and continue there would be serious danger of the supply falling short. For the past two years 40,000 lamps per year had been added, and the demand at the present time was even greater. There were no means of estimating the probable demand, and that explained the frequent applications for borrowing powers. Comparing the consumption of last year with the year ending March, 1896, there was an increase of no less than 973,678 units, or 54 per cent. Such a rate of increase had never been known in this country. The whole of the consumption last year was for private purposes. Public lighting of the three squares had, however, given great satisfaction, and the committee anticipated a demand for the lighting of public streets. The cost of lighting the three squares was £80 a year less than the cost of gas. Turning to the profits, Alderman Higginbottom stated that for the first eight months there was a loss of £278, but only after paying the interest on the sinking fund and depreciation charges. For the year ending March, 1895, there was a net profit of £5,709, and £4,000 was placed to the renewals fund. In March, 1896, there was a net profit of £11,139, the sum of £3,492 was paid to the renewals fund, and £8,521 to the reserve fund. In that year also they paid to the city fund £6,964 in aid of the rates. In March, 1897, they made a net profit of £16,812, put to the renewals fund £3,307, placed to the reserve fund £7,965, and promised to aid the rates to the extent of £10,000. The Chairman of the Electricity Committee then showed how the price of the current had been reduced, and said that it was now 6d. per unit, and 2d. per unit where 3s. per lamp per quarter was paid. The result of that arrangement was that there were many firms in the city getting the current for 3d. a unit. After further evidence had been given by Councillor Phythian, who said that he thought the chairman's statement was a little too modest, and by Mr. C. H. Wordingham, the inspector proceeded to view the works.

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PROVISIONAL PATENTS, 1897.

MAY 31.

13363. Improvements in apparatus for distributing gas liquids, solids, or particles of solids by electricity. Henry Nehmer and Ferdinand Nehmer, 27, Sekforde street, Clerkenwell, London.

13371. Improvements in wheels for cycles, motor, electric, or steam cars and carriages. James Shaw, 35, Chorley Old road, Bolton.

13392. Improvements in and connected with electrical alarm clocks and alarms, time locks, and the like. Arthur Charsley, 11, Furnival-street, Holborn, London.

13413. Improved means for controlling the working of lifts, motors, and other engines operated by electric energy. William Arthur Ker, 191, Fleet-street, London.

13414. Improvements in or relating to safety fuses for electric currents. Charles James Hall and Henry James Fuller, of Messrs. John Fowler and Co., Limited, 37, Essex-street, Strand, London (Complete specification.)

13422. Improvements in coin-freed mechanism for electric lighting of vehicles or apartments. Oliver Imray, 28, Southampton-buildings, Chancery-lane, London. (La Société Anonyme d'Etudes et d'Exploitation de l'Accumulateur "Eclair," Belgium.) (Complete specification)

13434. Improvements in incandescent electric lamps. Herbert Godsal, 4, Temple-gardens, London.

JUNE 1.

13436. Combined electric motor and polishing spindle. Henry Shaw, 56, Witton-road, Aston, near Birmingham.

13520. Improvements in pneumatically-worked electric switches. Siemens Bros. and Co, Limited, and Alfred Ernest Le Rossignol, 28, Southampton-buildings, Chancery-lane, London.

13523. An improved starting rheostat with automatic cut-out for electric motors. Henry Henderson Cutler, 11, Southampton-buildings, Chancery-lane, London. (Complete specification.)

13524. An improved starting rheostat with automatic cut-out for electric motors. George Augustus Mower, 11, Southampton-buildings, Chancery-lane, London. (Henry Henderson Cutler, United States) (Complete specification.)

13532. Improvements in windings for the armatures of direct-current dynamo-electric machines. Valere Alfred Fynn, 47, Lincoln's-inn fields, London.

JUNE 2.

13564. Improvements in and relating to electric motors and dynamo-electric machines. Sidney George Brown, 1, St. John's-road, Chelmsford.

13581. Improvements in electric arc lamps. John Edmondson, Penny Bank-chambers, Halifax.

13594. Improvements in or relating to electrical meters—applicable to prepayment electrical meters. Charles Orme Bastian, 31, Southampton-buildings, Chancery-lane, London.

13599. An improved self-acting mule with electrical driving gear. Waldemar Bretschneider and Wilhelm Lauth, 11, Southampton-buildings, Chancery-lane, London.

13617. Improvements in and connected with electric arc lamps. James Brockie, 33, Chancery-lane, London.

JUNE 3.

13679. Mechanism for operating the bells of cars or carriages of electric or other railways. Joseph Torry Haskins, 36, Chancery-lane, London. (Complete specification.)

13689. Improvements in or relating to electric batteries. Ernst August Jahncke, 78, Fleet-street, London.

13702. Improvements in generators of static electricity. Henry Benjamin Ford, 21, Finsbury-pavement, London.

13703. Adjustable shades or screens and attachments therefor for diffusing electric or other intense light. Charles Ebenezer Challis, 47, Wray-crescent, Tollington park, London.

13717. Improvements in or relating to switches for starting resistance for electric motors and other cases where resistances are required. John Walter Gibbs, 6, Lord-street, Liverpool.

13727. An improved tubular carbon filament for electrical incandescent lamps and process for the manufacture of the same. Victor Scholz, 45, Southampton-buildings, Chancery-lane, London.

13732. Improvements in or relating to incandescent electric lamps. Hiram Stevens Maxim, 45, Southampton-buildings, Chancery-lane, London.

13733. Improvements in systems of telegraphy and in apparatus for use therein. Roderick Henry Weiny, 45, Southampton-buildings, Chancery-lane, London.

13735. Improvements in primary batteries. Walter Rowbotham, The Gables, London-road, Twickenham, Middlesex.

JUNE 5.

13838. Improvements in or relating to electrical switches. George Page, 3, St. Nicholas-buildings, Newcastle-on-Tyne.

13906. An improvement in terminal connections of telegraph cables. Louis Marche, 28, Southampton-buildings, Chancery-lane, London.

13923. Improvements relating to electric incandescent lamps. William Robert Lake, 45, Southampton-buildings, Middlesex. (Compagnie Generalé des Lamps a Incandescence, France.)

SPECIFICATIONS PUBLISHED.

1896.

8906. Electric batteries and appliances connected therewith. Atkinson and Treharne.

9959. Electrical arc lamps. Lauder.

10119. Electrical thief alarm for vehicles. Pearson and Gooding.

10414. Electric hoists. Scott.

11338. Electrodes for electrolytic purposes. Street.

11617. Electric alarm for railway trains and other purposes. Binko.

13730. Electric arc lamps. Baumer.

14555. Process and apparatus for the papering of iron sheets for electrical and magnetical apparatus. Siemens Bros. and Co., Limited. (Siemens and Halske.)

15326. Insulating and supporting electric wires intended to act as electrical resistances, applicable as radiators of heat for cooking, warming, and other purposes. Crompton and Fox.

15559. Conduit system tramways and appliances for the same. Hughes and Meacock.

15614. Electrical relays. Smith and Granville.

16152. Apparatus for controlling electric currents. Estrade.

16256. Electric furnaces. Bullier. (Date applied for under International Convention, December 28, 1895.)

16257. Electric furnaces. Bullier. (Date applied for under International Convention, January 27, 1896.)

22069 Electric accumulators or storage batteries. Young. (La Société Anonyme "Accumulateur Eclair.")

1897.

7305. Brushes for the commutators of electric dynamos and motors. Joseph.

9425. Electromagnetic clutches or couplings. Fynn.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	9½-9¾
Brush Company, Ordinary	3	1¾-1¾
—— Non. Cum., 6 per cent. Pref.	2	1¾-1¾
—— 4½ per cent. Debenture Stock	100	104-108
—— 4½ per cent. 2nd Debenture Stock	100	95-99
Callender's Cable Company, Debentures	100	110-115
Central London Railway, Ordinary	10	9¾-10¼
——	6	5¾-6¼
Charing Cross and Strand	5	13¾-14¼
Chelsea Electricity Company	5	9¾-10
—— 4½ per cent. Debentures	100	113-115
City of London, Ordinary	10	23½-24½
—— 6 per cent. Cumulative Pref.	10	17-18
—— 5 per cent. Debenture Stock	100	131-136
City and South London Railway, Consolidated Ordinary	100	58-60
—— 4 per cent. Debenture Stock	100	137-139
—— 5 per cent. Pref. Shares	10	15¾-16
County of London and Brush Provincial Co., Ordinary	10	12¾-13¼
—— 6 per cent. Cum. Pref.	10	15-15¼
—— 4½ per cent. 2nd Debenture Stock	10	14¾-15¼
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	1¾-2¼
—— 5 per cent. Debentures	—	90-95
Edison and Swan United Ordinary	3	2-2¼
—— 5 per cent. Debentures	5	3¾-4¼
—— 4½ per cent. Debentures	100	105-110
Electric Construction, Limited	2	1¾-1¾
—— 7 per cent. Cumulative Pref.	2	2¾-3¼
Elmore's Copper Depositing	1	¾-1
Elmore's Wire Company	2	2-2¼
W. T. Henley's Telegraph Works, Ordinary	10	18¾-19¼
—— 7 per cent. Preference	10	18¾-19¼
—— 4½ per cent. Debentures	100	108-113
House-to-House Company, Ordinary	5	8¾-9
—— 7 per cent. Preference	5	9¾-10¼
India Rubber and Gutta Percha Works	10	20¾-21¼
—— 4½ per cent. Debentures	100	104-107
Kensington and Knightsbridge Ordinary	5	12¾-13¼
—— 6 per cent. Pref.	5	8-8¼
London Electric Supply	5	1¾-2¼
Metropolitan Electric Supply	10	16¾-17¼
—— 4½ per cent. First Mortgage Debenture Stock	100	120-124
National Telephone, Ordinary	5	6¾ 6¾
—— 6 per cent. Cum. First Pref.	10	15-17
—— 6 per cent. Cum. Second Pref.	10	15-17
—— 5 per cent. Non. Cum. Third Pref.	5	6-6¼
—— 3½ per cent. Deb. Stock	100	105-109
Notting Hill Company	10	15-16
Oriental, Limited, £1 shares	1	1¾-2
—— £5 Shares	5	8¾ 8¾
—— £4¼ shares	4¼	7¾-7¾
Oriental Telephone and Electric Company	1	¾-¾
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	102-104
St. James's and Pall Mall, Ordinary	5	15¾-16¼
—— 7 per cent. Pref.	5	10-11
Telegraph Construction and Maintenance	12	36 39
—— 5 per cent. Bonds	100	103-106
Waterloo and City Railway, Ordinary	8	10¾-11¼
Westminster Electric Supply, Ordinary	5	14¾-15¾
Yorkshire House-to-House	5	8¾-8¾

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NOTES.

Municipal Electrical Association.—It may do no harm to note here that the convention of the Municipal Electrical Association begins at Manchester on the 30th inst.

University College.—University College has been celebrating what is called "foundation week," and, by way of opening to what is intended to be an institution of the college, an oration was given by Prof. G. Vivian Poore in the Botanical Theatre on the history of the college. The chair was taken by Lord Reay, the president.

Workshop Power Transmission.—In the *Revista Tecnológico Industrial*, which is published by the Association of Civil Engineers of Barcelona, there has been commenced a series of papers by Mr. José Playá on the electrical transmission of power in factories and workshops. It is not proposed to give an abstract of these papers here, but their appearance may be worth note as an indication that the subject is receiving attention in what is probably the most advanced and enterprising district of the Spanish Peninsula so far as engineering is concerned. It should be remembered, too, that in Catalonia even a small saving of the coal bill is of more relative importance than it would be here, and there is a better chance of getting cheap water power. When electric energy is transmitted to the works from water power at a distance, it is decidedly better style to make the whole equipment electrical rather than put up shafts and harness one big motor to them.

The Metric Measures in America.—According to the *Engineering News*, the Bill for the adoption of the metric system of weights and measures in the United States, which has been brought forward by Congressman Hurley, proposes to make the metric system the legal system of weights and measures recognised in the States, after 1900, in the transaction of all business requiring the use of weight and measurement, except in completing public land surveys. The Bill has been referred to the Committee on Coinage, Weights, and Measures, and ordered to be printed, but whether it will go very much further may be doubted. Of course if the United States should really, and not merely nominally, adopt the metric measures, it will be the beginning of the end. In this matter the match of England and the States against all the rest of the world is not the unequal one that it seems, but neither could stand alone in refusing to adopt a really international system.

Telegraph and Telephone.—The (paper) campaign against the existence of an independent telephone service competing with that of the Spanish State telegraphs is still continued in *El Telegrafista Español*. It is argued that it would be better for the public if the State undertook both services, and better for the telegraphic service, the members of which would have more scope for their energies. Arguments are drawn from all sorts of sources—socialism, co-operation, and the conflict of class with class all come in. Some evidence that the Spanish public would like to see the telephone service in the hands of the telegraphic department would be a little more to the point. Meanwhile the energies of the telegraphic department might be devoted to remedying the chronic block on the lines, by which, according to another writer in the same journal, it is brought about that between Barcelona and Madrid, unless you telegraph early in the morning, your message is delayed for hours.

Electric Light and Fruit Forcing.—In the "Forcing-Book" (which relates to the cultivation of vegetables in glasshouses), by Mr. L. H. Bailey, reference is made to proportions for the use of the electric light for forcing-houses. The results obtained in America appear to be substantially the same as observed on different plants by the late Sir William Siemens on this side. Mr. Bailey, however, says "it will be found profitable to use the electric light for plant-growing, if at all, only in the three or four months of mid-winter." The experiments on the effect of artificial growth on plant life are very interesting, but it is questionable at present whether one ought to talk of its use being "profitable" at all. If it should turn out a success from the gardener's point of view, the thing becomes a question of whether it is more profitable to manufacture an artificial climate, than to spend money on a rapid and careful transit from a country where a suitable climate is provided by Nature cost free.

Electric Traction on the Railway.—It is not altogether certain that the United States will lead the way in adapting the electric locomotive to the needs of the ordinary railway service, and it may even come to pass that if we do not do it here on the District Railway, it will first be done on a commercial scale on the southern side of the Alps. Reference has already been made to the efforts to take the Cenis Tunnel in hand and improve its atmosphere by this means. Now, according to *L'Elettricità*, an Italian-Swiss syndicate is pressing on the railway authorities a project for working the Treviso and Belluno line electrically, and the Adriatic Company, to whose system the line belongs, regard it not without favour. The power is to come from a waterfall with an effective height of nearly 400ft. It is in this respect that the Italians have the advantage both of us and our American cousins. Instead of being merely a choice of where you can burn cheap coal most economically, it is for them the choice between using dear coal or cheap water.

Technical Education Congress.—On Tuesday, at the rooms of the Society of Arts, an international congress was opened on the subject of technical education. Amongst those present were the Duke of Devonshire, the president; Major-General Sir Owen Burne, chairman of the council of the Society of Arts; Major-General Sir John Donnelly, secretary of the Science and Art Department; Sir F. Bramwell; Sir D. Galton; Sir P. Magnus; Sir H. Roscoe; Sir H. Trueman Wood; Dr. H. E. Armstrong (City and Guilds Central Technical College); Dr. J. H. Gladstone; Mr. Léo Saignat (président du Bureau Permanent du Congrès); Prof. Silvanus P. Thompson; Prof. Viriamu Jones; and various foreign delegates. The Duke of Devonshire delivered the presidential address. Subsequently, among other papers read, were some on the teaching of chemistry, and the discussion of that subject was begun, but what notice that may be necessary of the work of the congress had better be deferred to next week.

Acetylene.—The Italians appear to have much more confidence in the practical utilisation of acetylene for lighting purposes than we have on this side of the Alps. In Milan there is a weekly journal—*L'Acetilene e le sue Applicazione*—with a distinguished list of contributors, which is entirely devoted to the industry. Like the motor-cart, however, the acetylene burner is more often talked of than seen in actual work. The rather nasty explosions which occurred at Paris and Berlin have shown practically that, as the chemists predicted, acetylene under compression in steel cylinders is to be safely used only with the very greatest precaution, and, therefore, there are obstacles to its taking possession of the main field that seemed open to it. In one way and another it does not seem that the electric incandescent lamp is likely to find a serious rival in the acetylene burner, nor is the manufacture of carbide for the subsequent production of the gas likely just at present

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to entirely revolutionise the kind of machine which comes out of the dynamo-builders' shops.

The Old Tale Retold.—"'Tis the voice of the consul, one hears him complain, I have told you before, must I tell you again?" This time the complaint comes from Rio Grande do Sul, which, unless there is a revolution going on, is Portuguese for South Brazil. The complaint is the usual one. Brazilians, as a rule, do not understand English. (Englishmen, as a rule, do not understand Portuguese—colonial variety.) "All price-lists, catalogues, etc., should be in Portuguese, Spanish, or French. Many British prices current and other similar publications are received at this consulate; but, with two exceptions, they are all in English. The metric system should be used for all weights and measures in such lists; for no Brazilian will trouble to convert British measures into kilos. and metres when other catalogues are at hand with the work already done, as is the case with many American and German lists." German catalogues are preferred simply because the dimensions are given in the metric system, even though the Brazilian can no more make out the German than he can the English, and so forth.

The Marconi Telegraph.—Mr. Preece first exhibited the Marconi telegraph somewhere down Whitechapel way, but that is now very many months ago. After showing it in Albemarle-street a fortnight or so ago, he promptly took it off to Islington. The lecture delivered last Friday at Myddelton Hall, Islington, was practically a repetition of his Royal Institution discourse. There were, however, two additions which are worth note. The first was Mr. Preece's estimate of the discovery. He had, he said, spent 47 years of his life in the study of electricity. Not a day passed that he did not come across something new and interesting, but he ventured to say that the system of telegraphy he was there to explain was the greatest and most important discovery that had yet been made in this branch of science. The second was that at the end of the proceedings Mr. Marconi made a little speech in English on his own account. It was merely an expression of his acknowledgments for the way in which he and his invention had been received in this country, but it would have been interesting to have heard it.

Physical Society.—As was anticipated, the papers at the Physical Society last week were interesting. The first, in spite of its mathematical character, brought up questions of practical importance. It showed pretty clearly that no one exactly knows what happens when it is attempted to send an induction wave through such a medium as sea-water. Mr. Heaviside, who possibly knows more about the theory of such waves than any other man, says plainly that the conductivity is not sufficient to stop signals under circumstances in which, as a matter of fact, signals failed to go. According to Mr. Whitehead (the author of the paper), the proportion of the loss due to having to go through water instead of air should be a mere fraction instead of nearly the whole. Mr. Evershed, who has tackled the matter experimentally, doubted whether Mr. Whitehead had put everything into his mathematics which he ought to have done. It is possible to make several suggestions as to what is the matter, but it really requires a series of experiments. Dr. Fleming's paper concerned a very different matter. The result that comes out is decidedly pretty.

The Institution Conversazione.—The conversazione of the Institution of Electrical Engineers was held on Tuesday evening at the Natural History Museum at South Kensington. The Institution is to be congratulated on its change from Piccadilly. The fine central hall of the museum is about as suitable a place as may be in which to sit and listen to a good band or to walk about and meet other people. And it appeared to be generally thought so, if it may be judged by the number that were there. The guests were received by Sir Henry and Lady Mance. The enumeration of distinguished visitors must be left in more capable hands than those of the present writer. Prof. Silvanus Thompson was at the president's side from the beginning, and Prof. Hughes and Prof. Crookes were there early. Prof. Kennedy, Prof. Ayrton, Prof. Perry, Major-General C. E. Webber, and Dr. John Hopkinson one remembers, as, of course, and Prof. Unwin, Major McMahon, Mr. Spagnoletti, Mr. A. R. Binnie, and Mr. Thorneycroft. Lord and Lady Kelvin came late, evidently having "come on" from somewhere else. So did Mr. Preece. Lighted with arc lamps, the place really looked very pretty, and was delightfully cool, without the suspicion of a draught. The band was the Royal Engineers.

Society of Engineers.—At a meeting of the Society of Engineers, held at the Royal United Service Institution last Monday, Mr. G. Maxwell Lawford, president, in the chair, a paper was read by Prof. Herbert W. Umney on "The Compression of Air by the Direct Action of Water." The author, by way of introduction, referred to the importance of obtaining compressed air by the simplest possible means, and in particular he called attention to the best of all methods, being the only one whereby the compression takes place isothermally, and stated the general principles underlying the system. He directed special attention to a plant erected by Mr. Frizell, of New York, which gave an efficiency of 52 per cent. when tested (that this is good shows how bad the process in its nature is), and stated that an abstract of these experiments was recorded in the *Proceedings* of the Institution of Civil Engineers in 1880. The author also described a plant erected by Mr. Taylor, of Montreal, giving an increased efficiency of 10 per cent. He gave in detail the method of impregnating the water with minute bubbles of air, the improvement being entirely due to this feature, and pointed out the alterations necessary, being confident of obtaining 75 per cent. of the power at command.

Contact Phenomena.—Some experiments exhibited last Friday by Mr. Rollo Appleyard at the Royal Institution deserve some mention, although they, or others very like them, have been before referred to in connection with the meetings of the Physical Society. The first was a liquid coherer, which differs from all other coherers in that you can see it cohere, or, rather, you can see the change take place when the current passes. Mr. Appleyard also showed an electromagnet and tuning-fork driving, or being driven (the action is reciprocal), by a microphone in series with it. Another was a perpetual pendulum. Three rods of carbon (electric light carbons) are arranged H-wise, the cross-carbon rolling on and carrying a current between the two parallel rods. If a pendulum is attached to the cross-rod, it will rock as long as there is a current. The explanation suggested is that at the end of the swings, when the motion is slowest, the contact is best (and therefore the current largest). Thus far Mr. Appleyard, but whether the tiny kick at the end of each stroke which is required to overcome the air and rolling friction on the pendulum is due to electric forces, or to a heating and expansion of the carbons, or to the little explosion of the air (there was a visible spark), or to some other cause which the writer has not thought of, why every man may at present choose for himself.

Eclipse Photography.—A total eclipse comes so seldom, and lasts for so little while, that one is naturally anxious to make the most of it. The idea of connecting

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several different kinds of photographic instruments with some sort of central automatic arrangement by which one man may work them all during an eclipse of the sun has been suggested, but never actually got tried in practice, but Mr. David P. Todd has now described in the *Astrophysical Journal* the special automatic shutter and electric commutator which was devised for the Amherst eclipse expedition of last year, but which was unfortunately not used owing to the bad weather. In all, 20 photographic instruments would have been worked by an automatic system, which would have given more than 400 exposures with several types of reflecting and refracting telescopes, photographic doublets, a pair of spectroscopes, photometers, and a pair of polariscopes. The system which Mr. Todd advocates is an electric system of control, and he has found that it is perfectly competent to operate any available number of eclipse instruments adapted for photographic purposes; it further makes the time record of every automatic movement in a form which can be identified. An eclipse expedition would be much better fun if one could look at the eclipse in peace without having a tiresome instrument to attend to. In Mr. Todd's way of doing it one ought to be able to throw all the work and all the responsibility for failure upon a single victim.

Power Distribution in Machine Shops.—While Mr. Scott has been discussing in our columns the question of the electrical distribution of power in workshops, Mr. Louis Bell has also been dealing with the same question in our American contemporary, the *Engineering Magazine*. Mr. Bell gives the following suggestions as to the best method of arranging a motor plant. He would abolish long shafts and quarter-turn drives. He would use separate motors for machines requiring large and intermittent power, while he would drive groups of machines, steadily loaded, from a single motor. The machines that can be advantageously grouped are those having small average and large maximum power. Another suggestion is that machines driven through long intervening shafts, or otherwise disadvantageously, should be supplied with individual motors; but this is self-evident. In most cases to get the factory owner to substitute motors for shafts one must show him results, and it is only gradually that efficiency of motors in shops is being demonstrated. According to Mr. Bell, when the machines are scattered over a considerable area, an average net efficiency of from 65 to 75 per cent. can be obtained, counting from the indicated horse-power of the engine to the motor pullies. (The exact figure depends on the ratio of average to maximum load.) This is, as a rule, considerably better efficiency than can be obtained by any other scheme of distributing power in similar circumstances.

A Spanish Plant.—An unknown correspondent, to whom we return our best thanks, has been good enough to send us a copy of the *Gaceta de la Produccion Lanera*. At first sight the fortunes of the Spanish wool trade do not seem to have much in common with the subjects dealt with in these columns, but, as it happens, this particular number of the *Gaceta* contains a long account of an electric installation at Tarrasa. Besides being an illustration of Spanish enterprise, the Tarrasa central station is interesting, as it is another example of the substitution of the producer for the steam-boiler. There is the usual Dowson gas plant, and the gasholder (empty) occupies an imposing position in Mr. J. M. Ballester's photographs. Anthracite is, of course, the material consumed. There are at present four Crompton dynamos, driven by belts from Crossley gas-engines. The voltage is 120, and each machine gives about 70 amperes. Additional machines are intended to be put in as required. The distribution is on the three wire system, and overhead conductors on wooden posts are used. The engineering part of the work rests between the firm of J. G. Neville, of Barcelona, and Mr. Bronton, who was the resident engineer during the work of construction. In this country we are so used to the steam-engine and its ways that the proportion of gas plants is, and seems likely to remain, a very small one. In fact, they have the reputation of being troublesome. On the other hand, there are advantages in a good big gasholder by way of a store of energy, and it is not ruinously expensive.

The American Electrical Engineers.—At the annual meeting of the American Institute of Electrical Engineers the following were elected as officers of the institute for the ensuing year: Dr. F. B. Crocker, president; Dr. A. E. Kennelly, C. S. Bradley, and Prof. D. C. Jackson, vice-presidents,; Ralph W. Pope, secretary; George A. Hamilton, treasurer; Gano S. Dunn, Dr. Alexander Macfarlane, Herbert Laws Webb, and Lieutenant W. E. C. Hasson, Board of managers. There was a report about the design of a badge for members to wear. The annual dinner followed. Mr. Comerford Martin introduced the new president, and there were speeches by Mr. Francis W. Jones, Dr. Pupin, Dr. C. E. Emery, Dr. A. E. Kennelly, Mr. R. W. Pope, Mr. J. W. Leib, jun., Mr. Herbert Laws Webb, Mr. Nelson W. Perry, E.M., and Mr. Joseph Sachs. We have to acknowledge the receipt of vol. xiii. of the *Transactions* of the institute. The principal papers, with the discussions on them, contained in this volume relate to elevators (Mr. Sprague), alternating arc lamps (Prof. Puffer), vacuum-tube lighting (Mr. Moore), distribution of energy (Dr. Duncan's presidential address), speed regulation (Mr. Leonard), not to mention long discussions on electric railway working and the Röntgen radiations. Transformer curves and the influence of temperature on insulating materials and some other matters have a place also. Most of these have had some notice in these columns, if not at once, at any rate as soon as the American technical papers reach this side. There are obituary notices of Mr. H. A. Craigin and Mr. H. L. Lufkin, of New York. The institute numbers 351 members and 716 associate members.

Rotary Transformers.—A paper has been read by Mr. Thordarson before the Chicago Electrical Association on the direct-current transformer. Mr. Thordarson makes some practical remarks as to bearings, wear of brushes, and so forth, and states that he has made a 200-watt machine that will run for 90 hours continuously without any attendance. Considering, however, the way in which the Americans sometimes instruct us on the subject of rotary transformers, the following about another machine he made is distinctly interesting. One cannot but admire the *naïveté* of the tale: "In working out various designs of direct transformers, the idea of rotating brushes and keeping all the other parts stationary will naturally suggest itself. Considerable experimenting has been done in this direction, especially by the Westinghouse and General Electric Companies, but very little of this information has found its way into print. A year and a half ago I designed and constructed a machine on this plan, taking an ordinary laminated ring slotted on the external edge, and into each slot was wound one primary and one secondary coil, and over this ring was slid another laminated ring of the same width and sectional area, thereby encasing each pair of coils in a closed magnetic field. The leads were connected to a stationary commutator. Inside of the ring was mounted on a vertical shaft a field magnet of sufficient strength to produce rotation, and on this shaft were secured the arms carrying brushes

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and collector rings. The results might have been predicted. Each pair of coils acted as if it were an independent static transformer. That is, the same results would be obtained by taking so many static transformers, placing them anywhere at random on the floor, and connecting them to commutators. We have in both cases induction and an immense amount of sparking, and the sparking is so violent that it is difficult to run the apparatus even through an experiment. The advantages of slotted armatures are well known, and spreading of the core teeth greatly diminishes the magnetic reluctance of the air-space. If the coils are deeply sunk in the core and the slots closed over them, the self-induction caused by the closed magnetic field surrounding each coil will become troublesome."

The Crehore Quick Telegraph.—It cannot be said that the discussion by the American Institute of Electrical Engineers of the paper by Prof. Crehore and Lieutenant Squier on "The Synchronograph," as their rapid telegraph transmitter is called, was a very fruitful one. Mr. F. W. Jones, chief electrician of the Postal Telegraph Company, opened the debate. Automatic transmitting systems were limited to the transmission of about 165 words per minute; would require twice as many operators to send and twice as many to report the messages. The delivery of the received message in its original form was a matter of great difficulty, and as to the possibility of increased traffic, it was Mr. Jones's experience that the ordinary Morse system could do more than it gets in regular business, and that with such systems the clerks and operators are about 44 per cent. of the entire maintenance of the system. Automatic systems were not as desirable as generally expected, owing to the fact that the cost of the tariff which would have to be charged would be far in excess of present methods, owing to the fact of the greater cost of operation, not in transmitting messages, but in preparing and receiving them. Dr. A. E. Kennelly, who followed, thought that if the business of transmission became enormously great, the telegraph people would find a solution for the expeditious handling of the messages to be transmitted and received at either end. Mr. Patrick Delany contested Mr. Jones's argument. Speed was not the only advantage of the Wheatstone and other machine telegraph systems, but one of their great advantages, and one which had materially aided in their adoption, was their extreme accuracy in the transmission of messages. As with all innovations of this kind, the first introduction was always beset with many objections from those who are directly interested in the present systems. In regard to the proposals of Messrs. Crehore and Squier, however, Mr. Delany was somewhat in doubt as to the application of the plan proposed. Lieutenant Squier and Prof. Crehore replied, and, so far as one can see in the reports in the American technical journals, the whole matter was considered simply from the business and office point of view, and the questions upon which the opinions of electrical and telegraphic engineers and experts would have been most valuable were not even entered on. Before one discusses whether a system is worth adopting, the first thing to settle is what it can do.

Royal Institution.—The last Friday evening discourse of the session drew a crowded audience. The ladies were there in great force to see Mr. Crookes play with diamonds. He had quite a quantity of beautiful stones, and still more beautiful imitations—that is to say, they were bigger. Mr. Crookes himself is supposed to have a stone or two for purely scientific purposes, but on this occasion Mr. Streeter came in to the affair; so diamonds black, white, and tinted were there by the trayful. But such things are not, as a general rule, for electrical engineers; one may come to the experiments, which were arranged regardless of expense. Mr. Crookes heated a diamond, and showed that it burned away cheerfully when dropped into a glass—one's pen slips, it should be a vacuum-jacket vessel—of liquid oxygen. He converted another into graphite by putting it in the crater of an arc. Regarded as a material for lamp carbons, diamond does not seem to have the good qualities which would compensate for its costliness. The other carbon did not at all approve of the intruder, and showed a tendency to sulk. Then Mr. Crookes gave another stone about five minutes' cathode ray "bombardment." He broke the tube, and showed that the stone was hopelessly blackened by the process. No one sympathised with the disfigured diamond, but one could not help feeling some compunction at the murder of the vacuum tube. The conclusion of the whole matter was to show the first stage of the making of (microscopic) diamonds artificially. The final process of dissolving out from the iron is an affair of weeks, and the Royal Institution hour cannot well be stretched to that. The nature of the process is well known, though few have witnessed it. What was wanted was about 500 amperes at, say, 50 volts for five minutes. Mr. Crompton had lent a special dynamo, and there were the great conductors and square copper leads to the electric furnace behind the lecture table. The half-dozen or so people behind the lecture table put on blue spectacles, the arc was made, and the ammeter ran up to about 400. When the little crucible was cooking properly, the lid of the square furnace was put on in the most prosaic way, and the ammeter ran up to somewhere about 600. There was a fine display of the sparks of burning iron, and a hitch and a restart about half-way through. When it was all over, and Mr. Crookes went to fish for his still white-hot crucible with a pair of tongs, and we were all waiting to see what boiling iron looked like, and what happened when you dropped it into water, he found the crucible had cracked. This is the sort of thing which will happen, so there was another crucible ready, and it was decided to start up again. After a little waiting, the reason of which we did not understand at the time, there was more glare and more iron sparks, and then, when everything seemed going nicely, no more current. Something wrong with the dynamo. Mr. Crompton went out himself to remonstrate with the machine, and did not return. Then Prof. Dewar went out to see if what was missing could in any way be supplied from the resources of the Royal Institution. Lastly, Prof. Fleming could sit still no longer, and followed the others. Still no current. At last a whispered message was conveyed to Mr. Crookes, and the experiment had to be abandoned. The belt, which was a new one, had given when the load came suddenly on the machine, and thereafter refused to remain on at any price. One knows exactly how to avoid this happening next time; but on this occasion there could be no next time. With this and other things there was little time left to see the exhibits in the library.

Electrolysis of Copper Sulphate.—An abstract by Mr. E. C. Rossiter of a contribution by Messrs. F. Förster and O. Seidel to the *Zeitschrift für Anorganische Chemie*, is published in the current issue of the *Journal* of the Chemical Society. Some of the results of the authors are in contradiction to a result obtained by Dr. Schuster, and they say that copper is appreciably soluble in copper sulphate solution (acid) protected from the air. The abstract is much too long to reproduce, but the conclusion of the authors is that the electrolysis of copper sulphate solutions at 100deg., and at the ordinary temperature, when a small current density is employed, takes place as

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follows: The anode copper forms with the contiguous cupric ions cuprous ions, and the latter, under the influence of the current, are converted into cupric ions. At the cathode the current converts the cupric ions into cuprous ions, and the latter, as soon as a certain proportion is reached, become unstable, and are converted into cupric ions with deposition of copper or cuprous oxide. The formation of cuprous oxide, observed with very small current density, takes place to a greater extent with high-current density when the potential difference of the bath is a little above one volt, which voltage is necessary for the decomposition of water. The cuprous ions then unite with the hydroxyl ions to form cuprous oxide. The deposition of powdery, red copper which takes place both from neutral and acid solutions depends on the current density alone. The deposit does not contain cuprous oxide. The formation of the black deposit which is obtained from very dilute copper sulphate solutions under a high voltage is determined by the dilution of the copper sulphate; in N/20 copper sulphate solutions it is formed if the solution is not stirred, but on stirring red copper is deposited; in N/100 solutions it is formed even when the solution is stirred. It is probably a compound of copper and hydrogen similar to those which have been prepared by Mylius and From by precipitating very dilute copper solution with a more positive metal. It oxidises easily in the air with formation of water and red copper. It is also obtained from N/100 copper nitrate. If, however, a small quantity of ammonium nitrate is added and the electrolyte stirred, red copper is deposited and hydrogen evolved. With larger quantities of ammonium nitrate, red copper alone is deposited if the solution is not stirred. Cuprous oxide is also deposited to a slight extent at the anode, and under certain conditions a yellow, amorphous precipitate is obtained, which the authors believe to be a basic cuprous sulphate. The errors in the results obtained when a small current is measured by the copper voltameter can be eliminated to a great extent by adding alcohol to the electrolyte. The alcohol decreases the concentration of the copper ions, and therefore the solubility of the copper in its sulphate solution. Very small currents can be measured with fair accuracy by this method, provided very small cathodes are employed whereby a high current density is obtained. With a current of 0·005 ampere the error is about 0·5 per cent. Results of like accuracy are obtained by employing an electrolyte saturated with cuprous ions, which is obtained by electrolysing a 2N copper sulphate solution with 0·1 ampere at 100deg. for a few hours and then allowing it to cool. In the electrolytic refining of copper it is advantageous to heat the electrolyte to some extent. With the same current density the deposit at the anode at 18deg. contained 2·9 per cent. Ag and 62·5 per cent. Cu; at 40deg. it contained 10·2 per cent. Ag, 1·4 per cent. Cu, and 86 per cent. Pb. The electrolyte can be heated to 50deg. without influencing the yield, but above this temperature the yield decreases. The authors point out the bearing of the above results on the theory of lead accumulators, and maintain that the formation of lead peroxide at the anode is similar to the formation of cuprous ions as described above.

The Electrical Engineer Volunteers.—The formation of the Royal Engineers (Volunteers) Electrical Engineers—for that is the correct though cumbrous title of the corps—was suggested by a committee of the Institution of Electrical Engineers considerably more than a year ago, at a moment when it seemed as though the national spirit had resolved to resent the continuous manifestations of ill-will which it had up to that moment never noticed, or noticed only to disregard. The particular crisis passed, but the idea of organising the technical knowledge of the electrical profession so that it should be available for the service of the nation was not allowed to drop. Though little has been said about it, steady progress has been made, and the suggestion, which was started and carried through by Dr. John Hopkinson, will, beyond all doubt, leave an abiding monument of his second year's presidency of the Institution of Electrical Engineers. Since the time the War Office formally approved the proposal, Lord Kelvin has been appointed the honorary colonel, Dr. J. Hopkinson the commanding officer, and several gentlemen have expressed their willingness to accept commissions in the corps—indeed, almost too many. Amongst the new officers will pretty certainly be Mr. R. E. Crompton, Mr. A. E. Mavor, and Mr. R. S. Erskine. These names are obvious, though probably Mr. Mavor's commission in the Chilian navy, and the electrical work he did there, are less well known than the service Mr. Crompton saw in India with the Rifle Brigade in the days before electrical engineering, as apart from telegraphy, had come into existence. The corps will begin with four companies, and for each company there will be required a captain and two lieutenants, so that there will be in all only 12 commissions. These it is now pretty certain will be very easily filled, and the only difficulty will be in selecting the candidates likely to make the most efficient officers. The adjutant for the new corps has been appointed in the person of Lieutenant Brady, R.E. It is hoped that among those who might have wished to take up commissions there will be several who, if no other place can be found for them, will be ready to join in the ranks, at any rate for the present. It should be said that the members of the corps will be placed under somewhat different conditions with regard to the requirements of the service from those of the rifle volunteers; and in the event of war they would be liable to be called out, even though there was no immediate fear of actual invasion. Indeed, the War Office, from the first, propose to give important duties to the corps in connection with harbour defence, and to treat it in regard to capitations in exactly the same way as the Submarine Miners are at present treated. With regard to a site for headquarters, more than one place has been looked at, but they will probably be either in Greenwich or Woolwich, or possibly at some place on the north side of the Thames. Electrical engineering, unfortunately, does not leave to all members of the profession the time necessary to qualify themselves as efficients of the new corps. But the numerous body of those who would join if they could have not been overlooked. It is proposed to have a considerable number of honorary members of the corps, and it is intended to so arrange the headquarters that it shall present attractions to induce the honorary members to visit it. It is understood that the War Office will provide at the headquarters of the corps adequate material for training purposes, both in regard to the use of searchlights and the electrical part of the submarine mining. If the arrangements in connection with the headquarters can be carried out with a sufficient degree of promptitude, and the necessary number of men be enrolled, it is proposed to have a number of Electrical Volunteers in camp this summer for their annual training. It is to be hoped that this will be done. Elsewhere we publish what may be taken as an official statement of the objects, duties, and requirements of the corps. At present it will be seen that it is almost necessary for members to reside in London. Anyone desiring further information as to joining should communicate at once with Dr. Hopkinson or the adjutant, as time presses if there is to be a summer camp this year.

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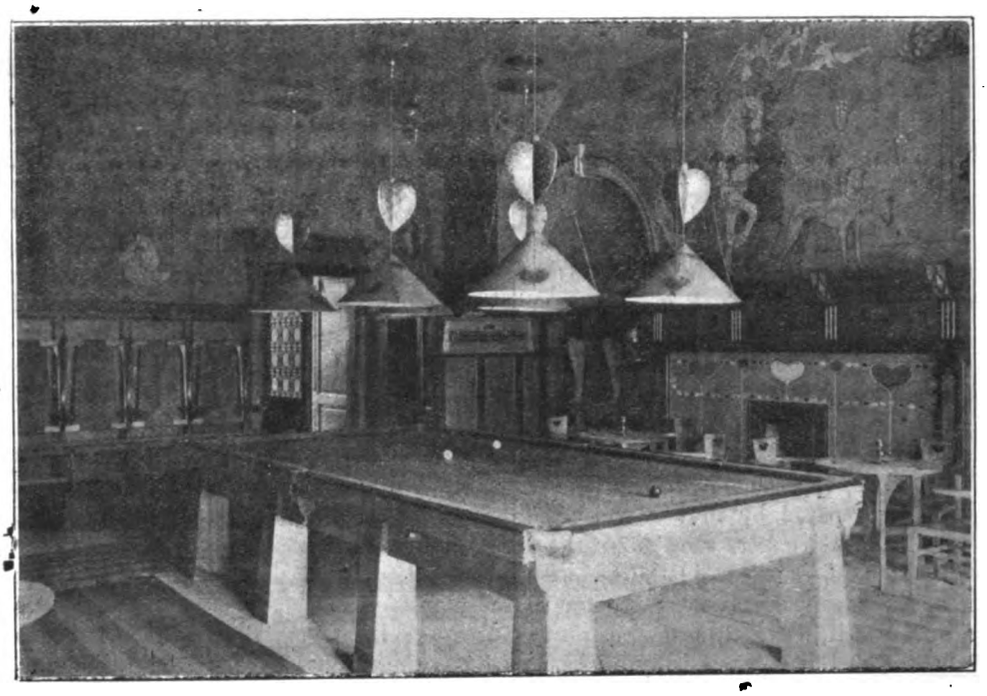
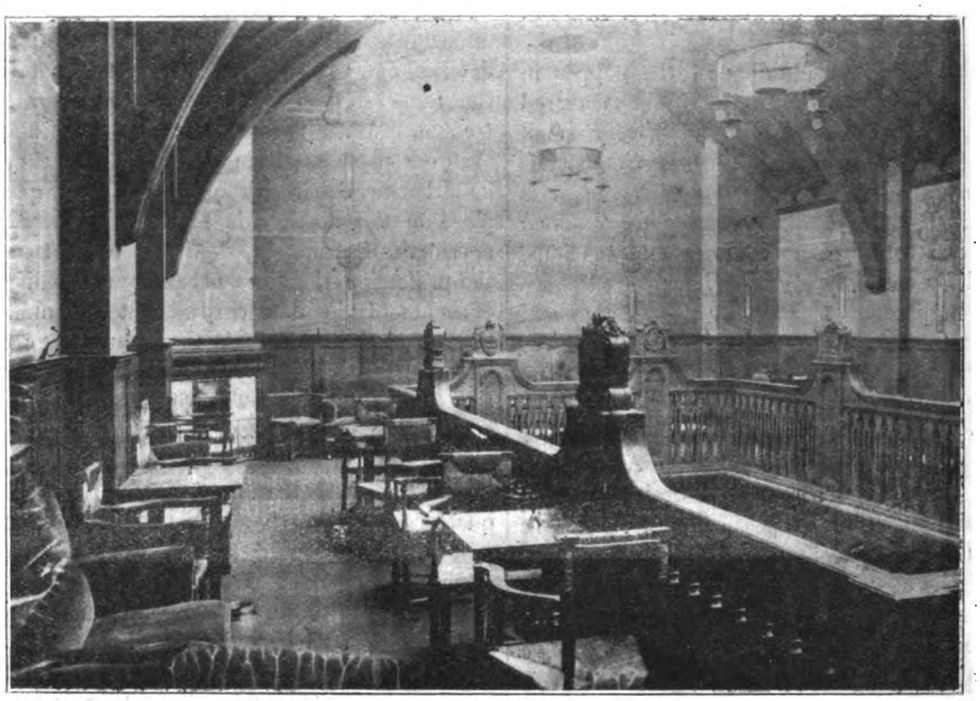
ARTISTIC ELECTRIC LIGHTING.

In districts where electric lighting is at all general one is surprised at the numerous instances that are seen of most incongruous and inartistic electric fittings; the question of art or harmonious surroundings seems in a very large majority of cases to be totally neglected by the electrical contractor. The general proceeding is for the contractor to take his client, who is perhaps quite as wanting in artistic taste as he is himself, to some showroom, or else submits to him books of designs, with the result that fittings are selected which are quite out of keeping with their surroundings, even if in themselves they show good taste in design and carrying out. For instance, we can call to mind a room in the West-end of London over which the architect and designer spent a great deal of time and trouble, and in the end turned out a perfect specimen of an "Empire" drawing-room. A year or so later the supply mains came along, with the certain result that the electric light had to be installed. The work was entrusted to a firm of electrical engineers of very high standing in the profession, but who, doubtless, were more used to the foundry and erecting shop than to the artistic adornment of a drawing-room. As a consequence, their client was allowed to select what took his fancy, and the result was the spoiling of the room from an artistic point of view, by the supplying of fittings of the "Benson" style, fittings which in a modern "Liberty" style of room would have looked perfectly in keeping, but which, under the circumstances, were most inartistic.



The Billiard-Room.

In a similar manner, how frequently do we see replicas of Versailles candelabra fixed in rooms filled with modern furniture, and so on. These are cases where the fittings themselves might be perfectly artistic, but then there is the other side of the question, where the fittings themselves bear no sign of artistic treatment at all; and we fear this is an aspect of the case which is only too frequent. One reason is that the making of electric fittings has got so much into the hands of the makers of gas fittings, and



The Smoking-Gallery.

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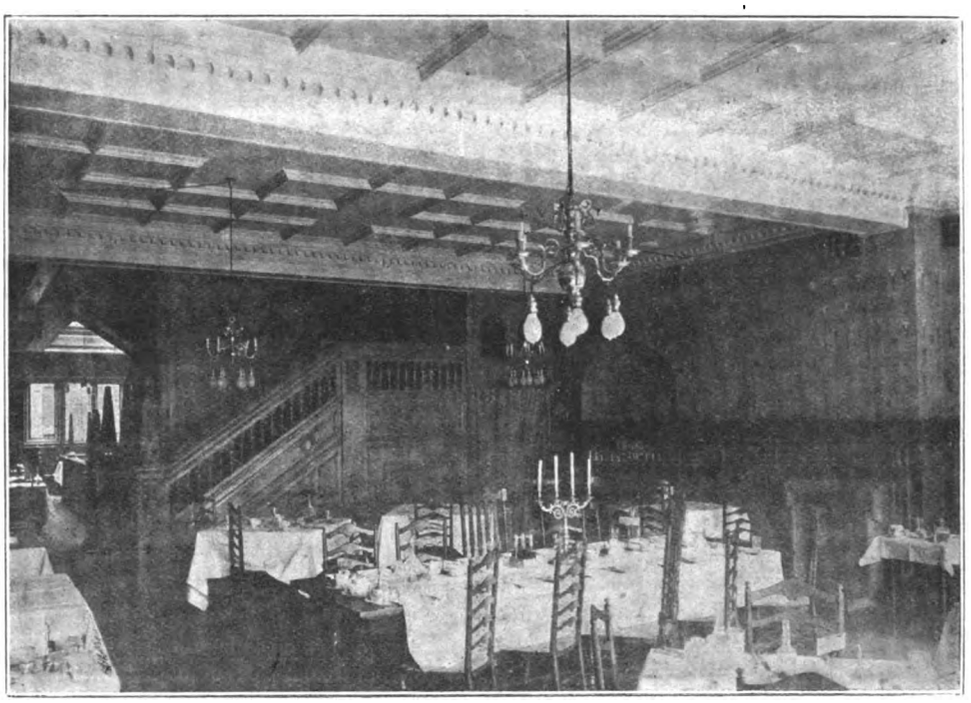
their idea of electric fittings often is simply to turn their old patterns upside down, overlooking the fact that with gas fittings there is not much scope for artistic treatment, whereas with electric light its chief beauty is the easy manner in which it can be successfully treated artistically.

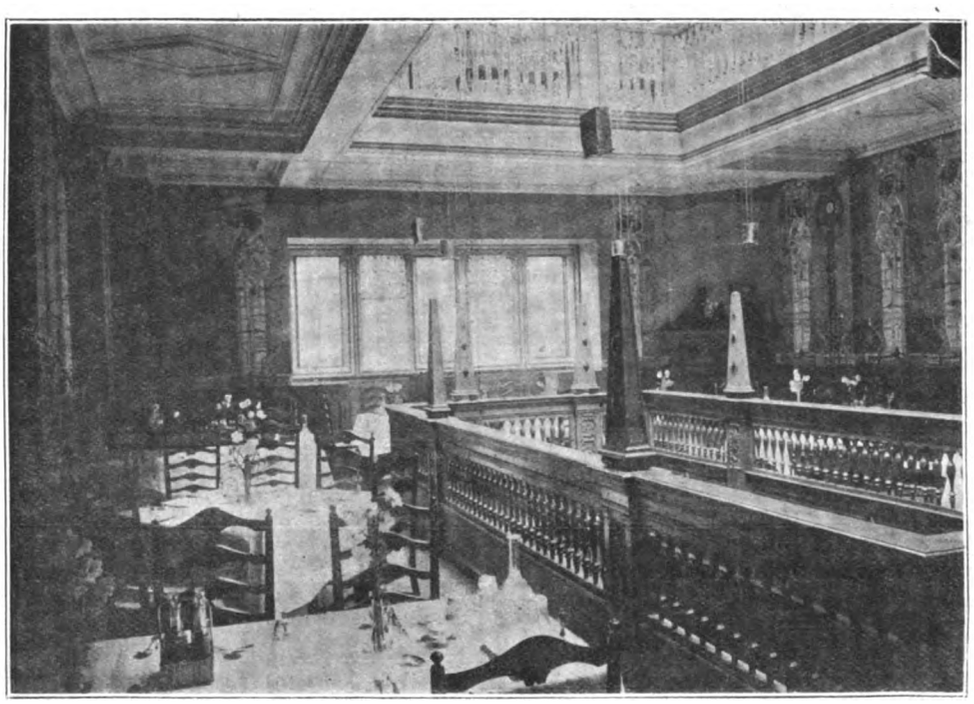
However, we now and again—much more frequently now than a few years ago—come across really artistically designed and executed fittings fittings designed either by the artists themselves who designed the decoration of the rooms, or somebody who is used to designing for the electric light, and who carefully consider the style and decorations of the room, and designs the fittings accordingly. We refer more especially, of course, to those places which are elaborately decorated and carried out with some particular idea in view, and not to the many ordinary or nondescript rooms in which almost any artistic fitting would look well and be suitable.

One of the most, if not quite the most, artistic places of its kind has just been opened in Glasgow under the title of "Miss Cranston's New Lunch and Tea Rooms." This is a small place compared with our large London restaurants, but so far as it goes it is a gem of artistic ideas, every detail having been carefully designed, even to the knives and forks and hat and coat hooks. Seeing that the electric fittings form an important item in the whole scheme, we think that a description of the place might be of interest to our readers as an example of a place artistically designed throughout, and where all fittings, etc., are in perfect harmony with their surroundings.



Empire Room.

Before describing the various rooms in detail we might mention that the electrical installation consists of about 140 16-c.p. lamps and two 10-ampere Blackman electric fans. These lights are supplied with current by the Glasgow Corporation at 200 volts pressure, the two motors being run in series, as the Blackman Company are not yet in a position to supply their fans to run on a 200-volt circuit. The wiring of the building was carried out by Messrs. Anderson and Munroe, of Bothwell-street, Glasgow, but the fittings were designed and made under the superintendence of the artists who designed the respective rooms.



Second-Floor Gallery

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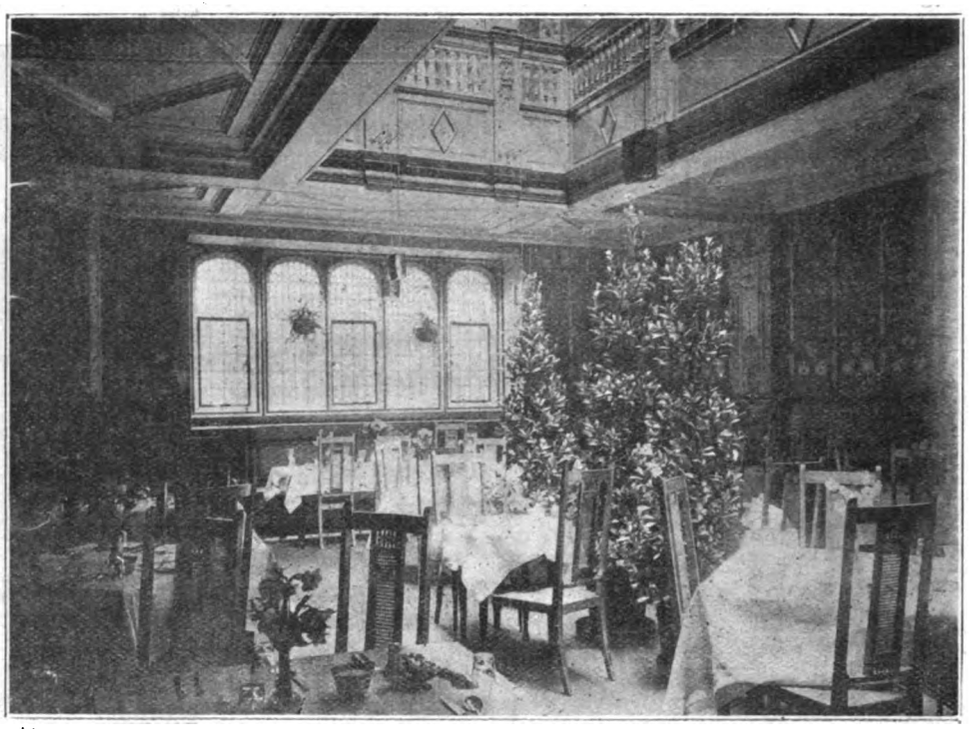
As a rule it is to be noticed that throughout the building most of the fittings are attached to two-pin wall sockets, so as to allow of their being easily taken down for cleaning purposes, etc.

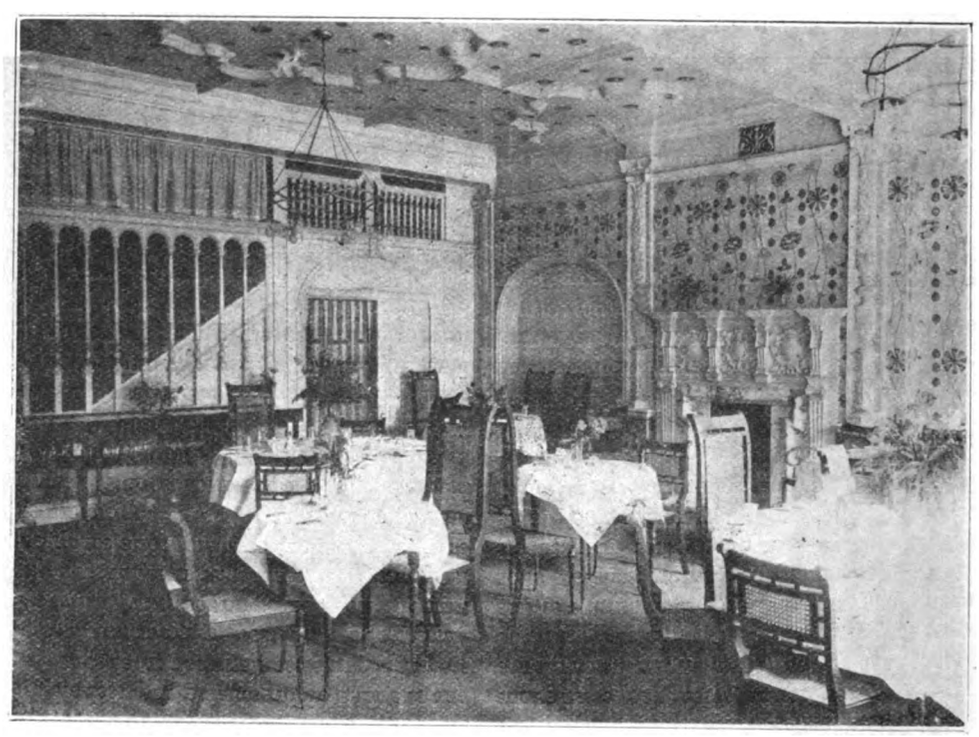
The decoration of the rooms have mostly been designed by Mr. George Walton and Mr. Mackintosh. The former gentleman is responsible for the billiard-room, the Rose or White Room, and the general room on the ground floor, the decorations having also been all carried out by Mr. Walton's own firm. The smoking-room, with the lunch-room and balcony below, and also the Empire Room, were designed by Mr. Mackintosh, the well-known exponent of art poster work, and the decorations, etc., were carried out by Messrs. Guthrie and Co., of London and Glasgow.

The elevation of the building is carried out in red sandstone, and is lavishly ornamented with carved work, and relieved with projecting windows, balconies, etc. The style is something after an enriched Scottish baronial, although this is not severely adhered to throughout. One of the most noticeable points in the interior is the lavish use that is made of carved oak work. The details of the various rooms are as follows:

The Billiard-Room.—This room, which is situated on the top floor front, was designed and decorated by Mr. George Walton. The theme of decoration is based on the impression given in nature by a wood in autumn. The scheme of colour is in green, brown, and amber. The subject of decoration represents on one wall a domestic flower garden with mother and child; the wall to the right representing a huntsman starting for the chase with a flight of birds overhead. The last subject panel is the wood with startled fawn and deer and falling leaves. The background of the whole frieze is diapered on a ground of amber colour with flowers, leaves, etc. The room is panelled up 6ft. from the floor, and is stained in full colour of rich green with black framing. The furniture is in ash: large rush-seated



Ladies' Lunch-Room.



Rose Room.

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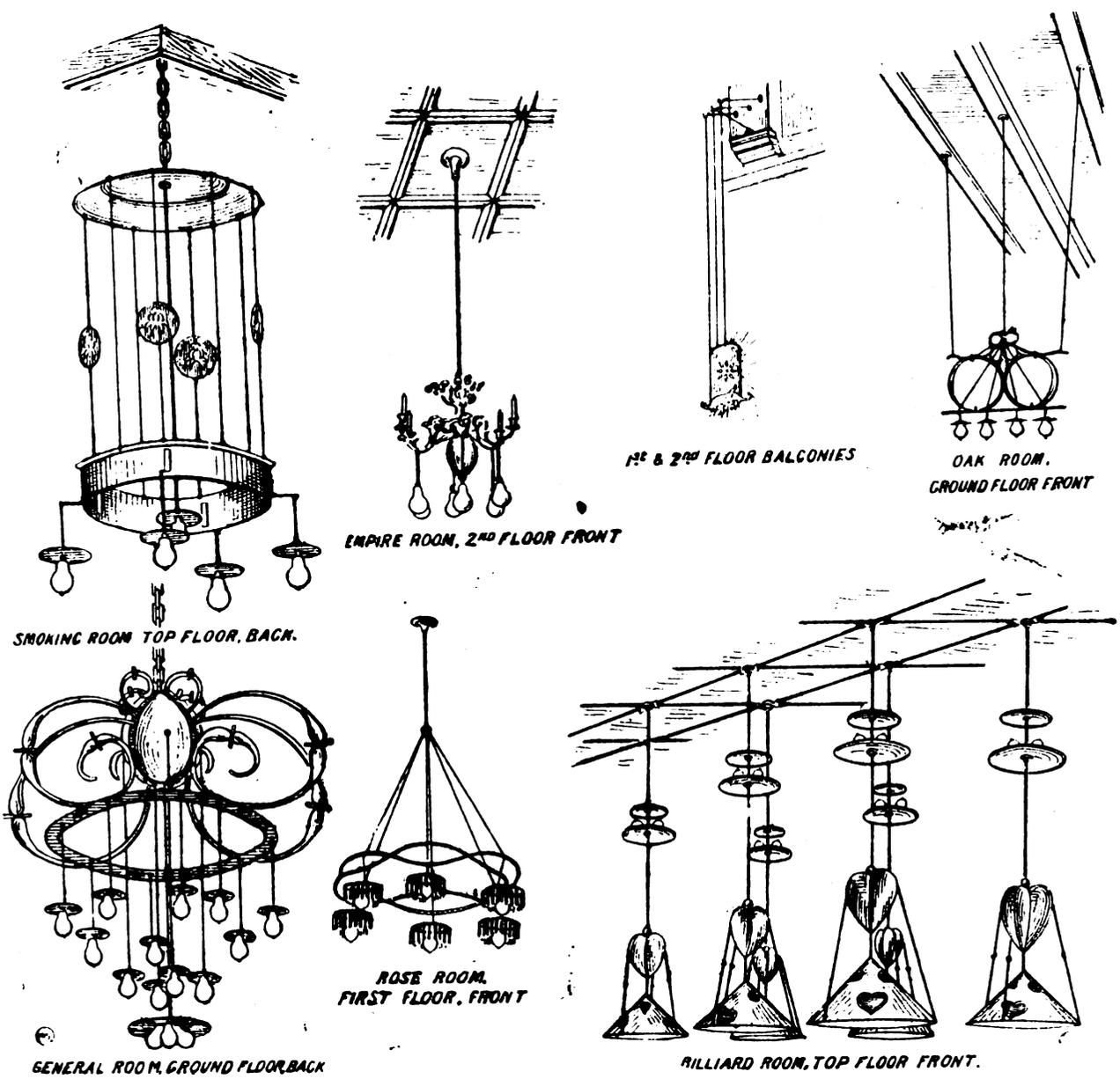
settles, tables, etc. The billiard-table is of ash, the legs of which are solid blocks, rather tapered towards the top, giving the effect of substantial construction, the principal necessary to a billiard-table. The fireplaces are decorated in modelled cement and ornamented with colour, giving a fresh look and connection with the floor of stone-like effect. The electric light is so arranged as to light the room generally with a diffused light, and still having a strong light thrown on the billiard-table when being used. The archways are to have large metal sconces with hanging electric lights well shaded from the table, and still giving a light convenient to those reading while sitting on the settles. The central fittings, in reality, consist of six separate pendants suspended by flexible cords from the ceiling (see illustration). About half-way down the cords are two hammered brass dishes, the lower one containing two incandescent lamps, the light from which is thrown upwards on to the upper one, which disperses it over the room, by which means a general light is diffused over the room without there being any point of light which can catch the eyes of the players. Below these brass dishes again are hung large curiously-shaped ornaments, from the segments of which the shades are hung for lighting the table itself. As will be noticed, the general scheme of the room is continued throughout the fittings also, which are, although decidedly unique, in perfect harmony with the rest of the decorations. Besides the six 32-c.p. lamps for lighting the table, and the 12 16-c.p. lamps under the dishes, there are two small brackets over the window seats, and, as above mentioned, there are to be metal shields fitted with electric light placed in the arched recesses,

The Smoking Gallery.—This is situated at the back of the billiard-room, out of which it leads. Mr. Mackintosh is here responsible for the decorations. The predominant colour is a deep blue, upon which the design is worked in in pale blue and green. The roof, which is arched, the four-foot dado, balustrade, and other woodwork is stained oak, the balustrade in particular being elaborately carved, each pillar being finished off with a coat-of-arms; the Glasgow city shield with its two supporting fishes will be noticed in the centre of the photograph. The lighting is done by two five-light pendants hanging from the arched roof over the centre well. Each pendant consists of a large hammered brass inverted dish, from which is suspended a broad hammered brass hoop, from the edge of which are hung four small brass saucers, each carrying an obscured 32-c.p. lamp, while the fifth one is hung from the centre of the fitting. The wires supporting the lower hoop are relieved with pierced brass discs, which gives a Moorish look to the fittings. The furniture is in ash, with rush-seated armchairs, while the lounges are upholstered in snuff-coloured ribbed velvet.



Sketches of Electric Light Fittings at Miss Cranston's Tea-Rooms, Glasgow.

The Empire Room.—This room, situated on the second floor in the front portion of the building, is used as a lunch and dining room. Here, again, Mr. Mackintosh looked after the design of the decoration. There is a 4ft. to 5ft. oak dado running round the room, which, together with the open staircase leading up to the smoking gallery, is elaborately although severely panelled. The walls are filled in with a self colour, and frescoed with a small floral design. The electrical fittings consist of four five-light pendants, valuable real old French candelabra having been

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adapted for the purpose with very satisfactory results. The furniture is in oak, the tables being massive and boldly carved.

Second-Floor Gallery.—The furniture and general scheme of this is similar to the Empire Room, out of which it leads, except that Mr. Mackintosh has treated the walls in a bolder manner, and has worked a series of "art" female figures in a most effective manner into the decoration of the wall. The lighting is assisted by the lights in the smoking gallery above, and beyond this there are eight pierced brass reflectors, each containing a lamp hung round the edge of the gallery which throws a good light well under it, and shows up the fresco paintings very well.

Ladies' Lunch-Room.—This is again below the gallery, and the general treatment and lighting arrangements are very much the same. The walls, instead of the female figures, however, are treated in a more severe but none the less effective manner.

First-Floor Front Ladies' Luncheon or Rose Room.—This room has also been designed and decorated by Mr. George Walton. The ceiling, walls, and woodwork are all painted white, the ceiling and walls being decorated with a rose design in pink and green. The floor is of oak parquetry, and is covered in the centre with a rose-coloured carpet. The furniture is ebonised black, of artistic pattern, and is decorated with pink roses. The electric fittings further carry out the theme of the room, consisting of simply two entwined circles of gilded wrought iron representing the stem of a rose bush, and at each intersection a pendant drops, consisting of a gilded saucer, from the centre of which the lamp springs, and round the edge of which are crystal drops to give a sparkle and the idea of dewdrops among the roses. The effect between furniture and walls is that of contrast.

Ground-Floor Back Room.—This is another of Mr. George Walton's rooms. The lower part of the walls are panelled in oak to a height of about 6ft. up. Above this, the frieze is decorated in floral ornaments in eight panels enclosed in dark richly-decorated pilasters running from top of panelling to ceiling. The theme of the room is taken from the pattern of an Eastern carpet, and the general appearance of the room, although not carried out in Oriental style, has a certain richness in colouring and treatment suggestive most strongly of the East. The furniture is of oak, and the chairs covered with a bright yellow material. The room, which is the darkest in the building, and requires constant artificial light except on the brightest day, is fitted with a single central hanging pendant which is rather a novelty. There is a large hammered ball of polished brass mounted in wrought iron and suspended by a wrought-iron chain. The lights are applied to this by numerous little globes hanging in flower-like fashion.

The Oak Room.—This room is immediately inside the entrance, and is reserved as a ladies' room. The decorations are entirely in heavy carved oak, and were designed by the architect of the building himself. The ceiling is ribbed with old-fashioned oak beams, and the seats take the form of high-backed oak benches, both them and the tables being heavily carved. The electric light fittings are very unique and very effective. They consist of four obscured lamps arranged in a straight line hung from a bar, which is supported by a scroll of wrought-iron work, the whole hung by three wires from the overhead beams.

We might add that there is a lift running from top to bottom of the building, and all the single-light fittings about the entrance to this and elsewhere in the building are all carefully thought out. The kitchens are in the basement, with lift communication to each floor, and are fully equipped with plain pendants and other serviceable fittings.

Forthcoming Events.—Naturally, the events of the week are those connected with the Jubilee. There is, however, a meeting of the Physical Society next Friday (June 25), when the following papers will be taken: "A New Theory of the Earth's Magnetism," by Mr. Sutherland; "Experiments in Critical Phenomena," by Dr. Kuenen; "On the Attenuation of Electric Waves in Wires," by Dr. Barton; and "On the Steady Motion of an Electrified Ellipsoid," by Mr. G. F. C. Searle.

VERBAND DEUTSCHER ELEKTROTECHNIKER.

EISENACH MEETING.

(BY OUR SPECIAL CORRESPONDENT.)

Once more the editor of the *Electrical Engineer* has bidden me pack up my traps and visit the land of the Rhine wine. This year the meeting place of the Verband Deutscher Elektrotechniker is Eisenach, a pleasant little town on the borders of the "Thüringer Wald." This health resort is in the centre of Germany, and hence is convenient for all the members. It has no special attraction for the German electrical engineer in his professional capacity, but its scenery and association appeals strongly to the social element in his character.

The gathering, although smaller in numbers than the one at Berlin, is hence much more sociable, and the "Begrussungs-Abend" in the "Waldhaus" on Thursday, the 10th inst., served as a general introduction to everyone present. The Waldhaus is to be seen high up among the trees in the general view of Eisenach given herewith. The members met on the terrace overlooking the valley at 8 p.m., but as the sun set we adjourned to the large room inside to attack the refreshments provided. During the repast and the beer-drinking which followed a party of Eisenach gentlemen sang to us, and the music was of such high order as to quite recompense me for missing the Handel Festival. The kindly greetings from old friends who I had met in Munich and Berlin added to my pleasure, but I disappointed them sadly in my capacity for beer. One prominent engineer in the German electrical world complimented the English technical Press on its promptitude in reporting electrical developments, and I found that his knowledge of the past few numbers of the *Electrical Engineer* took away much of the news I wished to tell him. Thus he was quite prepared to talk over Mr. Mordey's recent paper on "Dynamoes," and although the spelling of the word did not draw any comment, he had followed both the paper and discussion. His opinions on this subject were as follows: from practical trial he has found chord winding not so good as the usual methods—firstly, because with large machines the sparking limit is more narrow; and secondly, because it reduces the possible output of the dynamo. This is a statement from trial of a 45-kilowatt dynamo, and the theory of the facts observed is clear, although for small machines there may be some advantage from the chord winding. He also differs from Mr. Mordey in his statement that there is little or no strain on conductors buried in iron cores. From observations as to the stability of the insulating tubes used in such construction, he has assured himself that the fact of burying a conductor in iron does not transfer the torque to the iron core. The explanation he suggests from the results of the experiments quoted in the above paper is as follows: A single conductor was taken, and the flexible return lead did not give working conditions. He held that if a complete coil had been experimented on in a similar way (the coil being made loose in the holes in the core) totally different results would be obtained. The matter is certainly worthy of further trial to assure designers as to what is the stress on buried conductors. It is surprising how little practical information is available on this subject.

The genial past-president of the Verband, Prof. Slaby, is also here, and has much to tell me of his recent visit to England. He was invited to see the experiments of Mr. Marconi in telegraphy without wires, and was impressed with the success of the trial. The cordial reception extended to him by Mr. Preece, Mr. Gavey, Major Carr, and others delighted him.

The function at the Waldhaus lasted till midnight, and then most of the members proceeded to drink coffee and more beer at the other noted restaurants of the place. The view of the church and gateway in the Karlplatz gives some idea of the architecture of Eisenach, but I regret that no photographs are as yet to be had of the older houses in the by-streets and of the electric light wires. These latter would cause the London County Council to discourse with vigour on the "free air of heaven," etc., but they are not so very unsightly, and the cost is small compared with buried wires. The house wiring is even more primitive,

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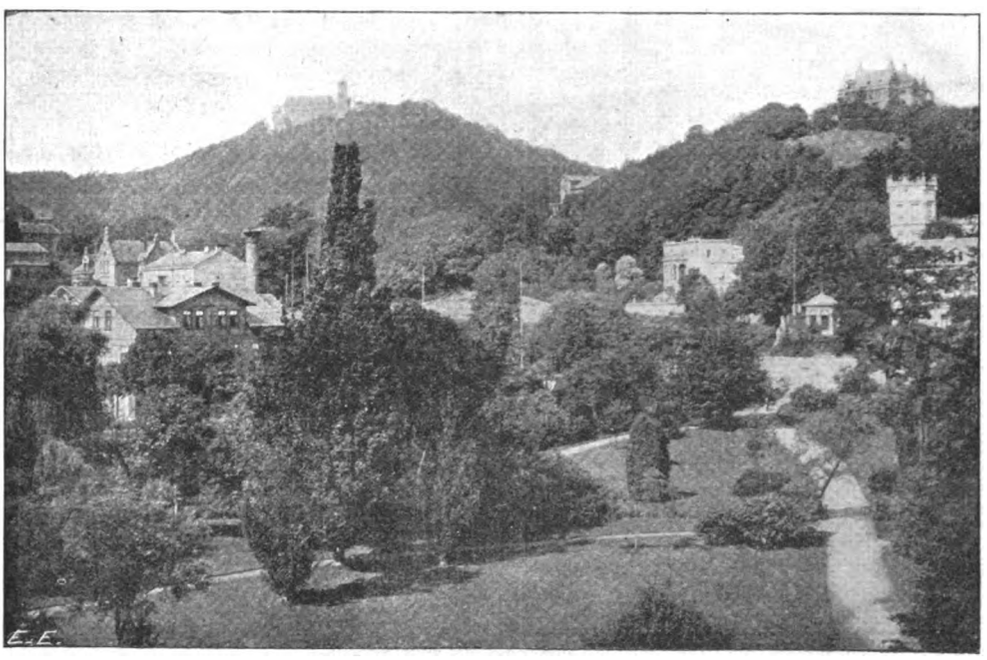
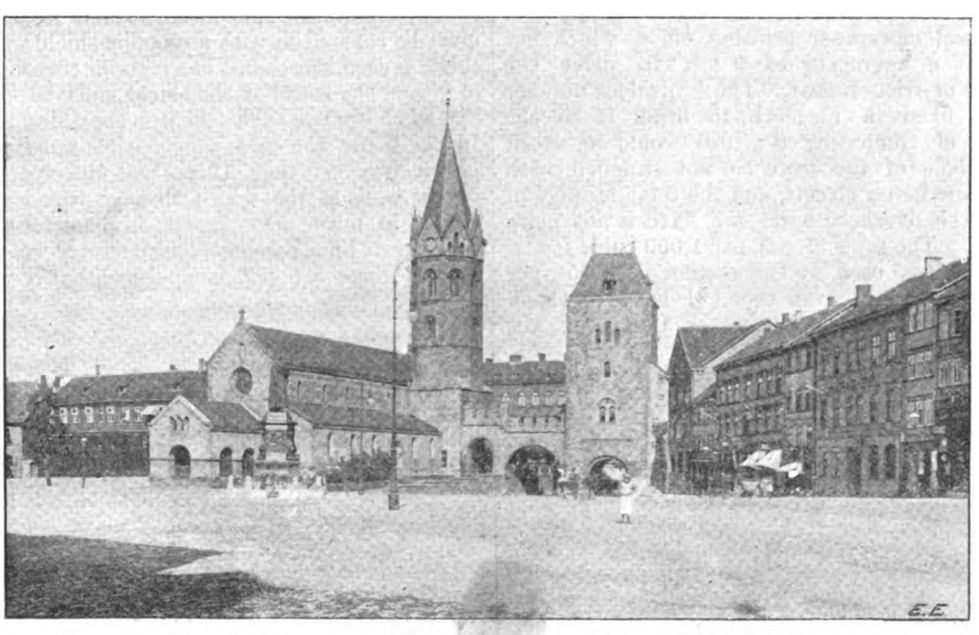
and only conforms to the noted Phœnix fire rules in accessibility. In many places the wires are stapled to the walls, while in other cases small insulators are employed to support the conductors. The streets of the town are now in the hands of the Allgemeine Elektricitäts-Gesellschaft, who are putting down the rails and posts for electric tramways. Posts with side brackets will be used in most



View of Hills behind Eisenach.

places, and the rails are placed close to the edge of the pavement, as is the custom in Germany. The power will be taken from the electricity works, some new 500-volt dynamos being installed for the purpose. These works supplying the town are owned by a company, and are well worthy of inspection, although the machinery is not of the latest types. The engineer to the company kindly showed me the station, which is now being remodelled to receive the



View of Church and Gateway in Karlsplatz, Eisenach.

traction plant. The engine and boilers were made by Messrs. Wolf and Co., of Magdeburg. There are two sets, each of 120 h.p. The boilers are of the Cornish type with a single furnace, and the flue returns under the bottom of the boilers. The steam pressure used is about 105lb. per square inch. On the top of the boilers a horizontal compound engine is perched, with a large flywheel on either side. The engine exhausts into a jet condenser, as plenty of good water is available. The dynamos are of the old Edison three-limb type, and were first used in the Berlin stations in 1884, some 23 years ago. The engines were also taken from the same station. The commutators do not look as though they ran sparklessly, but the light supplied appears to be satisfactory. The two dynamos to each engine are belt-driven from the flywheels. The output of the set is 500 amperes at 110 volts. Accumulators are used as a stand-by and as regulators. The conductors are run on the three-wire system with 110 volts at the consumer's premises, but the motors take supply from the two outside wires at 220 volts. The wires are either supported on insulated lattice-work, iron poles, or, as is more frequent, on bracket attachments to the houses. Bare wires are mostly used, and where long spans are employed insulating struts are bound to the wires in the centre of the span to prevent short-circuiting due to the wires touching when they oscillate. The load obtained in the town up to January 1, 1897, is divided as follows: There were some 4,142 incandescent lamps of 16 c.p., and the street-lighting was effected by 85 arc lamps. Besides these there are a number of motors, most of them of small size, but the aggregate power taken by these motors was

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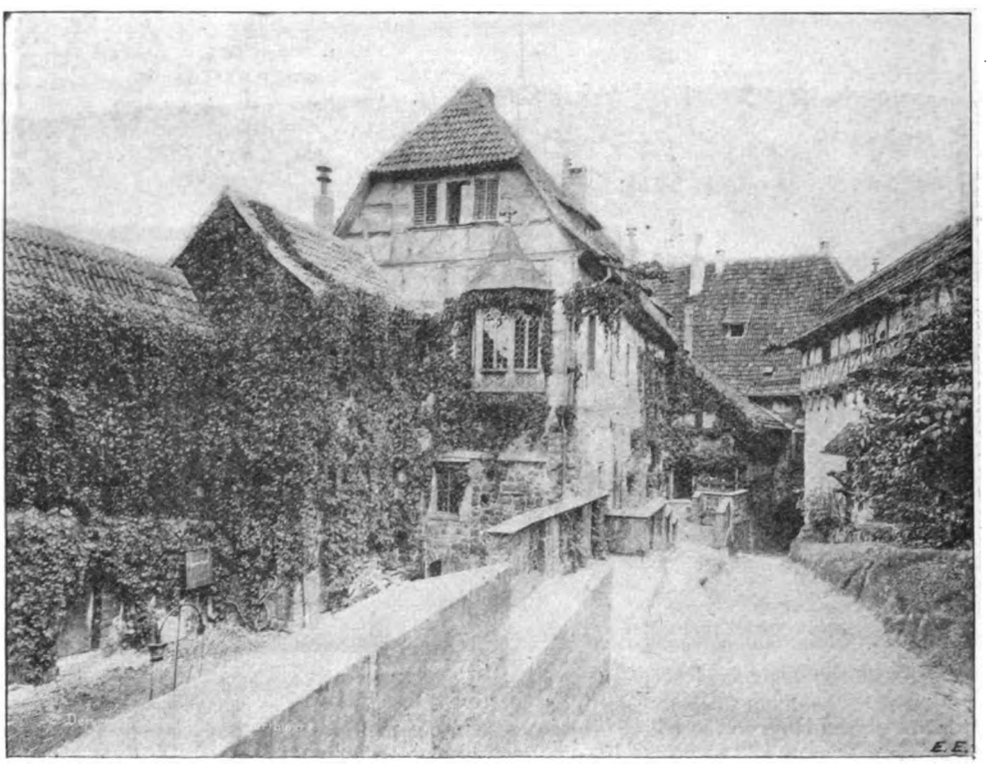
73 h.p. These numbers are taken from the annual report and balance sheet, from which I gather that several more consumers are being connected. The price charged for energy is 8d. per unit for private lighting, and 2d. per unit for power. These prices give a good return on the capital expended, as last year the total receipts amounted to £2,437, while the works costs were only £752. The total capital expended to the first of the year was about £17,000. It must be remembered, to appreciate the figures, that Eisenach is a small town with about 22,000 inhabitants, and that there are no great industrial or manufacturing firms in the town to take power. The largest consumer of power is the local newspaper printing office, which has four motors of an aggregate of 9 h.p. to drive the presses by means of friction gear. The equivalent number of 8-c.p. lamps fixed in Eisenach to bring it to the English method of computing the load would be about 11,500. The whole of the town is not supplied with mains, but only the better streets, and the total mileage of streets in which the overhead wires are fixed is not more than three miles. The price of gas per 1,000 cubic feet is about 5s. 9d. The coal used at the station costs 16s. per ton, and is very poor coal even then. I have to thank the engineer of the Eisenach Electricity Company, Mr. Majewsky, for the figures given above.



The First Courtyard of the Wartburg, Eisenach.

Fig. 1.

On Friday the business of the meeting began. The president, Baurath Stübben, of Cologne, gave a short address welcoming the members to Eisenach, and then called on Mr. Kapp for the report of the past year. I shall have cause to refer to this again, but as an amendment was moved by a country member who had a grievance to ventilate, the report of the committee on safety rules for high-tension cables was taken first. The gist of these rules for preventing accidents from high-pressure wires is briefly as follows, and they apply to all conductors used for pressures over 1,000 volts: All overhead wires to be of bare copper, and no insulation is to be used on such conductors. Where the wires pass through towns, over houses, or over the grounds surrounding the houses, guard wires are to be provided, which must be efficiently earthed. These guard wires are to be placed always underneath the high-pressure conductors, but where the wires cross roofs, or where they are accessible, further guard wires or nets must be placed where protection is needed. All the posts for high-tension conductors and all conduits inside houses, etc., must be marked in red with the mythical and artistic flash of lightning (Fig. 1). In the houses all the conductors other than concentric and iron-armoured cables must be covered in with a metallic shield. If an insulating shield is used, there must be a metallic covering on the outside of it, and the metal of the shield must be earthed. In the case of concentric cables the iron sheathing must be earthed. In the house the bare copper wires must never be placed nearer together than 10cm., say 4in. apart, and the hole in the walls of the house through which such conductors are led in must never be less in diameter than the above. As regards lines passing along country roads, guard wires in such cases are not compulsory, but it is essential that

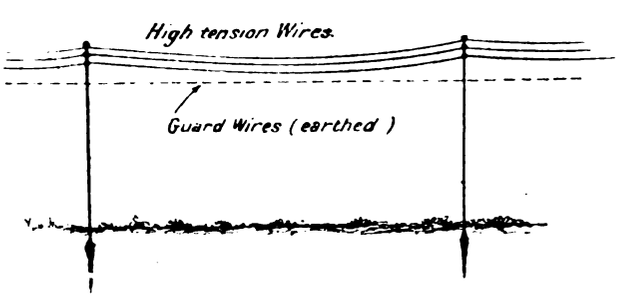


Fig. 2.

some efficient means be provided so that the high-tension conductors automatically earth themselves should they break and fall. As regards the protection of the workmen repairing high-pressure wires, it is required by the new rules that no repairs or connections shall in any case be made unless the lines have been first short-circuited and then connected to earth; also in no case shall one man work alone on high-pressure conductors, but two shall always work together.

The details beyond those given above are not fixed by the Verband, but Fig. 2 gives a general view of the con-

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ductors in a town where guard wires are used. The following method of earthing the conductors in case of fracture where guard wires are not required, has been suggested by Mr. Gisbert Kapp. The diagrammatic connections of this method are shown in Fig. 3. It is for a three-wire system, but can be equally applied to all systems of distribution. The neutral point of the three-phase generator, A, is connected to earth through the high-tension winding of a transformer, T. The secondary winding of this transformer

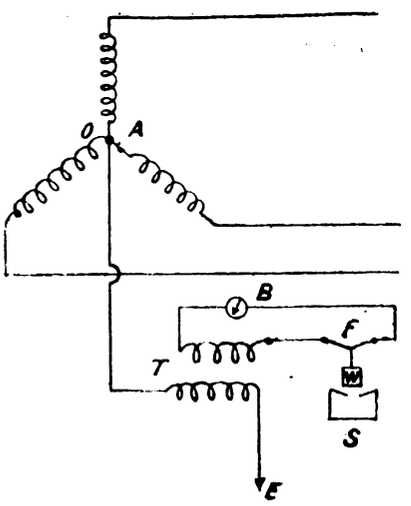

FIG. 3.

is connected to a warning bell, B, and also through a fuse, F, on which a weight is hung. As long as the three wires are intact and of equal resistance to earth, no current flows through the transformer. When a wire breaks and makes even a high-resistance path to earth, a small current will pass. This will be transformed to a large current in the secondary of the transformer, which, by melting the fuse, can be made to release the weight, and either to short-circuit the wires or to cut off the excitation of the alternator.

(To be continued.)

WHAT IS TRUE AND FALSE ECONOMY IN LIGHT RAILWAY CONSTRUCTION ?*

BY ARTHUR CADLICK PAIN, M.I.C.E.

What is true or false economy in light railway construction is largely governed by the fact that the capital that can be raised for such undertakings is very limited, and therefore expenditure which might be very good economy if the funds were easy to get is very bad economy where the reverse is the case. Apart from the cost of financing the capital, it is clear that the smaller the volume of traffic to be carried into or out of the district the smaller should be the capital expenditure. If railways are to be made in purely agricultural districts, the earning power will only equal from £4 to £7 per mile per week. The greater economy in first cost is therefore absolutely necessary.

In the United Kingdom it may be taken as a rule that the public roads are unsuitable for the laying down of light railways, although there are a few exceptions; were it otherwise, light railways might be extended to a very considerable mileage. It is evident that most of the roads follow the route of the old pack-saddle tracks, or what were only footways or occupation roads, and the services of an engineer were rarely called for except in very hilly or mountainous districts. In the construction of the turnpike roads the talent employed was mostly local, and a glance at the Ordnance map will show how even these roads, as well as others, have been pushed out of their natural route to suit the convenience of the all-powerful landowners. As a result the gradients are unnecessarily bad, causing a permanent daily loss to the district by the extra cost of traction and wear of vehicles and roads. To perpetuate this loss by laying light railways along them would be folly. This daily loss going on all over the country has never been fully recognised, and the indirect as well as the direct advantages to be gained by the construction of properly located light railways, or subsidiary lines, or elongated sidings to the main lines, has never been properly appreciated. It is true economy in locating these lines to contour the hills rather than go through them.

Since the days of canal construction, when contouring was an art in which the engineers of that time were adepts, the numerous advantages to be gained by following the surface of the ground has been lost sight of in the desire to make the line of as short a length as possible. When cuttings and banks are made, works of art follow in the crossing of roads and streams. The ordinary maintenance, apart from the permanent way, is less on a surface line. A line of greater length with easier gradients allows of the use in working of lighter engines, and this again allows of the use of lighter permanent way. Permanent way suitable for a line of easy gradients and a maximum weight of engines, say, of nine tons on a pair of wheels, with rails of 50lb. per yard, would cost laid, complete, £1,300 per mile, so that it is generally true economy to lengthen the line rather than shorten it.

It may be argued that it would increase the cost of transit to the passengers or the conveyance of goods to the trader, because mileage is the unit of charge rather than cost of construction; but to the investor the greater length of line at a reduced capital cost appeals favourably. It is true economy to provide plenty of stations or sidings on the route so as to secure all the traffic in the district; to construct shelters for passengers and provision for receiving light goods and parcels and protecting them from damage by wet or from pilfering; to make stages to unload goods upon to save labour at the stations and release the trucks, also enabling the goods to be easily loaded into carts; to lay in loops to the running lines at stations, so that trucks can be easily attached or detached with as little shunting as possible, and thus avoid delay to the trains: this is very important in the case of mixed goods and passenger trains; to erect a strong timber fence where the line passes through grass land on which cattle are placed, and of light steel wire through arable, down, wood, or heath land.

In light railways it is desirable to insist on the trains being limited in speed. The saving in wear and tear of engines and rolling-stock is considerable, and greatly reduces the cost of maintenance of the permanent way. From 12 to 15 miles an hour should be the limit of speed. The inconvenience that was occasioned through the adoption by the late Mr. Brunel of the 7ft. gauge for the Great Western Railway appears to have sunk deeply into the minds of the public, and any proposal to construct lines of a narrower gauge than 4ft. 8½in. is received with disfavour. The inconvenience of a break of gauge for a light railway has been very much overstated, and it certainly is not more inconvenient to a passenger to step from a carriage of the ordinary gauge into one of a narrower gauge than into one of the same. As regards goods and minerals, the prime cost of handling varies, according to the description, from 3d. to 6d. per ton, without using machinery of any kind.

The expenditure in construction between a broad and narrow gauge line used to be put on the slice taken out of the centre, varying with the widths of the gauges. That argument, however, does not hold water. It can be shown that in the difference between a 4ft. 8½in. and a 3ft. gauge the saving in the cost of permanent way will be upwards of 40 per cent., and this saving may be increased in works if the country is at all heavy. If the load to be carried will only fill a wheelbarrow, it is false economy to provide a cart. It is equally unnecessary to buy land wide enough for two lines of way, and the experience on the main lines has no sort of bearing on light railways. Such lines can be worked with few exceptions without the provision of a line of telegraph or telephone. It is unnecessary to provide cattle-pens, carriage-ramps, long or high platforms, goods-sheds, carriage-sheds, turntables, weighbridges, signal-boxes, and interlocking of signals (except at junctions) until the requirements of the traffic when developed have shown them to be necessary. It is false economy to permit the use of any permanent-way materials during construction.

* Paper read at the engineering conference of the Institution of Civil Engineers.

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THE MECHANICAL CONSTRUCTION OF ELECTRICAL MACHINERY.

BY F. M. WEYMOUTH.

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THE DYNAMO.

(Continued from page 744.)

Bearings (continued).—In Fig. 221 we illustrated a true spherical bearing taken from a drawing of a Blakey-Emmott alternator presented in Prof. S. P. Thompson's "Dynamo-Electric Machinery." This, we pointed out, also sustained a slight end thrust in one direction due to the varying effort required to maintain the shaft in position lengthways.

With the above we also intimated that we should show a "swivel" bearing designed similarly for steadying the shaft endways. This latter is now produced in Fig. 224, and is again an example borrowed from Prof. S. P. Thompson's book, being part of a Siemens and Halske's ring dynamo therein depicted. It will be observed, however, that, as compared with the last, this bearing differs in that it steadies the shaft in *both* directions. Thus the shoulder, *a*, on the shaft bears against it at the one end, and the boss, *b b*, of the pulley at the other end. But the whole of this duty falls ultimately on the lower end of the tap-bolt, *d*, which keeps the bush in place. As will be perceived from the end view, this bearing is of the "solid" type, not having a cap, and thus the sleeve must be small enough at the ends to pass through the cylindrical seating, *c c*. The sleeve is lined with anti-friction metal which is also formed into flanges at the ends, as shown, for the shoulder, *a*, and pulley boss, *b b*, respectively to run against. Waste oil is caught and drained away at *g*, as in previous bearings we have discussed.

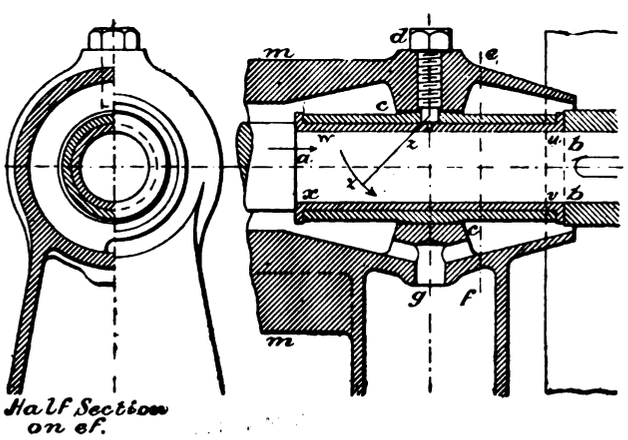

FIG. 224.

To examine this arrangement more critically, we may note that inasmuch as the sleeve is held only by the one screw at the top, there is no direct resistance of the sleeve to end thrust on its lower side. Direct resistance is along the top only where the sleeve is here put into compression between the lower end of the tap-bolt, *d*, and either the pulley boss on one side, or the shoulder, *a*, on the other side. Hence most wear of the flanges of the sleeve lining will take place at the top at each end, rather than at the bottom where there is no such direct end-on resistance. The effect of endways "lunging" of the shaft may thus be noted. If the shaft lunges to the right, as indicated by the arrow, *a*, and supposing the end on the upper side to be most worn, this "lunge" of the shaft will be received at the bottom at *x*. Such a pressure on the sleeve will immediately tend to make it turn in a vertical plane round a centre in the holding screw point, in the manner indicated by the curved arrow and radius, *z z*. Thus the end, *a*, of the sleeve will tend to drop, and the end, *b b*, to rise, with the obvious result that extra wear will take place at *w* and *v*. With a lunge of the shaft to the left, extra wear will similarly occur at *u* and *x*. Hence the result in general will be that the sleeve will wear oval toward the ends, the large diameter, so to speak, of the oval being vertical, or in the same plane with the holding screw. This particular effect, it will be noted, due to the end play of the shaft, would not occur with a true spherical bearing such as that shown Fig. 221: for in this latter all end pressure would be met by a resistance central to the spherical seating, and the pressure of the shoulder on the shaft would be received equally all round the end of the sleeve, and thus equalise the wear. But the arangement Fig. 224 has the advantage of simplicity and cheapness. It has a long wearing surface, so that the length of the sleeve will tend to minimise the evil above dilated on by offering large surfaces for the extra wear at the places *w*, *v*, *u*, and *z*; while the evil is still further lessened by the fact that no end play is allowed the shaft. Accumulation of momentum in the lengthways direction of the shaft is thus obviated.

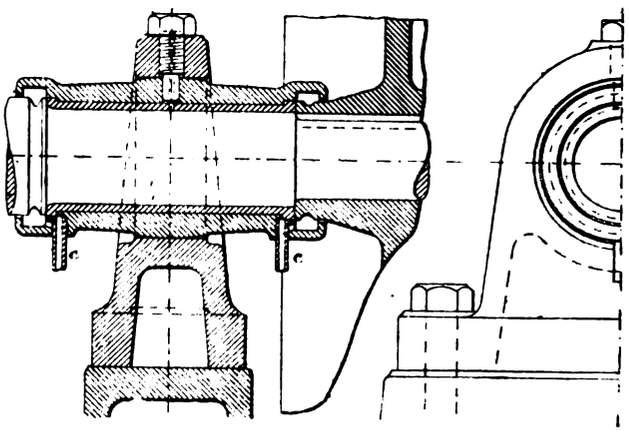

FIG. 225.

This may hence be compared with Fig. 205, where considerable end play of the shaft was permitted. As already mentioned, it is no difficult matter to put in a new sleeve, or re-line one that is worn. This bearing is for a machine having internal poles, and is, in fact, part of the same casting with the magnets; and the section at *m m* indicates the development of the casting toward these latter.

Fig. 225 shows a design which to a great extent compounds the special points of the last two. This will be better described as a suggested design. It will be seen to be a swivel bearing purposed to steady the shaft endways in both directions: while, as in Fig. 221, the sleeve projects at each end, and there is no overhanging barrel of the main casting such as was shown in Fig. 192 The waste oil is caught in hoods formed on the ends of the sleeve itself, from whence it is drained away by pipes, *c c*, as shown, which may be continued downward wherever convenient, with or without a union joint, as was illustrated and described in connection with Figs. 221 to 223. To remove the sleeve from the bearing, at least one of these pipes must, of course, be unscrewed. The fixing of these latter is shown more clearly in the enlarged views Figs. 226 and 227, of which Fig. 227 is a section on *a b* in Fig. 226. It will be perceived that the tube having been screwed home,

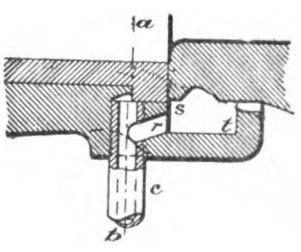

FIG. 226.

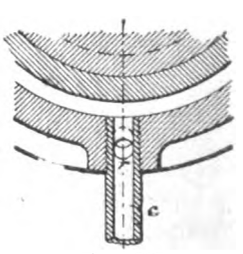

FIG. 227.

an oil-hole, *r*, is drilled, which is continued into the tube. When the pipe is put back after removal, it must, of course, be screwed properly "home" again to avoid stopping the hole, *r*, as would result from rotating the pipe half a turn from the position shown.

The sleeve, having been bored inside, including the hoods for catching the waste oil, will only need turning on the outside on the curved surface of the seating: elsewhere it may be left rough and painted. If required bright for good appearance, the bosses receiving the small drain-pipes, *c c*, will need to be dispensed with, inasmuch

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as they would interfere with the turning; and a little more metal, without enlarging the diameter, would best be added for the sake of holding the drain-pipes. A point that may further be noted here is that the hood has square inside angles, as at *r* and *t*. Oil flying off the thrower at *s* is caught on a surface normal or at right angles to its direction, at least in the sense that it is not deflected toward the outer lip, in the manner that was represented Fig. 215.

We now come to another bearing, which is taken from a large machine designed by Mr. C. E. L. Brown, of Oerlikon, also published in "Dynamo-Electric Machinery." This has various points of interest, and is illustrated herewith (Figs. 228 and 229). On the method of oiling by

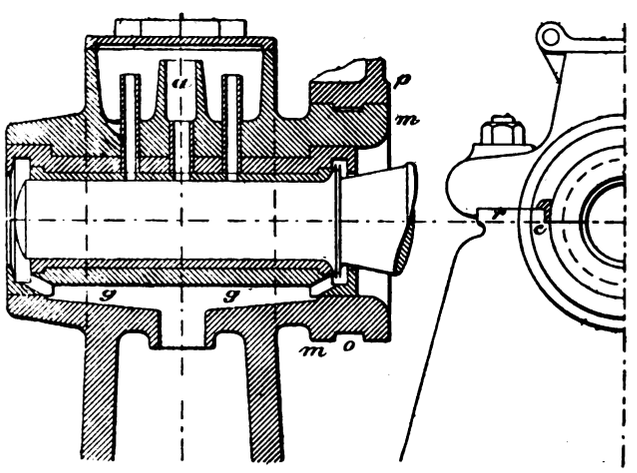

FIG. 228.

means of tubes and syphon wicks we need not enlarge, having done so in connection with Fig. 205. An additional feature here, however, is the central oil-way and pipe, *a*, evidently intended for pouring oil down bodily if the bearing heats, or else for filling with tallow or other solid lubricant which will melt with undue heating of the bearing, and so afford additional lubrication.

As will be seen on inspection, this bearing is of the split type, and has a cap. Like that shown Fig. 221, however, the lower half is the top of a pedestal cast in one with the bed-plate. The oil-catching hoods also are not formed in the main casting, but are turned out of the bush as in Fig. 225, and similarly, with square interior angles. Fig. 229 is a half plan with the cap removed.

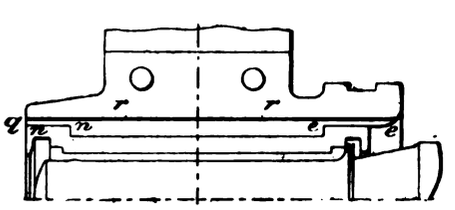

FIG. 229.

Observing this together with the end view it will be seen that there are uprising portions of which one is visible at *r r*, and these retain the cap and upper brass in position sideways. This is beyond the limits of the brasses, and thus there is no overlapping of the flanges of the upper brass on the base of the bearing; and the cap and upper brass are apparently only steadied in the direction parallel with the shaft by a fit on the holding-down studs. A weakness that seems to attend many designs of dynamo bearings is here evident in the very thin and fragile downward projections from the cap, indicated in section at *c* in the end view, and corresponding to the narrow ledges, *n n* and *e e*, in the plan. Such weak projections are too easily knocked off while the work is yet in the shops; and there is no mending these little breakages.

As will be evident, this bearing is intended to carry the brush gear, the method of mounting which differs from those which we have hitherto shown. A wide collar, *m m*, is provided for this purpose with a shallow groove, *o*. At *p* a section of the rocker ring is shown, which it will be seen has an interior projecting annulus corresponding to and fitting into the recess, *o*. The rocker is, of course, made in two halves, as in cases we have previously noticed.

Apart from the fact that there is no apparent means of making the upper brass sustain end thrust other than a fit on the studs, this bearing will be seen to be of simple and yet substantial construction. The outer end of the bush being flush with the main casting, as at *g* in the plan, is a somewhat unusual feature, though it is not evident from the design whether these ends will be machined flush; or whether any projection of one beyond the other will be merely chipped and filed away, and then a coat of paint applied, rendering the joint more or less invisible. It will be observed that the tubes from the oil-box are all carried quite down to the white-metal lining of the bush in accordance with good practice. The oil-thrower on the shaft is a double annular ridge; and it is so turned that its outer periphery stands away from the end of the bush, the radius on the shaft being continued in a tangent forming an angle with the axis of the shaft, leading up to the periphery of the first oil-thrower. It will be noted that the drain passage, *g g*, is here only a groove much such as was shown in section at C, Fig. 192, and would be fully exposed as such on the removal of the lower brass. It may thus easily be cleared if necessary.

The intention of this design is evidently that the two brasses shall fit tightly together where they meet, so as to minimise leakage of oil through the joint, while allowing a working fit on the shaft between them. The cap is also made a fit on the pedestal, and is bolted hard down. A further advantage of the step up at *c* is that any oil working through the joint of the brasses would be checked by the vertical portion of the joint between the cap and the pedestal. The plan (Fig. 229) is based on the two views shown in Fig. 228, and a perspective engraving from a photograph of the same machine.

(To be continued.)

INSTITUTION OF ELECTRICAL ENGINEERS.

The conversazione of the Institution was held on June 15 at the Natural History Museum, South Kensington. Sir Henry Mance (the president) and Lady Mance received the guests, and amongst the very large number present were the following:

Prof. W. G. Adams, F.R.S.; Prof. W. E. Ayrton, F.R.S.; Sir Benjamin Baker, K.C.M.G.; Mr. J. Wolfe Barry, C.B. (president, Institution Civil Engineers); Mr. Horace Bell; Mr. A. R. Binnie; Mr. E. J. Bristow; Mr. Bennett H. Brough; Sir E. H. Carbutt, Bart.; Major P. Cardew, R.E.; Mr. Latimer Clark, F.R.S.; Mr. Conrad Cooke; the Chairman London County Council; Mr. H. W. Christmas (consul-general for Servia); Mr. R. E. Crompton; Prof. F. W. Crookes, F.R.S.; Mr. F. C. Danvers; Mr. H. E. Edmunds; Mr. R. S. Erskine; Mr. C. E. Fagan; Mr. S. Z. de Ferranti; Major-General Festing, C.B.; Sir W. H. Flower, K.C.B.; M. Xavier Gosselin (local hon. secretary for France); Mr. J. Hookey; Dr. John Hopkinson, F.R.S.; Prof. D. E. Hughes, F.R.S.; Mr. R. Inwards; Colonel R. J. Jocelyn; Lord Kelvin, G.C.O.V., F.R.S.; Prof. A. B. W. Kennedy, F.R.S.; Mr. J. C. Lamb, C.B., C.M.G.; the Lord Bishop of London; Signor Marconi; M. Julian Manes; Mr. Macrory, Q.C.; Mr. W. G. McMillan; Major McMahon, R.A., F.R.S.; Mr. Kenric B. Murray; Prof. John Perry, F.R.S.; Mr. W. H. Preece, C.B., F.R.S.; Prof. O. Pyfferoen; Mr. E. W. Richards (president, Iron and Steel Institute); M. Leo Saignet; Major B. Scott, R.E.; Prof. R. H. Smith; Prof. H. Spooner; Mr. C. E. Spagnoletti; Dr. W. E. Sumpner; Mr. J. W. Swan, F.R.S.; Mr. A. A. C. Swinton; Prof. S. P. Thompson, F.R.S.; Prof. W. C. Unwin; Mr. R. W. Wallace, Q.C.; General C. E. Webber, C.B.; Mr. F. H. Webb (secretary); Mr. Edward Woods; Dr. W. Woodward; Major A. E. Wrottesley, R.E.

Royal Society.—The ladies' conversazione of the Royal Society took place on Wednesday evening at Burlington House. A large gathering of guests were received by Lord and Lady Lister. Among the exhibits were, of course, Mr. Marconi's wireless telegraph, and Dr. Oliver Lodge's apparatus for doing the same thing was also exhibited by Dr. Muirhead. Dr. Lodge has adapted his receiver to a Kelvin recorder.

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POSTS AND TELEGRAPHS.

In the current number of the *Fortnightly* Mr. Henniker Heaton, M.P., discourses upon postal and telegraphic progress under Queen Victoria. The history of this progress is but lightly sketched, and, in a manner, is of comparatively little interest. The real interest of the article lies in what it proposes and suggests. Two of the suggestions are as follows:

Introduce a Bill providing for the acquisition by the State of existing cables.

Lay on the table a similar Bill for the purchase of the telephones.

With the latter we entirely agree, though as regards the former, in our opinion, far less costly a method would meet the exigencies of the case. There is really nothing new to be said as regards telephones. Ever since 1880—when it was legally decided that telephony was a phase of telegraphy, just as, if the question ever arose, signalling without wires would be held to be a phase of telegraphy, and thus under the control of the State—it was certain that sooner or later the telephone system would be absorbed by the Government. That the time will be later instead of sooner is but a continuation of that red-tapism and hatred of change which keeps back almost all departmental reforms. Mr. Heaton tells of the opposition to Rowland Hill's penny post, tells of the millions of letters and papers franked gratuitously through the post by those who had the power to frank—aye, even to the franking of a piano, though the parcel post was not then introduced: and 'tis hard to see how far a piano answers the description of a letter or paper. Mr. Heaton would like to see a telephone in every house the rental of which was over twenty pounds; and again we agree. The value of telephony is not yet known in Britain, and never will be rightly understood till it forms a part of the equipment of every house in the land. The difficulty, perhaps, would be to divine some simple method of payment. The present method of exchanges is costly, cumbrous, and unsatisfactory. The future system will be by automatic methods worked electrically, so that any one person can himself connect with any other if that other's line is disengaged. A far-fetched idea this? Oh, no! It will come, and when adopted, the working cost of telephony will be reduced, and the charges will be determined more upon the initial outlay and repair of lines and connections than upon other considerations.

The acquisition of existing cables by the State is another matter altogether. Without going deeply into the subject, we may point out that there are usually two ends to a cable, one of which is often upon a foreign shore. Is it for one moment to be supposed that foreign Governments would agree to the acquisition by England of all cables? If both ends were upon British territory, the case would be different. We have consistently advocated cable connection with our great Colonies, outside connections through other countries, and the strategic argument which holds good in this case will hold good when other countries consider a position whereby private and public messages

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would pass through the hands of officials employed by our Government. The general commercial cable system of the world may well be left in the hands of private enterprise, and if such a cable system be supplemented by another the whole of which is under British control, we, at any rate, shall be satisfied that the duality is the better scheme. It is absolutely certain that if cables had waited the action of Governments, no cable network would have existed to-day. Commerce has been the incentive to cable development, and must be so still; and commerce does not quickly move Governments, unless it cares to change its ways and proceed by agitation and the control of votes. Governments have to be driven. Commercial men lead. The former must not initiate speculative enterprises; the latter revels in them. That is all the difference, but it is sufficient to bar Government action. The main part of the cable network of the world must be governed by commercial requirements. The exceptions we have advocated seem to prove this rule. Thus we are against Mr. Heaton's suggestion, and, being so, it is unnecessary to discuss the further question of the penny-a-word tariff. This ubiquitous copper token seems to govern Mr. Henniker Heaton's views in all financial matters. Many people will not agree that the "true index of the degree of civilisation" is given by the number of letters forwarded and received by the inhabitants of a country. The expert letter writer, whether male or female, is usually a person to be avoided, there being plenty of verboseness, but little else. Does it not strike one that the business interests of the country are a little too heavily handicapped in being taxed to pay for something that does not pay commercially, and to which these interests have already paid commercially more than would suffice to carry on the work so far as they require it. At the present time the purchase of cables and the adoption of a penny tariff would simply be robbing Peter to pay Paul—and to this Peter objects.

THE SHYNESS OF LEARNED SOCIETIES.

Mr. G. H. Stockbridge, in an article in the *Engineering Magazine* on "Epoch-Making Events in Electricity," refers to the fact that Brewster credited Barlow instead of Arago with the discovery of the "magnetism of rotation," and speaks of Brewster being "unaware in the usual British way" of these discoveries, or of the differences between the results of the researches of the two men. Brewster, of course, ought not to have been ignorant of what was going on in the experimental world, nor ought a good many people to be ignorant even now of what is being done around them in scientific work. But they are, and cannot well help being so, while some of the learned societies look upon their papers as choice bits of feminine finery to be laid up in lavender and hidden in scented boxes till doomsday. The Royal Society shall be our object-lesson. It is perhaps the worst transgressor, when it should be the first to assist the extension of information. The writer of this note is a privileged person, and can obtain the *Transactions* if he chooses, so that in this particular instance "sour grapes" does not apply. The object in writing is to suggest that all scientific societies should make a practice of sending their papers or *Transactions* as read or published to the scientific Press. The columns of the latter are read by scores of thousands, whereas the pages of the *Transactions* are not read by as many hundreds, perhaps not so many tens. The scientific Press would assuredly scatter broadcast the conclusions arrived at by the author of a paper, or the results of his experiments; all told and with the utmost generosity in ascertaining what publications may be included within the term "scientific Press," this suggestion would mean the sending out of a score or two copies of a paper or of *Transactions*. Young experimentalists cannot be expected to have at command the *Transactions* of half a dozen scientific societies, some of which are in London, others in Cambridge, Oxford, Edinburgh, Dublin, Manchester, or Liverpool. They may, and often do, waste a lot of time in researches which have been done before, but of which the general body of scientific men know nothing. A more generous disposition to disseminate information by the learned societies would also save bitter controversies as to priority, and ofttimes long and costly legal action. A poor inventor is met with "prior knowledge," and quotations are made out of practically sealed treatises, showing that all his work has been done before, and is therefore common knowledge. Of course that is a kind of "legal fiction," for knowledge in learned societies' *Transactions* is generally uncommon rather than common; and the best way to oblivion is to bury it therein.

ROYAL ENGINEERS (VOLUNTEERS) ELECTRICAL ENGINEERS.

The following relating to the new corps of Electrical Engineer Volunteers has been drawn up for the information of the profession:

Objects of the Corps.

The corps is intended to bring together a body of men having adequate knowledge of applied electrical science and train them in the application of their knowledge to defence. The principal duty at present to be entrusted to the corps will be to undertake, in connection with the home defence, to provide officers and men to assist the regulars in working defence electric lights at all our defended ports, and in particular at certain ports of the first importance where there is at present a deficiency of trained men. For this purpose a certain number of electricians will be required and a certain number of men accustomed to drive engines. In addition to this, it may be expected that the corps will have other duties in which electrical knowledge will be useful.

Duties of Officers and Men.

Both officers and men will be required to qualify themselves as efficients. The conditions of efficiency will be analogous to but not identical with those of the Submarine Miners; these are as follows for captains and subalterns. An officer of Volunteer Engineer Submarine Miners shall be returned as efficient as follows: (*a*) Under one year's service, provided that he shall have received a certificate from a school of submarine mining for Part I. of the submarine mining course, and shall have attended the continuous training for eight days, or, if he has not received a certificate, that he shall have attended 78 submarine mining drills and the continuous training for eight days. (*b*) Over one year's service provided that he

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shall have received a certificate for Part I. and II. of the submarine mining course from a school of submarine mining, and shall have attended the continuous training of his division for eight days, and shall further have attended 48 submarine mining drills of his division during the year. If exempted under the provisions of the Volunteer Regulations from attendance during the full or any period of the continuous training, a certificate may be granted provided that he shall have attended 60 submarine mining drills.

The conditions of efficiency for non-commissioned officers and sappers of the Submarine Miners are as follows:

Recruits—Non-commissioned officers and sappers with under two years' service may be returned as efficient who have attended 78 submarine mining drills and the continuous training for eight days. They shall pass the test examination previously specified (either at the end of their first or second year of service) before being classed as "trained men."

"*Trained Men.*"—Non-commissioned officers and sappers with over one year's service who have passed the test examination previously specified may be returned as efficients provided that they shall have attended the continuous training for eight days and 78 submarine mining drills.

Experts.—Non-commissioned officers and sappers with over three years' efficient service who have passed the test examination for experts may be returned as efficient provided that they shall have attended the continuous training for eight days and 48 submarine mining drills, or the complete period of 15 days continuous training and 10 submarine mining drills.

Special Exemptions.—Non-commissioned officers and sappers specially exempted from attendance at the continuous training under the provisions of the Volunteer Regulations may have their certificates granted provided that they shall have attended the following number of drills, which may be counted by attendance during a portion of the camp at whole-day or half-day parades or at hourly drills: recruits, 90 drills; trained men, 90 drills; expert men, 60 drills.

NOTES.

Drills.—A submarine mining drill is one hour's actual submarine mining work. Periods of continuous work of not less than 1½, 2, 2½, 3, and 3½ hours may be reckoned as equivalent numbers and fractions of drill towards efficiency. Recruits shall not do more than two hourly drills in one evening.

A working day during the continuous training will count as six drills in computing the number of drills required in excess of the period of eight days' continuous training, and also in the case of volunteers specially exempted from attendance for the period of eight continuous days.

All certificates of efficiency are issued subject to the recommendations of the officer specially deputed to make the technical inspection of the division.

On the outbreak of war with a powerful maritime Power the officers and men told off for working the defence lights will, like the Submarine Miners, have to join their stations immediately, independent of the question of an anticipated invasion. This duty is imperative, and must be unreservedly accepted.

Expenses.—Officers will be required to provide their own uniforms, but the War Office now allow £10 at once and £10 some time after efficiency is certified. The necessary cost for uniform is about £20. Uniforms for non-commissioned officers and men will be found by the corps.

The rule in regard to allowances of the Submarine Miners are as follows: when in camp for not less than eight days, or more than 15 days, 10s. a day is allowed for commissioned officers and 5s. a day for men, representing ordinary pay, subsistence, etc., and an allowance for travelling expenses according to the regulations. Similar allowances are made for full and half day's training at the school, provided the man has already attended 40 drills in the year as a recruit, 10 drills as a trained man, provided the total payment for such days does not exceed £5 for any man or £10 for an officer. Something similar will be arranged for the Electrical Engineers.

THE BEST MEANS OF EFFECTUALLY PREVENTING THE LEAKAGE OF CURRENT TO "EARTH" IN ELECTRICAL INSTALLATIONS FROM GENERATING HEAT AND SETTING BUILDINGS ON FIRE.

BY SYDNEY F. WALKER.

(Continued from page 755.)

Another possible source of dangerous heating from leakage to "earth" is when insulated wires are brought in close proximity to something, not necessarily metal, in connection with "earth," and the insulation resistance between the cable and "earth" is gradually broken down by the chemical action of the current building a bridge across between the cable and "earth." Then at some favourable opportunity, at some instant when the E.M.F. between the two is momentarily increased—say, by self-induction—a large proportion of the current in use having been switched off, or from some other cause, the increased E.M.F. is able to completely break down the now slender insulation of the bridge; it then throws a current across the bridge, consumes the latter, and leaves an arc behind it which will ignite anything in its neighbourhood, and which will also, if it continues, raise the temperature of surrounding objects, and particularly of any metals that may be near, so that inflammable substances at some little distance from the arc may be ignited by reason of the heat communicated by the arc to these metals, and conducted by them to the neighbourhood of the inflammable substances. Instances of this are badly covered joints lying in imperfectly protected wood casing, the whole being in a position where it is subject to damp, and the wood casing lying on a gas-pipe, the latter being only a short distance from the joint. In such a case the wood lying between the joint and the gas-pipe may become gradually altered, so as to form a bridge of at first very high resistance between them, but gradually decreasing, till some day when there is a sudden change in the current taken by the neighbourhood, a small extra current is thrown across the bridge, leaving an arc behind it, which carbonises the wood, lowers the resistance of the bridge again, and possibly sets fire to the wood; the tape with which the joint may have been wrapped possibly melts the gas-pipe if it is of composition, and fires the house. Such a bridge may be formed by dust, especially if the dust contains any particles of metal or of coal, and when so formed will behave in precisely the same way.

Another possible source of dangerous heat from leakage currents to earth is from the passage of a spark through the insulating envelope of the cable itself. In those cables in which the insulating envelope is protected either by a covering of lead or of wire armour, it may and does occasionally happen that some portion of the insulating envelope is not quite as perfect as the rest. The copper conductor may be slightly out of centre in that place. The insulating material may have a flow there. The thickness of the insulating material as a whole may not be sufficient to resist the ability to spark across the distance between the conductor and the outer protecting covering. The same process goes on as described in the last case. The nature of the material at that point, and through the whole cable if the insulating envelope be too thin, is gradually altered. Its resistance to the conduction of electrical currents is lowered. A small leakage current passes across through the insulation from the time when it is first used, which does work upon the insulating envelope. At some favourable moment, when, as explained above, the E.M.F. is temporarily raised, a spark passes across at the point mentioned between the copper conductor and its protecting sheath, an immense quantity of heat is generated, igniting the insulating material if inflammable, melting the lead covering, or raising the wire covering to a high temperature, which in its turn ignites anything inflammable near it. The writer knows of a case in which a cotton cargo was ignited in this way. The degree of danger in this case, as in the others, is measured practically by the E.M.F. present between the copper conductor and its outer metal covering, and this will depend upon how far the outer covering is in metallic construction with earth, and where the first connection is made with earth.

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It will be noticed that in all cases mentioned above that two connections must be made to "earth" to create a dangerously heating current, and it is on making the second connection that the trouble begins, though not necessarily at the point where the second connection is made. A connection to "earth" through a short length of small wire may exist first, and may exist for a long time without doing any harm, when suddenly the accidental second connection, made elsewhere, possibly at a great distance from the first, even on another system, causes the small wire to have the dangerous heating current passing through it and leads to fire. It should be mentioned that a leakage current takes place to "earth" when only one connection is made, but the cases in which it could cause dangerous heating would be very rare.

Broadly, then, it may be stated that dangerous heating takes place, from leakage to earth, when the conditions are such that a conductor of low resistance, but also of comparatively small section, is exposed to the passage of a current through it, created by an E.M.F. loss in proportion to its resistance. It should be mentioned here that both the temperature created and the danger arising from that temperature vary with the conditions present. The temperature assumed by any conductor, or other body, through which a dangerous current is passing, depends on the following: The rate at which heat is delivered to the body, the rate at which heat is dissipated by the body, the mass of the body to which heat is being delivered, and bodies in connection with it; the specific capacity for heat of the body to which heat is being delivered, and of the bodies in direct connection with it. Thus, where both the connections to earth are by short, stout pieces of metal, the temperature assumed by them may not be much above the surrounding atmosphere, and particularly if the conditions are such that the heat is conveyed away, say, by radiation, or convection, as fast as delivered, as it would be, say, where the connections were on top of a pole, or outside a house in cold, windy weather. On the other hand, it is easy to imagine conditions under which a comparatively small current would cause a dangerous rise of temperature. So, too, if nothing inflammable is near when the dangerous current passes there is no danger to the building, but such a condition would be rare.

And now as to how the leakage current to earth is to be prevented from generating heat and setting buildings on fire. An examination of the formula that was given above, $H = \frac{E^2}{R} t$, shows that there are three points at which the evil may be attacked: (1) by reducing the E.M.F. present at the terminals of the leakage path; (2) by increasing the resistance of the leakage path; (3) by reducing the time during which the leakage current is passing. A further consideration of the matter shows that the best method of reducing the E.M.F. present across the leakage path, the path over which the dangerous heating current passes, is by increasing the resistance of the whole path traversed by the current between the two points where connection is made to earth. As is well known, Ohm's law may be written $E = C R$; where E is the E.M.F., either present across the resistance, R, when current, C, is passing, or that is lost from the initial E.M.F., by reason of the passage of current, C, through resistance, R. If, therefore, we can increase this resistance under all conditions under which a leakage current may arise, we have also decreased the E.M.F. that can be present across the leakage path where the dangerous heating arises. So that (1) and (2) reduce themselves practically to increasing the resistances of all the paths to and through earth. If, in the case mentioned above, for instance, the resistance of the "earth" between the first and second connections had been such as to reduce the E.M.F. present at the ends of the 20ft. of No. 22 wire to 10 volts, the energy delivered to the wire would have been in time t,

$$H = \frac{10^2}{\cdot 1} = \frac{100}{\cdot 1} = 1{,}000 \text{ watts},$$

still a very serious amount of energy to deliver to a small wire of the kind, but by no means so terribly dangerous as that which actually did pass. And further, the increase of temperature in the wire itself, with its accompanying increase of resistance, would have partially reduced the trouble. By reducing the current strength with some metals, such as iron, for instance, whose coefficient of increase of resistance with increased temperature is high, the increase of resistance might even have prevented the rise of temperature of the wire above a dangerous point.

The question therefore first arises, can "earth" itself be attacked, so as to increase its resistance—the resistance of the paths for the leakage currents to and through earth? It would perhaps be too much to ask the gas companies to assist in strengthening one of the weak points in electrical distribution, and so help in the development of its rival. Still it may be pointed out that if the iron gas-pipes which are laid in the ground were enamelled, and their joints made with indiarubber rings, the resistance of the connection to one portion of the masses of metal lying in the earth's crust would be considerably increased. In houses also in which the gas service is already laid on, but in which gas has been displaced by electricity, if the house gas service is completely severed from the supply mains, the severed portions being placed well out of sparking distance, the resistance of the path to earth by way of the house gas-pipes would be increased almost to infinity. For the purpose of connection in case of a temporary failure, an indiarubber tube might be provided, such as is often used for the connection to a gas-engine. Further, as is well known, the white lead and tallow that gas engineers use to stop leakages in their gas-pipes has a very much higher resistance than that of the gas-pipes themselves. If in all joints in gas-pipes as much of this is used as possible in the joint, the resistance of the earth path itself will be considerably increased. In new houses in those districts where electrical supply has been established sufficiently long to have inspired confidence, and in which even temporary failures of minute duration are unknown, gas-pipes will not be fixed where electricity only is employed, and one possible source of leakage to "earth" will have been removed. In old houses, also, in which gas is permanently displaced, electricity having thoroughly established itself in the district, it would be wise to remove both the house gas service and the supply main at the first convenient opportunity.

The water service is far more difficult to deal with, inasmuch as water itself, if present in large volume, offers a path of comparatively low resistance to the leakage current. Something, however, in the writer's opinion, may be done here. If, for instance, the water-service pipes were also of enamelled iron, connection to them from outside would not be so easily obtained as at present, and the resistance of the pipes themselves, if connected with rubber joints, would be increased. In those cases also, where it is practicable, if glazed earthenware pipes were used instead of iron or lead, a further step would be taken in the same direction. If connections to boilers, to engines, etc., were made with short lengths of stout rubber tube where practicable, another step would be taken to divide up the masses of metal present in and on the surface of the earth's crust.

One object to be sought in increasing the resistance of the earth is, undoubtedly, to divide up the masses of metal as far as possible by interposing either insulators or materials of high resistance between them, so that the resistance of the earth path between, say, one part of a town and another should be as high as possible. Another thing that might be done, which would tend also to sanitary improvement, is: at each point where water is consumed—at the entrance to each house, etc.—filters might be placed, specially designed to be of high electrical resistance, so as again to increase the resistance between the consumption pipes and the main supply pipes. If, also, all the pipes that are laid under the streets in a town were either laid in concrete or in culverts arranged so that the moisture path between them was of as high electrical resistance as possible—that is to say, as long and of as small cross-section as possible—the "earth" path would have an appreciably increased resistance. The importance of the above will be seen from another examination of the formula $H = \frac{E^2}{R} t$ as applied to the case already quoted. Wherever the first

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connection to the gas service was made, the combined resistance of the connection and the gas service between the two points must have been so small, so infinitesimal, that it had no appreciable effect upon the initial pressure when the heavy leakage current passed. If the resistance of the "earth" path had been at the comparatively low figure of 100 ohms, the E.M.F. present at the ends of the No. 22 wire would have been less than ·1 ($\frac{1}{10}$) volt; and, as electrical engineers know to their cost, often, when they are seeking earth, a resistance of 100 ohms and more is very easily introduced.

Broadly, then, the dangerous effects of leakage currents to earth may be enormously reduced by increasing the resistance of all possible means of connection to earth, and by dividing up the conducting masses which constitute earth in every possible way. These things are to be accomplished by interposing in the paths of the currents passing to and from earth and through earth at every available point bodies having a high electrical resistance. A number of leakage paths of moderate resistance may have the same effect as one of very low resistance in making the first all-important connection to earth. A thousand connections to earth, each having a resistance of 1,000 ohms, reduces the combined resistance of the first connections to one ohm only, and this may easily lead to the delivery at the ends of the thousand and first path of an E.M.F. sufficiently powerful to drive a dangerous current through the short length of small conductor of which that path may be composed. It should also be remembered that leakage currents and dangerous pressures across leakage paths are not confined to the portions of any one installation. Two or more electrical supply services in one town will combine to deliver leakage currents and dangerous pressures through the common "earth." Even perfectly distinct electrical plants, situated some distance apart, may combine in the same way by means of any water connection that may exist between the two, such as a river or canal. To accomplish the above, the insulation of the dynamo from earth should be very high, and its insulation resistance should increase in the proportion of the square of the E.M.F. delivered at its terminals. In the case of dynamos furnishing alternating currents, the insulation resistance from "earth" should vary in the proportion of the square of the total difference of E.M.F. between the extreme points of its characteristic curve.

Looked at from the point of view of the prevention of leakage to "earth," it would be decidedly better if the dynamo could be insulated from its bed-plate, though the writer is aware that in many cases this cannot easily be arranged for mechanical reasons. For the same electrical reason the rope or belt driven dynamo is better than the direct-driven. Every time that a resistance can be introduced between the distributing circuits and their connections and "earth" something is gained towards the reduction of possible leakage currents, and the avoidance of heating therefrom. From this point of view, therefore, the dynamo mounted on a block of close, well-dried concrete, and driven by ropes or a belt, is very much better than the dynamo coupled directly to the steam-engine that drives it, and possibly also mounted on the same bed-plate. In the former case the only path for the leakage current to "earth" at the dynamo is through the insulation of the coils to the frame of the machine, and thence through the moisture held in suspension in the concrete foundations to the whole body of moisture and metals in the earth's crust—a path of high resistance under any circumstances, and one that can always be increased within large limits by increasing the thickness of the insulation of the coils from the frame of the machine, and by a careful selection of the site of the dynamos and careful arrangement of the design of the foundations. In the latter case, where the dynamo is directly driven, the only point at which the resistance to earth can be attacked—in fact, the only resistance present—is that between the coils of the machine and its frame. As is well known, though insulation may be carried some way in this, after a certain thickness of insulation is reached, the efficiency of the dynamo begins to fall. The remarks that have been made with reference to the dynamo apply with equal force to the switchboard, the main distributing cables, the transformers, sub-switchboards, to the low-tension network supplying consumers, and to the cables, wires, and fittings within the consumer's premises. "Earth" is at hand, ready to receive a leakage current, or to deliver a leakage current—everywhere, at every point of the system, whatever the system may be, and it should be kept at the greatest possible distance, measured in electrical resistance, by every means at the command of the engineer; and these insulation resistances should vary, as with the dynamo, directly as the square of the highest differences of E.M.F.'s they may be exposed to. The insulation of cables, particularly of those for high-tension currents, should be as high as it is possible to make them, consistent with the other conditions necessary in cables. In the writer's view, a very heavy thickness of vulcanised rubber, well covered with jute thoroughly saturated with waterproof material, offers the very best insulation obtainable, and he would only limit the thickness of the rubber, by the facility of handling the cable after it is made, by the assurance of getting the whole thickness perfect, and by the amount the engineer is allowed to spend. All joints should be treated in the same liberal, or, if possible, a more liberal manner. In the writer's opinion, from the point of view of the present paper, connecting either the primary cables or any part of the transformers of a transformer system to earth is very strongly to be deprecated. The transformers, of whatever kind, in his view should be insulated from "earth" as fully, or more so, if possible, even than the dynamos, say, by immersion in oil of high resistance, or by any other suitable means. The low-tension network and the consumers' cables and wires should all be well insulated, in proportion to the E.M.F. present in them. Consumers should be instructed that while the addition of a little more rubber, or the provision of a higher class of rubber, adds to the initial expense, it also adds enormously to the life of the cables, and reduces the chance of leakage and the danger of heating from leakage currents. Another point that should not be forgotten in both high and low tension mains and in consumers' cables, is that cables and wires should on no account be allowed to rise in temperature appreciably above that of the surrounding atmosphere from the passage of the current through them, and that ample provision should be made for promptly cutting off the supply to a cable or wire in which the resistance has fallen so that a dangerously heating current is passing. It should be remembered that the quality of all insulating materials deteriorates in the presence of heat, and that heating the insulating covering of a cable or connecting wire reduces its resistance and prepares the way for leakage. Where cables or wires have to be laid in warm situations, additional precautions should be taken, by ventilation where practicable, and by either providing a special quality of rubber insulation or an extra thickness.

In fixing connecting wires and cables, both in consumers' premises and outside, routes should be chosen which place the largest distance between the cables, or wires, and gas, water pipes, or other conductors in connection with "earth."

The very safest plan is to have several inches of dry air interposed between the cable and the "earth" connection. Where this is not practicable, make the distance as large as possible; and where it is an absolute necessity that an "earth" conductor, such as a gas or water pipe, should be crossed, take additional precautions, such as the interposition of a rubber sleeve between the two. Keep all cables and wires away from damp places, such as damp walls. Where this is not possible, interpose something, such as rubber, between the cables and the damp so as to increase the resistance of the possible leakage path. Another point in which consumers might be instructed is in keeping their rooms as dry as possible. In many houses the rooms that are not in constant use are often allowed to get damp and musty, leading to numerous leakage paths to earth of high resistance, but that may become serious when multiplied many times, as the leakage currents are silently but surely doing work on the substance of the insulating material. In short, the utmost care should be taken in designing and laying every part of an electric supply system to interpose resistance to earth at every point, and to see that the resistance is maintained at the highest point possible.

A word or two may perhaps be added with reference to

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the use of concentric cables, lead-covered cables, armoured cables, wood casing, iron pipes, etc. The writer's view is that while outer protecting coverings are good as a protection from mechanical injury, they should be used as sparingly as possible, both because they tend to damage the insulating covering in putting on and because they reduce the resistance of the leakage path. Wood casing and metal pipes come, in his opinion, under the same category. Wood casing should only be used where the unprotected wires or cables would be unsightly or liable to damage, and the pores of the casing should always be saturated with some material, such as shellac, varnish, or asbestos paint, that will exclude moisture. Metal pipes, in his opinion, should only be used where no other means of protection exist, and where protection is absolutely necessary. Concentric cables are very tempting to the engineer, on account of their neatness, and in those cases where it is not necessary to break into the outer covering at all they tend in the direction sought after in this paper—they decrease the possible E.M.F. present across the leakage path; but where the insulating envelope must be broken, as in making connections on a low-tension system, it appears to the writer that the concentric cable has all the drawbacks of every other metal-covered cable. There is the danger of having damaged the insulation between the two cables in the process of construction, and the resistance of the leakage path to earth is reduced. In every form of cable in which an outer metallic covering is used, whether that be in the form of wire armour, a lead pipe drawn on, the concentric form of cable, or even where the cable is drawn loosely through a metal pipe, there is, in addition to what has been mentioned above, the ever-present danger of a spark passing between the inner conductor and the outer metal protecting covering, with all the attendant troubles arising from the heat generated by the arc that is usually left after the spark has passed. Further, the outer metal covering, whatever its form, deprives the engineer of one all-important requisite, the facility of examination and repair. This applies more particularly to wires or cables buried in metal pipes, whether they are under the streets, under a floor, or exposed to view as part of the decorations of a building.

The writer is aware that the practice of connecting one cable to "earth" has been strongly advocated by many electrical engineers, and that it is in vogue in many electric light and power installations. He is aware, of course, of the principal reason given for this practice—viz., the protection of the consumer from dangerous shock. He will be prepared to discuss this, if the question should be raised, but it hardly enters into the scope of this paper. So far as the dangers of heating from leakage currents to "earth" are concerned, the writer's view is that the practice of connecting one cable, or one part of an electric supply system, to "earth" can hardly be condemned too strongly. If the reasoning given above is correct, by connecting one cable to "earth" you have made the first connection, and have surrendered half your defences.

The writer would once more impress it on his readers that it is not only leakage to earth, but leakage from "earth" as well, that has to be feared. Once connected to earth, you are open to give to "earth" or take from "earth" everywhere.

With reference to alternating-current supply, the writer's view is that the same reasoning applies as to continuous currents, but that, in addition, leakage paths in alternate-current systems are exposed to very much higher E.M.F.'s than continuous-current systems to furnish the same pressure at consumers' terminals; also, that while the electrolytic action of alternating currents upon the insulating envelopes of cables is smaller than that of continuous currents for the same consumers' pressures, a certain quantity of heat is generated within the insulating envelope itself by the condenser action of alternate currents. It would appear to the writer, therefore, that for the same supply, the insulation resistance of all parts of alternate-current systems should be higher than for continuous current, particularly in the direction of possible leakage paths to "earth."

Another point that may fairly be discussed is, can anything be done with automatic apparatus to reduce the dangers of heating from leakage currents to earth. Unfortunately, it would appear that automatic apparatus can only help to effect this result indirectly. Electromagnetic cut-outs in place of fusible cut-outs would reduce the chance of overheating wires, if more generally adopted, as the former are much quicker in action, and can be arranged to fulfil any given requirements. Apparatus also that indicate to the engineer-in-charge at the generating station, and to any consumer, the resistance between the system at that point and "earth" are very great service, provided the apparatus are kept in order, periodically inspected, and their warnings acted upon.

As will be gathered from all that has been stated above, the very best precaution is care all through, care in designing and in laying every part of the system, with a liberal allowance in the matter of insulation and in the sectional area of cables for any given current. Keep the insulation high, the current density low. After that, the very best precaution that can be taken is that of careful periodical, registered testing. Let the whole work be carried out as well as the state of knowledge at the time and the funds at the engineer's disposal allow. Then let careful tests be taken and recorded of the resistance to "earth" of every part of the apparatus, individually, isolated from the rest, and of the whole system collectively. Let these tests be repeated at stated intervals or whenever opportunity occurs, and at the first appearance of a tendency for the resistance to earth to lower, let the first opportunity be taken to search out the section in which the resistance is lowering and remove the fault before it can do any harm. If the fall be general let the whole still be watched, and portions of the system renewed from time to time, so as to keep the insulation resistance from "earth" up to a certain safe standard.

In conclusion, to eliminate all danger of leakage currents to earth, or from "earth," see that every part of the system is well insulated from earth, and that the insulation resistance from earth is maintained at a certain standard.

ON RATING ELECTRIC POWER PLANTS UPON THE HEAT-UNIT STANDARD.*

BY WM. S. ALDRICH.

The progress of power-plant engineering has reached such a stage of development that electric power plants should be contracted for on a somewhat similar basis of guaranteed performance as that now in vogue for pumping plants. There should be guaranteed a definite output in the case of the electric plant to be measured at the switchboard and expressed in kilowatts per 1,000,000 B.T.U. supplied to the steam used in the whole plant. Following are some of the advantages of having such a standard for this purpose founded upon the heat-unit basis:

1. *It is a Simple Basis, Involving Quantities Easily Measured.* (B.T.U. input): The computation is based upon the quantity of heat required to raise all of the feed-water from its temperature to that of the steam at the boiler pressure with such additional determinations and allowances as are now regularly made in obtaining the similar quantity of heat supplied in the duty trials of pumping engines. (Kilowatts output): The work is obtained from corrected voltmeter and ammeter readings at the switchboard for a definite interval of time at a given specified load which is maintained uniform throughout.

2. *It Applies to all Plants Operated by any kind of Heat Engine.*—The present way of stating such performances is: (*a*) kilowatts per pound of coal; (*b*) kilowatts per cubic foot of gas; (*c*) kilowatts per gallon of oil—according to the kind of heat engine furnishing the motive power for the plant. The proposed standard is superior to such ratings as the latter, and furnishes a common, practical, and scientific one for all of them. They involve the efficiency of the boiler, or of the gas producer, and this last requires the determination of the thermal value of the fuel. It is not alone the difficulty of such determinations, but the unsatisfactory nature of the fuel basis, which has led to its disuse in pumping plants.

3. *It Forms the Most Satisfactory Basis for Comparison of Plants.*—Efforts are being continually made to obtain such ratings for existing electric power plants as will enable the probable performance of similar projects to be predetermined when installed and operated in like manner. Sufficient and

* Presented at the Hartford (Conn.) meeting (May, 1897) of the American Society of Mechanical Engineers. The author is a member of the society, residing at Morgantown, W. Va.

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reliable data may be obtained at various proportional parts of the full load of the plant as will enable one to determine what may be called the characteristics of the particular type of electric power plant under consideration. The inherent advantages of each type of plant will then appear in its characteristic curves, showing the variations in its efficiency and economy at various proportional parts of its full load or rated normal capacity. Then it will be possible to compare, at different loads, system with system and plant with plant. Such determinations and comparisons will be all the more valuable if based upon commonly accepted standards and ratings, such as the heat unit proposed.

4. *It will Facilitate the Predetermination of the Performance of Electric Power Plants.*—The engineering precedent which will be established by such a standard will promote the predetermination of the efficient and economic performance of electric plants quite as much as similar ratings have accomplished for pumping plants. While both units are rarely built by the same concern, as in the case of the latter, still this should not debar the installing engineer from advocating the use of such guarantees based on the heat-unit basis if his work is to hold its own in the light of the guarantees and contracts made in other branches of engineering, and notably so in the installation of pumping machinery.

5. *It will Promote the Most Economical Arrangement of Plants.*—The power plant is an aggregate of units and of an ever-increasing complexity. It is therefore quite as essential to have the whole system economically arranged as to have the most economical units. It is this economy of arrangement or of installation, so to speak, which, in a measure, the duty of a pumping plant so clearly expresses when based upon the heat unit standard. It is such a method of stating the final outcome of the arrangement of all of the details of a power plant of which designers, builders, managers, and owners wish to know the value.

6. *Heat-Unit Specifications will Form Proper Basis of Agreements.*—Builders of both engines and dynamos are equally interested in the adoption of some such common standard. Unfortunately, however, in many cases, this interest extends only so far as the economic performance is concerned of the individual machines which they manufacture.

7. *Contract Trials of Electric Plants Should be Based on Heat Units.*—Contract trials of the completed plant are necessary to establish the guarantees of satisfactory fulfilment of contract as to both efficiency of installation and economy of operation. The present method of basing the performance of such upon the final plant efficiency is misleading. In electric installations, particularly, there is a set of conditions ensuring a maximum value for such an efficiency, usually at some fractional load. There is also in such plants another set of conditions, at some other load, ensuring maximum economy of operation of the engine. Only contract trials for definite periods of time, at specified and uniform loads (at various proportional parts of the full load), will enable all claims to be adjusted regarding guaranteed efficiency or economy when such is based upon the quantity of heat supplied to the system in thermal units.

8. *It will Advance this Industry along Engineering Lines.*—The business of power-plant design, construction, installation, and management is not altogether in a formative period. Nevertheless, when an electric power plant can be contracted for on the basis of so many kilowatts output per 1,000,000 B.T.U. in the steam supplied to the plant, and that at a certain specified load, or proportional part of the full load, then we may expect somewhat the efficiencies, economies, guarantees, and contracts now being regularly realised in some of the other lines of power generation.

The subject is developed in this paper as follows: (1) the heat unit as a basis for rating steam-power plants; (2) the heat unit required for such a standard; (3) present use of the heat unit in steam pumping plants; (4) present way of stating performance of electric plants; (5) the load factor in power-plant ratings; (6) proposed use of heat units in electric plants; (7) determination of the heat supplied to the steam; (8) performance of the boiler not in evidence; (9) determination of work done by electric generators.

1.—The Heat Unit as a Basis for Rating Steam-Power Plants.

It is not the purpose of this paper to review the line of argument for such a use of the heat unit as a standard basis for rating and comparing the performance of steam-power plants in general. Nor is it proposed to advocate anew the great value of heat-unit specifications as the proper basis of agreement between contractor and builder, on the one hand, and the subsequent contract trials on this basis as the most satisfactory means of adjusting all claims in power-plant installations, on the other hand.

The heat unit is the most scientific basis for the engineer to use in stating the final performance of any power plant driven by a heat engine. It is in consequence the most satisfactory standard upon which to base an agreement between the contracting parties for the installation.

The merits of the heat-unit standard in these particulars cannot be longer open to discussion. It has been so completely defined for pumping plants, for instance, and is in such constant and satisfactory use in this branch, as to prove its engineering value.

Heat-unit ratings are also coming into more general use as the most suitable standard upon which to base the performance of prime movers in power plants deriving their energy from fuel, whether by steam-engines or other heat engines. The value of such a standard has been ably advanced by Prof. C. H. Peabody in a paper* before this society, from which we quote as follows: "It is customary to state the performance of a steam-engine in pounds of steam used per horse-power per hour, a method which is open to objection, since the value of a pound of steam depends on the pressure and quality of the steam. It has frequently been urged upon the attention of engineers that the British thermal unit (B.T.U.) should be used in stating the performance of engines. . . . In order to obtain convenient numerical quantities it is advisable to state engine performance in British thermal units per horse-power per minute. Incidentally, this method has the advantage that it may be used for any heat engine, such as a hot-air engine or a gas-engine."

2.—The Heat Unit Required for such a Standard.

The acknowledged scientific standard of temperature, of 0deg. C., is evidently impracticable for a heat-unit standard. Prof. H. A. Rowland has shown such a temperature is out of the question, because the mechanical equivalent of the heat is not definitely determined, and probably cannot be at this critical point. Nevertheless, such is the basis of the scientific heat unit, the calorie—the quantity of heat required to raise the temperature of one kilogramme of pure water 1deg. from 0deg. C.

The temperature of 39·1deg. F., at which water attains its maximum density, is equally undesirable, notwithstanding that it is the old British standard temperature of the days of Rankine. The determination of the mechanical equivalent of heat at this critical temperature offers similar difficulties to those of the freezing point. At neither of these points can the specific heat of water be satisfactorily determined.

"There is practical convenience in choosing 62deg. F. for the standard, because it is near the mean temperature of the air during experimental work," as Prof. C. H. Peabody has pointed out. Besides, the specific heat of water may be definitely known at this temperature, therefore "it is more scientific to take an easily verified quantity for the standard."

The British thermal unit now used, or the mechanical equivalent of the heat required to raise the temperature of 1lb. of water 1deg. from 62deg. to 63deg. F., is that of Prof. Rowland's determination, of 778 foot-pounds. This temperature is also that of the new British standard of weights and measures, and more clearly approaches the 15deg. C. of the French standard—a temperature frequently used and readily maintained in electrical and other testing work.

The only objection to the British thermal unit used in connection with the watt is that this heat unit is not, like the watt, one of the units based on the scientific standards of the C.G.S. system. Of course, such a heat unit is to be found in the calorie. But its mechanical equivalent requires that the most accurate scientific measurements be made at the critical temperatures for water, which have been found to be quite impossible of determination.

3.—Present Use of the Heat Unit in Steam Pumping Plants

The use of the heat unit in this connection was first suggested† by Dr. Chas. E. Emery, member of this society. He proposed that the duty for pumping engines should be based upon the foot-pounds of work done by the steam-pump on an expenditure of 1,000,000 B.T.U. in the steam supplied to the plant.

The adoption of this standard was the logical outcome of the old one, by which the "duty" was rated in foot-pounds per 100lb. of coal burned under the boiler. The ordinary specification of an evaporation of 10lb. of water, from and at 212deg. F., under atmospheric pressure, would result in 965,700 B.T.U. supplied to the whole plant per 100lb. coal burned under the boiler. Another advance was made when it was proposed to state this "duty" on the basis of the 1,000lb. of feed-water supplied to the system, rating the heat units per pound of water evaporated as before, from and at 212deg. F. But it was clear that the efficiency of the boiler should have nothing to do with the "duty" of the pumping engine. It

* *Transactions* of the American Society of Mechanical Engineers, vol. xiii., No. 484, on the "Economy and Efficiency of the Steam-Engine," by C. H. Peabody.

† United States Centennial Commission, International Exhibition, Group XX.; vol. vi., pp. 21 and 115 of the report of the judges.

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was therefore but a slight step, and one in the right direction, to change the standard to that of 1,000,000 B.T.U. in the steam supplied to the plant.

Such use of the heat unit was further considered before this society in the "Report of Committee on a Standard Method of Conducting Duty Trials of Pumping Engines."* The adoption of this method has since resulted in most remarkable developments in this branch of industry. Unprecedented economies of pumping engines have been brought about. Installations and contract trials upon such a basis have furnished valuable engineering precedent. The "duty" of pumping engines can be so closely approximated that binding contracts are willingly entered into by the builders. Bids are advertised for with the understanding that "No bids will be considered offering less duty than 130,000,000 foot-pounds."

The question was opened afresh and the cause further promoted by Mr. A. F. Hall in a recent paper† before the society, in which he writes thus: "But why use variable quantities as coal and steam for units when the heat unit is just as simple to obtain and use, and one which requires but little study to understand? . . . It has in it the elements of simplicity, and places all engines upon an equal footing for comparison, which no other proposed method does."

4.—Present Way of Stating the Performance of Electric Power Plants.

It has been previously noted, in the abstract of advantages of the heat-unit basis over the present rating, that the latter are: (*a*) kilowatts per pound of coal; (*b*) kilowatts per cubic feet of gas; (*c*) kilowatts per gallon of oil. This is merely to inaugurate a method of stating such performance for electric plants as that which has been tried and found wanting for pumping plants. Neither do builders of engines and dynamos care to be held responsible for the performance of the heat-generating plant, whether it be a steam-boiler or a gas-producer.

The watt, the kilowatt, or the watt-hour basis is perfectly intelligible. The fuel record is on the most unsatisfactory and unreliable basis that could have been selected for such ratings. The kind of coal or other fuel is rarely stated. It is always a variable quantity. Even if noted, it enables one to form only a vague notion of what the economic ratings should be with any other kind of fuel. Such records and ratings are not of permanent value. They are not given on a rational and scientific basis in conformity with the standards in electrical and other engineering work. It is proposed to substitute the heat unit as the standard about which there can be no dispute, unless it be as to the kind of heat unit which should be chosen. This objection has been considered in a preceding section with regard to the merits of the British thermal unit and the calorie of the French standard.

5.—The Load Factor in Power-Plant Ratings.

When the output of the plant is referred to, it is usually in terms of its load factor. Thus, for any one day's record of the performance of a good electric plant it would be at present expressed as, say, 200 watt-hours per pound of coal, with load factor of 40. From the very definition of this term "load factor" and the limitations placed upon it, it is apparent that the same factor may be obtained in quite a number of different ways. It is needless to point out that there will be a different coal bill for each and every set of conditions giving one and the same load factor.

This load factor expresses the rate of working. Prof. Unwin‡ states the case very clearly thus: "There may be various load factors according to the precise fluctuation considered. But for the object at present in view, the consideration of the influence of variation of load on the efficiency of steam plant, the load factor may be taken to be the ratio of the area of a day's load curve to the area of a rectangle enclosing it. It is equally the ratio of the average load during the day to the maximum load at any time during the day."

Such a load factor, therefore, takes no consideration of the performance under a steady load, but mainly represents the result of the general average of all of the various fluctuations during any given time interval, as one day. For the purpose of this paper it cannot be considered as being at all equivalent to what is herein termed "the proportional part of the full load," under which condition all parts of the system may be considered as running under a constant load. It is the performance under the latter uniform conditions which forms the basis for comparison of ratings by the British thermal unit standard.

(To be continued.)

* *Transactions* of the American Society of Mechanical Engineers, vol. xi., No. 381—"Report of Committee on a Standard Method of Conducting Duty Trials of Pumping Engines."

† *Transactions* of the American Society of Mechanical Engineers, vol. xv., No. 584—"Heat Units and Specifications for Pumping Engines," by A. F. Hall.

‡ "On the Development and Transmission of Power from Central Stations," by W. C. Unwin. London, 1894.

TELEPHONE COMPETITION.

It has been often said that allowing competition between rival companies in the telephone supply business has been a failure in the United States, although in that country everyone uses the telephone. But a bare fact without the circumstances is pretty nearly useless in a matter of this sort, and therefore the following, which comes from an interview with Mr. C. Schwed, of Somerville and Raritan, in New Jersey, may be of interest as showing the sort of things that happened with the competing companies. It is published in *Electrical Engineering*, a periodical which, it should be said, holds very strong views indeed as to the inexpediency of competing services. "When we organised two years ago, we believed that we could provide a cheap and satisfactory telephone service for our two towns, and make a profit on it. We have found out our mistake. There was no difficulty in making it cheap, but there were many difficulties in the way of making it satisfactory, and it was absolutely impossible to make a profit. None of us had any experience in the telephone business when we started. Now we have had quite as much as we want, and we consider ourselves lucky that it has not cost us more than it has. We began on the assumption that the expiring of the original Bell telephone patent made everything plain sailing; but we found that it takes much more than so many telephones to make a telephone exchange system. We thought that by mutually subscribing to the stock by building the lines ourselves, we could give good service at a low price. We sold our stock locally without trouble, as other people shared our views. We had a great deal of trouble in getting up our wires, the expenses were much greater than we had estimated, and we found also that various essential parts of a telephone exchange system were still subject to patent rights. As it was, the best apparatus that we could get from dealers who professed to be able to supply first-class material proved to be unsatisfactory, and after some months of trial it was found necessary to consider making a general change in the plant. This would have involved us in heavy extra expense, totally unprovided for in our plans."

LIGHTNING, HAIL, AND SNOW.

The last meeting of the Royal Meteorological Society for the present session was held at the rooms of the Royal Astronomical Society, Burlington House, on Wednesday afternoon, the 16th inst., Mr. E. Mawley, F.R.H.S. (president), in the chair. A paper by Mr. R. C. Mossman, F.R.S.E., on "The Non-Instrumental Meteorology of London, 1713-1896" was read by the Secretary. The author has gone through the principal meteorological registers and weather records kept in the Metropolis, and in this paper discusses for a period of 167 years the notices of thunderstorms, lightning without thunder, fog, snow, hail, and gales. The average number of thunderstorms is 9·7 per annum, the maximum occurring in July, and the minimum in February. The average number of fogs is 24·4, and of "dense" fogs 5·8 per annum. There has been a steady and uninterrupted increase of fog since 1841. The average number of days with snow is 13·6 per annum. The snowiest winter was that of 1887-8, with 43 days; while in the winter of 1862-3 there is not a single instance of a snowfall.

Mr. C. Harding gave an account of the hailstorm which occurred in the south-west of London on April 27, 1897. This accompanied a thunderstorm, in which the lightning was very vivid. The hail lasted only about 20 minutes, from 6.30 to 6.50 p.m., and in that short space of time the melted hail and rain amounted to about an inch of water. The districts affected by the hail were Tooting, Balham, Streatham, Tulse Hill, and Brixton. The ground was quite white with the hailstones, which in some places remained unmelted the whole of the next day.

Society of Arts.—The annual conversazione of the Society of Arts was held on Wednesday evening at the South Kensington Museum, which is one of the few places really capable of holding so large an assembly with comfort and still leaving space to spare. Major-General Sir Owen Tudor Burne, as chairman of the council, received the guests, who were exceedingly numerous. Music was provided by the band of the Royal Artillery in the North Court, by the Red Band in the Architectural Court, and by the Euterpean Ladies' Orchestra in the Textile Court; and in the lecture theatre Mr. George Grossmith lectured on musical form and composition, drawing-room elocution, poetry and the drama, and various other arts that are so very fine that they are not usually retained by the meshes of the society's very widely-cast nets.

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NORTHERN SOCIETY OF ELECTRICAL ENGINEERS.

The following discussion took place after the reading of the paper on "The Transmission of Power in Factories by Electricity," by S. V. Clirehugh, at the meeting of the above society on May 17, 1897. The paper was given in our issue of May 21 :

Mr. E. W. Cowan said he would not keep them long, because there were many visitors there, and it would be very much more interesting to hear them than to listen to a voice which was, unfortunately, heard too often in that room. To begin at the end of the paper, Mr. Clirehugh gave the dynamo losses in his table and the motor losses at 5 per cent. He did not believe that any dynamo had been built which would give an efficiency of 95 per cent., except on continuous runs at full load, and then it must be a very good dynamo indeed and very well designed. In practice the generator could not work at full load, but at the best must work at an average of 70 or 80 per cent. full load. As to the motor losses, he could not understand why Mr. Clirehugh imagined that these motors gave an efficiency of 95 per cent., and the only conclusion that he could come to was that he misunderstood the purport of that little table. If he had said 15 per cent. he would think he was putting it on the favourable side, considering all the starting and stopping and the low load at which he presumed those machines had often to run. On the subject of first cost they came to a very serious question—a question which concerned, he thought, manufacturers and consulting engineers alike. The first cost was much too high, and it certainly concerned them to reduce that cost if they possibly could. Consulting engineers should avoid putting in their specification clauses which unduly limited the temperature rise, and they should give a fair margin to manufacturers to work upon, and allow them to tender for motors which might be efficient and satisfactory in their work in every respect, sparkless and durable, and yet rise to a comparatively high temperature. Further, he found that the controlling arrangements and the gearing amounted in the second table to £60, whereas the motor cost only £69. He thought they should pay very close attention to this subject—they must reduce the first cost of the electrical plant. It was not so much the engine and dynamo, but in the motors and their switching gear where they must reduce the cost if they hoped to get hold of the very large business which was to be got hold of, not only in Lancashire, but all over the country. On the subject of gearing, he was surprised that the worm and wormwheel was spoken of as being in bad favour. He was under the impression that it had been recognised for some time that in connection with motor work, especially with lifts and cranes, the wormwheel was, when well designed and well made, an efficient apparatus, but unfortunately it was a very expensive one.

Mr. W. A. Chamen said he came there as a visitor to hear Mr. Clirehugh's paper, with which he was very pleased, and to hear the discussion on it. He did not know that he could give any information which would be of any great interest. His experience with worm gearing had been most disappointing, and he had not seen anything to give the results which Mr. Clirehugh gave in his paper. He would like to point out that when used in cranes or hoists they had the most favourable conditions for worm gearing, because the direction of thrust was always altering, and they could not possibly get continuous runs, but in continuous drives, such as with pumps, it was very far from satisfactory. Up to the present, if they went to all the makers they would not get one of them to guarantee an efficiency, and a great many would refuse to make worm gearing at all. Mr. Clirehugh made some remarks about the plant being capable of continuous running and not requiring duplicating. There was a good deal in what he said, but he had been into places driven by such steam-engines, and found the poor engineer almost tearing his hair because it was impossible to do even the most necessary and trifling repairs, and the engine was obliged to go on ripping itself to pieces until one day it was obliged to be stopped, and the whole place stopped also. He did not know that he should suggest that the plant should be in duplicate, but he thought there should be a sub-division. They all knew that it was the engine that required the stoppage, and not the dynamo. There was another point of Mr. Clirehugh's about the motors running from no load to 30 per cent. overload without moving the brushes. That was a very interesting statement, but he had not seen anything like it up to the present, unless it was a motor with Sayers winding. He believed that was very satisfactory. With regard to carbon brushes, Mr. Clirehugh had already done away with his objection to the views expressed in the paper by making a reservation in favour of carbon for use on motors which had to be reversed. He did think also, from some years' experience, that carbon brushes would be found to be more suitable than metal brushes in many cases because they did not require lubrication. Mr. Clirehugh spoke of having brushes running for six months, but he presumed some attention had been given to the commutators, and that some grease had been put on them. Of course with the carbon brushes, the carbon dust itself formed its own lubrication. Mr. Cowan had dealt with the points about the motor losses and cost of switch gear, and he agreed with him, but he would like to say that a great many people were complaining that the motors were all right, but that the switching gear was giving them trouble. Something like the sample in the room would probably be all right. Switches with a very large number of contacts worked well, but were expensive, and if made with a smaller number of contacts, keeping the total value of the controlling resistance the same, sparking was set up at the edges of the contacts, which soon ruined the switch. To get over this, an arrangement was introduced by his firm by which this spark between contacts was carried to another place where it could be dealt with by means of easily renewable sparking pieces. He had a transmission job in hand (concentric wiring) which might be interesting ; it was in London, and had nothing to do with a textile factory. The steam generator was to give 160 h.p., and the motors would drive all kinds of machinery, such as millstones for grinding white lead, fitters' shop tools, centrifugal pump, two blowers for blast furnaces. That would be a job which would give some interesting figures when completed. In that case he had arranged to use concentric wiring with the outer conductor earthed, although he had had some little discussion with the representative of the fire insurance office about it. He thought it was a better arrangement than that suggested by Mr. Clirehugh, as in his opinion it would be more permanent. He did not like wires stretched up unless they could be bare wires, which, however, could not always be used. He thought that concentric wiring with the outer conductor earthed would last a great deal longer than ordinary cables, and he doubted whether it would cost very much more in the first instance.

Mr. L. B. Atkinson said he thought that the society was fortunate in getting such a practical paper, and, in making some few remarks, he intended to confine himself to a few practical points, for which reason he would take them as they occurred in the paper. The author referred to the question of governing by means of automatic shaft governors. Governors were like a very great many other things, a matter of fashion, and he noticed that fashion was rather setting against shaft governors. He considered this was due, so far as it had a reason, to their generally being used to operate free-moving valve motions which were badly packed and had a large amount of steam leakage. In the same paragraph, with regard to ejector condensers, there was a little difficulty occurring in some cases, which might, however, occur with any class of condenser which was worked only when the engine was running. The engine must be capable of working at full power without the condenser, but in a case he was interested in, the engine was driving a pump and using the water that was pumped for the condenser, and before the condenser got the water the engine was not powerful enough to pump the water ; and thus the engine would not work, and they could not get any water at all. He quite agreed with Mr. Clirehugh in regard to the great difficulty that occurred in finding out the power that was ordinarily required ; this difficulty did not only occur in factories and mills, but in collieries and mining work, and it arose from the fact that if they were able to pin the people down to horse-power at all they were generally talking about the nominal horse-power—the result was they knew nothing of what they had to deal with. He had a case of some machinery provided for abroad ; the consulting engineers took care to bind the contractors down, and to test the machine before it went out, but when it got there it was found to be only about half the power that was required, because the purchaser had dealt with and specified the nominal horse-power of the engine previously used to drive the machinery. It was always well to find out what kind of horse-power was referred to with regard to the worm-gear. As Mr. Clirehugh referred to the appendix in Unwin's book as to the better design of worm-gear, he would like to make a few remarks, but he thought there was a gentleman (Mr. Holroyd Smith) there who could give them more information respecting worm-gear than he could. In 1889 he designed some worm-gear in accordance with the principles laid down in Unwin's appendix with very good results. He could not recollect the actual figures, but nevertheless he thought that Mr. Clirehugh had overrated the efficiency that was obtained with worm-gear. In some worm-gears which they tested at Messrs. Easton, Anderson, and Goolden's works some time ago, after running about a fortnight so that they would have settled to their permanent condition (they were about 6 h.p. or 7 h.p.), the reduction being from 700 revolutions per minute to 40 revolutions per minute, and the whole being enclosed in oil bath, the actual relation between the electrical power delivered and the power received on the slow-motion shaft as measured with a brake was about 71 per cent. There was thus 29 per cent. which disappeared, but even at that he thought the result was a good one. It was better than was expected. The specification gave 65 per cent. Another point : difficulty occurred with worm-gear when they got the larger powers, say, over 15 h.p., with regard to ball-bearing thrust, and he thought it was a great mistake to use them. They could not get all the balls of one size, and consequently the whole weight was thrown on, say, three balls. However, he hoped a little later on Mr. Smith would give them more information on the question of worm-gear. With regard to the table giving the relative efficiencies of belt-driven and worm-driven machines, he might be comparing the wrong columns, or it might be that his arithmetic was at fault, but, comparing the electrical horse-power hours in the worm-driven case with the electrical horse-power hours in the belt-driven case, he could not help thinking that the superiority of the belt over the worm-gear was incorrectly given. It appeared to him that the first case should be about 4 per cent., and the other case less than that. With regard to carbon brushes, ordinarily speaking, his own rule was that for any motor with carbon brushes, and for which carbon brushes were going to be used to keep sparking down, they must decrease the load by about 10 per cent. compared to the load with copper brushes. The reason that the carbon brushes were of use was that the energy which with copper brushes appeared as a spark, was with a carbon brush dissipated in the resistance of the carbon, or of the contact with the commutator. With a carbon brush there was a considerable amount of resistance at the contact,

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but when the carbon brush was used the commutator could be kept in better order. It had no advantage from the point of efficiency. They would find with ordinary carbons, if they used about 35 amperes per square inch, a fall of pressure of about one volt between the commutator and the brush. This fall of pressure with 100 volts was 1 per cent., and with 200 volts was ½ per cent., and since carbon brushes, even if they run perfectly sparklessly, are often on the position where ordinary brushes would spark, and therefore there was the same loss of efficiency through heating, which was the trouble with them. If they used high-conductivity carbon brushes then, so far as the suppression of sparking was concerned, the result was lost, and they came back to where they were with copper brushes. The author stated "that one secret of success and economy in electric power installations was to consider very carefully the machine they had to drive, and to spend a long time in its company." Everybody would agree with that. Some time ago he was asked to provide a motor to give a certain amount of power, and with it a switch which would enable it to be started and stopped in either direction. He did not know what the motor was to be used for, nor did he enquire, as there were other electrical engineers engaged on the matter, but very shortly after they had got it they started grumbling. They stated that the shaft was bent, and that the switch was burnt out. He found the motor was being used to screw down the setting rolls of a rolling mill, and it was started, stopped, and reversed about six times a minute, and they generally reversed it when running at full speed to stop it, with a result that they might easily imagine. The proper way would have been to keep the motor running continuously, and to throw clutches in and out. Coming to the table of efficiencies of power transmission, he did feel with Mr. Cowan that the table was a little over-rated. Granting that the dynamo would give 95 per cent. efficiency, he thought 5 per cent. for the motor losses was altogether out of the question for any motor such as was likely to be used in such instances as they were discussing. He thought, however, that 8 per cent. was a full allowance for gearing losses except with worm-gear. An ordinary motor which would give an average of 85 per cent. efficiency was a very good machine. He thought the paper was a very interesting one, and he was very glad to have heard it.

Mr. E. Holroyd Smith said he had not the slightest intention of speaking until he was called upon, but after his name had been mentioned he could not very well refuse. It gave him great pleasure to be at the meeting once more, and a greater satisfaction to find that their numbers had been increased. Looking broadly upon the question of the paper, he thought it was a question of producing power with a large engine or with a number of small ones. He did not think it was fair to compare the cost of, say, a 10-h.p. gas-engine and a 10-h.p. electric motor when the energy was supplied from a large generating station. It was simply a question of economics in the production and distribution of power. He was afraid that he could not give them much information on worm gearing without the aid of diagrams; it would require a somewhat lengthy paper to deal with so involved and interesting a subject. He was pleased to hear from Mr Atkinson that certain worm-gear with an electric motor driving it had given a combined efficiency of 71 per cent., because he was responsible for the design of the gear, which had to work under exceptionally difficult circumstances, and he did not expect, nor had he been prepared to guarantee, anything higher than 63 per cent. It was therefore a bit of pleasant news to him. He quoted the case of a worm-gear of some 15 h.p. with a reduction of 11 to 1 where the combined efficiency was 84 per cent., and he thought it would be rather a difficult matter to beat that. He considered the majority of engineers did not realise the care that was necessary to design worm gearing, and there was no reliable text-book in existence that properly treated the problem. If sufficient thought and care were bestowed upon the design and workmanship, nobody would repent employing it.

Mr. P. C Pope said that when Mr. Clirehugh commenced his paper he spoke about bleachworks and dyeworks as being the best examples for motive power. He thought if they took a ship-building yard it would be a better example. They would get greater distances, and he thought the tools used were heavier than those used in a bleachworks, and machines in the yard were also a great deal more scattered. There was an instance of this at Gray's, West Hartlepool, where he heard they had adopted electric driving and had reduced the number of their boilers, and were now using only half the coal they used previously. Colliery work was, he thought, a still better example for the application of power, coal-cutting, pumping, and hauling more especially. An even more advantageous use of electric driving was to be found in the application of machinery used intermittently, such as cranes and blowers for cupolas (which probably were not blowing more than about two hours a day), sawbenches, and wood-planing machines. The amount of labour required to look after a motive power plant was important. He knew of a case consisting of between 30 and 40 motors of sizes from half a unit to 35 units. The total output of all the motors was about 250 units. There were 50 arc lamps and about 1,000 incandescents, and the plant was worked perfectly satisfactorily with two men, one of whom received 30s. per week and the other 22s. They did not know anything about the theory of motors, but simply looked after the brushes, oiling, etc. If a bad breakdown occurred, which was very seldom, they engaged an expert. The motors were running day and night, and they had no trouble whatever with them. They ran sparklessly at all loads—no load to full load.

Mr. C. H. Wordingham said, for the same reason as Mr. Cowan, he did not wish to keep them very long, as there were many visitors there whom they would like to hear speak. There were one or two points, however, he would like to mention, and the first was in connection with the third paragraph of the paper, where Mr. Clirehugh said that power should not be distributed by means of a number of small motors, but rather that one large motor should be put down. Owing to the courtesy of one of his consumers, he was able to give a very striking instance of the correctness of that. This consumer now took current for a 23 h.p. motor, and they used on the average 20 units per day. While they were waiting for this motor to be made they used three small motors, with the result that they consumed 40 units per day for the same amount of work, so that the want of efficiency in that case was very strikingly shown. He could sympathise with Mr. Clirehugh as to the people who told him when asking for the power of a machine that they used, "that they used a pair of sixes." He had the same difficulty when finding out what power was required to drive mechanical stokers. He noticed in an American paper that the power taken by various machines, such as lathes and other tools, was largely over-estimated, that the motors put in often proved two or three times the size that they need have been. In connection with the worm-gear, he could in a somewhat different manner very fully bear out what Mr. Atkinson had said as to there being a limit to the size of machine for which ball bearings were desirable. He had had them running for a considerable time on a machine of moderate size, but on putting them in a machine 50 per cent. larger, all the balls smashed up. The difficulty seemed to be in hardening them to the proper amount. He thought that quite bore out what Mr. Atkinson had said as to their failure for heavy weights. With respect to enclosed motors advocated by Mr. Clirehugh, he himself not long ago was extremely taken with the enclosed motor, but he had recently modified his opinion on account of the heating being so very great. He had a case on the Manchester circuit where two 16-ampere motors of the enclosed type are used, and he thought, but was not certain, that they had carbon brushes. The consumer complained that he found these motors working much too slowly on Monday mornings. It struck him that this was very remarkable, and it occurred to him as just possible that the explanation might be that these motors got very hot during the week, and had not time to cool down at night, but had plenty of time during the week-end, and consequently the resistance of the field windings on Monday mornings was substantially lower. On testing them two weeks running, he found an enormous difference in the resistance of the field, and that actually did account for the motors running slow on Monday mornings. Coming to the question of cost, Mr. Clirehugh, perhaps naturally, only dealt with the cost where the power had to be generated by the consumer, but owing to the large extension of electric supply stations there were many cases in which power could be taken from public supply mains. There certainly seemed every prospect of its extending to an enormous extent in Manchester. At present they had not a vast amount of power, but it was just beginning to take root and to find favour. At the present time he thought they had about 133 motors, aggregating about 235 h.p., while they had 18 more motors, aggregating 150 h.p., applied for. The majority of these motors were supplied at 1½d. per unit, at which price electric power compared very favourably with either gas or steam. By the courtesy of the same consumer whom he had before referred to, he found that the 23½-h.p. motor put in was very much more economical than a gas-engine, and was actually costing less than about the same amount of power developed for similar purposes at a mill they had where steam power was used. The results were most encouraging. The consumer quoted as an advantage of electric driving over gas-engine driving, and also over steam, the great saving in floor space. For a gas-engine they would have required six times the space, and the steam-engine plant was taking 20 times the space, and in a city where land was expensive that meant an enormous saving in rent. They reckoned that they were saving £50 or £60 a year in floor space alone. The figures were obtained from an actual user, and the consumers were people who had gone into the matter thoroughly and had only their own interests to serve. They found that they gained a substantial reduction.

Mr. Clirehugh, in reply, said he did not think that anything had cropped up in the discussion which necessitated a long reply. With regard to the efficiencies of generators and motors which he gave, he was still of opinion that it was not unreasonable to expect an efficiency between the brake horse-power of the engine and the brake horse-power of the motor of 80 per cent. There had been a good deal of interesting discussion on worm gearing, a subject on which many speakers appeared to hold opinions diametrically opposed to one another. If worm gearing were as inefficient as certain gentlemen suggested, how was it that if you enclosed in it an oil bath and ran for 12 hours the oil was perfectly cool. One speaker said that they would lose 30 per cent. Assuming you had a motor developing 15 h p., his contention was that you lost about 5 h.p. in the gearing. This loss, if it existed, would very soon, it seemed to him (Mr. Clirehugh), bring the oil bath to boiling point. He was somewhat disappointed that no speakers had suggested other forms of gearing or discussed their efficiency. Mr. Atkinson's information on the subject of carbon brushes was most interesting, and explained the causes of the curious phenomena which were known to exist in connection with their use. With regard to Mr. Wordingham's remarks on the subject of the difficulty he had with the heating of enclosed motors, as he (Mr. Clirehugh) had pointed out in his paper, if you enclosed a motor you can only run it at 75 per cent. of its rated output if you wish to keep the same temperature rise. Of course, therefore, if you take an unenclosed motor which is doing certain work with a certain temperature, you cannot expect to do the same work with only the same rise when you enclose it.

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PHYSICAL SOCIETY.—June 11.

Mr. SHELFORD BIDWELL (president) in the chair.

A mathematical paper was read by **Mr. C. S. Whitehead** on "**The Effe t of Sea-Water on Induction Telegraphy.**" If a secondary circuit containing a telephone is rightly placed with respect to the field of a primary circuit traversed by an alternating current, signals may be transmitted over considerable distances. The author investigates the effect of filling the intervening space with sea-water; and, generally, the effect of a spherical conducting shell on the induction, at a point in a dielectric, due to an alternating current in a circular circuit, when the axis of the conductor passes through the centre of the shell. In the mathematical treatment two cases are considered: (1) to find the normal magnetic induction at any point in the dielectric outside the shell when a circular circuit carrying an alternating current is placed in the dielectric inside a spherical conducting shell; (2) to find the normal magnetic induction at any point on the remote side of an infinite conducting plate, due to a circular circuit parallel to the plate. In both cases the following result is arrived at: $\mu/\nu = e^{\eta t}$, where ν is the maximum value of the normal magnetic induction at any point outside; μ the maximum normal magnetic induction due to the current in the primary, supposing the conducting shell or plate absent, at the same point; t the thickness of the shell or plate; and $\eta = \sqrt{(2\pi p \phi/\sigma)}$, where p is the permeability of the conducting shell or plate; σ its specific resistance; $\phi = 2\pi$ times the frequency. If the frequency is 300, $\phi = 1885$. For sea-water, σ is taken as 2×10^{10} C.G.S. units, and $p = 1$. The sea-depth at the North Sand Head corresponds to $\eta = 2{,}000$cm. Hence, in this case, $\nu/\mu = \cdot 21$, or 79 per cent. is lost. Similarly, when $\eta = 1{,}000$, the loss is 54 per cent. The method employed in the investigation is that suggested by Lamb and Niven; the author adds an expression for Ω, the solid angle subtended by the circuit at any point, in terms of Bessel's functions.

Mr. Evershed referred to some experiments of his own, from which he concluded that the author's formula gave too low an estimate of the attenuation; the discrepancy indicated that some term had been neglected.

Mr. Yule doubted whether the equations given by the author were quite applicable to sea water. There was need, apparently, of a term involving the polarisation of the medium.

Mr. Heaviside communicated a criticism of the paper. It was not necessary to investigate the problem for any particular form of circuit from which the waves proceed. The attenuating factor for plane waves, due to Maxwell, was sufficient. Taking the best known value for the conductivity of sea-water, there was no reason why the conductivity should interfere with signalling. A considerably greater conductivity must be proved for sea-water before it could be accepted that the failure of experiments on telegraphic communication with lightships from the sea-bottom was due to that factor. It was unlikely theoretically; and Mr. Stevenson had contradicted it from a practical standpoint. For some reason, the account of the lightship experiments had not been published, so that there was no means of finding the real cause of failure.

Mr. T. H. Blakesley read a paper on "**A New Definition of Focal Length and an Instrument for Determining it.**" The author asserts the principle that the focal length of a lens-combination is an abstract quantity, not necessarily the distance between two particular points. It is a quantity best defined in terms of some function of the two distances of object and image from their appropriate focal centres. Such a function is the magnification factor, m, the linear ratio of image to object, positive if the image is erect with regard to the object.

Although **Dr. S. P. Thompson** characterised the paper as the most important contribution to geometrical optics that had appeared for many years, it will be seen that it hardly concerns our domain.

Dr. J. A. Fleming read a paper on "**A Method of Determining Magnetic Hysteresis Loss in Straight Iron Strips.**" The author's process is based upon the use of the bifilar reflecting wattmeter. The samples of iron, large or small, in the form of straight strips are inserted in a long solenoid. The solenoid is traversed by an alternating current, and the square roots of the mean square values of the current are determined by a Kelvin balance. A flat bobbin of fine wire may be slid along the strip; an electrostatic voltmeter connected to the ends of this exploring coil gives the square roots of the mean square values of the E.M.F. in that coil. From these measurements, and the known dimensions of the solenoid and coil, the induction density, B, can be found at any point of the length of the strip. From these results a curve is drawn, co ordinating the values of B to corresponding distances along the half length of the strip. Assuming the hysteresis loss per cycle per cubic centimetre of iron to vary as the 1·6th power of the maximum induction density, and then raising all the B ordinates to the 1·6th power, and plotting a new curve over the first, another curve is obtained which represents the variation of hysteresis loss per cubic centimetre of iron from point to point along the half-length of strip. Now, at some point along the half-length of strip there must be a section where the induction density is B_1, such that the true mean hysteresis loss for the whole bar is proportional to $B_1^{1\cdot6}$. Let this value of the induction density be called the "effective value," and the corresponding point in the strip the "effective point." Let $M \cdot B^{1\cdot6}$ stand for the mean ordinate of the curve representing the varying values of $B^{1\cdot6}$ all along the half-length. Then, evidently, $B_1 = \sqrt[1\cdot6]{(M \cdot B^{1\cdot6})}$. The following curious experimental result is found: whatever may be the length or section of the iron strip, the point at which the actual induction density has a value equal to the "effective" value always comes at the same proportional distance from the centre of the strip. This distance is very exactly equal to 0·56 of the half-length, as measured from the middle; or 0·22 of the whole length from one end. If, therefore, the secondary coil is placed at that spot, and the secondary voltage then observed is used to calculate the induction density, the value so obtained corresponds to the true mean value of the varying hysteresis loss per cubic centimetre all along the strip.

Mr. Carter asked whether roots other than the 1·6th gave a similar constant value of the induction density.

Dr. Fleming said it seemed to be the result of accident that the 1·6th root gave a constant value for iron.

The **President** proposed a vote of thanks to the authors, and the meeting adjourned until June 25.

COMPANIES' MEETINGS AND REPORTS.

HASTINGS AND ST. LEONARDS ELECTRIC LIGHT COMPANY.

On Friday afternoon an extraordinary general meeting of the Hastings and St. Leonards Electric Light Company, Limited, was held at the Queen's Hotel to confirm the resolution passed at the recent meeting: "That the shareholders approve the action of the directors in negotiating a sale of the undertaking to the Corporation of Hastings, and hereby authorise them to enter into a provisional contract with the Corporation for such sale, for the sum of £58,000, and they further authorise the directors to carry the same into effect at such time and in such manner as they shall think proper." Mr. F. A. Langham (chairman of the Board) presided.

The **Chairman** said this meeting was really a formal one to comply with the law, and he would not take up their time by making a speech, because the matter had been threshed out, he thought, very fully at the last meeting. But his attention had been called—and he expected, the attention of the shareholders, too—to a placard that had been stuck about the town, and a circular that had been sent round and, he believed, delivered at people's houses, in which the action of the Corporation had been criticised in no mild terms. It was hardly worth while noticing it, but now he had the opportunity—he should not have gone out of his way for it—he would just say that the attack was an anonymous one, by persons—he could not call them gentlemen, whether they were or not—who did not even have the pluck to put the printer's name at the bottom of it. Like all other anonymous things, it was worth but very little notice. He was not going to attempt to refute the statements made, inaccurate though many of them were. But if the parties who promulgated that document had the pluck to put their names to it—so that they could know with whom they were dealing—they might then enter the arena on fair terms. All he would say on the subject was that it smelt very strongly of gas. If they were people interested in the gas company, and they liked to put forward such statements, and add their names to it, it would be evidence of some—though very little—value. They could not expect a rival concern to be very pleased at what might mean a possible loss of business, and he quite understood their feeling in the matter. But if the documents emanated from some person or persons interested in the gas company, he would like to ask them one question: "Would they sell their concern for what it had been valued at?" They would reply: "Oh dear no; it would be simply ridiculous to talk of it. We have made a business by degrees, and sunk thousands of pounds in plant and other things." Their answer was the same. So far as he was concerned and his advice went, he would not dream of listening for one moment to any other offer than that they had already provisionally accepted. They had got a good thing, and if the town did not like to take it they would go on with it and make the concern pay. It would not be right to pass it over altogether, but he invited them to come out in the open, and then they (the electric light company) could protect themselves. For his part, he utterly despised these anonymous scribblers, stabbers in the back, and outside cowards, who had not the pluck to put their names to what they had written. He begged to move that the motion passed at the recent extraordinary general meeting be and is hereby confirmed.

Mr. H. G. Shorter seconded, remarking that it needed no comment from the shareholders. If the Corporation did not see fit to purchase, he was quite convinced if they continued with it it would be a very good thing.

The motion was then put and carried unanimously.

CALLENDER'S CABLE AND CONSTRUCTION COMPANY, LIMITED.

The first annual general meeting of this Company was held on Wednesday at the offices, 90, Cannon-street, E.C., Mr. H. Drake presiding.

The **Chairman**, in moving the adoption of the report, said that this was their first annual meeting since since the reconstruction of the old company. With reference to the results obtained by that, they had obtained the two objects aimed at: first, they had the additional capital required for the growing business; and secondly, they had put their share capital on a footing which would more truly represent the value of it than it did in its

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former condition. As regarded the balance-sheet, they would notice that the trade creditors were stated at £32,246, in the last balance-sheet they being stated at £49,768. He thought this an indication of the benefit they had had from the increased capital. On the other side they had got property £102,180, as against £71,741. This, of course, was naturally increased by the increase of the share capital. They proposed to write off from that £3,000, so that it would be reduced in future balance-sheets to £99,180. The stock in hand was very much the same. The next item was the shares in other companies, £8,800. That represented the value at the time the balance was made up, being December 31; but since then some of those shares had increased in value and could be realised at several thousand pounds beyond the amount at which they now stood. Then as to the item of "expenditure on works in progress." In the last balance-sheet this stood at £63,045; in this balance-sheet, however, adding it to the "expenditure on contracts and costs of execution," it amounted to £73,981. Bills receivable and cash in hand stood at £15,229, as against £4,748 at the end of 1895. The only other observation about the accounts he had to make was that they had no bad debts. All their business was done with corporations or first-rate companies, so they did not know what it was to make a bad debt. It was proposed to apply the profits made last year, after writing off £3,000 for depreciation of machinery and deducting the interest on the debentures, to declare a dividend for the year at the rate of 10 per cent., of which 4s. per share had already been paid. That would amount to £10 000. It was also proposed to write off the amount standing against the expenses of reconstruction, £3,000, and to carry forward a balance, £333. With regard to the statement in the report that considerable expenditure had been incurred for new plant and buildings at the factory, the business was increasing so much that they had to be in a position to cope with it. Every improvement was being made so that the business could be carried on with as much saving of labour as possible.

Lieut.-Colonel G. A. Elliot seconded the motion, which was adopted.

Mr. T. O. Callender (managing director) said he had very little to say about the business of the Company, except that at the present time they had a great rush of work. It was not a question of getting work, but of taking the best of the work offered to them. The Company had never been so busy before. Several departments of the works down at Erith were going night and day, and even then they were dropping behind with their orders. He looked forward to the time when still further additions would be made to the machinery. They were already taking orders at the new rubber factory, but were not particularly anxious to push it, in view of the competition that existed. They believed in going along slowly and making their own trade in the proper time. Their own material was getting, if anything, still further in favour with those who had the placing of orders, and they had, he thought, showed the superiority of vulcanised bitumen for the work. Wherever they had carried on their work it had been thoroughly satisfactory, and they intended that everything they did should be absolutely the best. Their business had been mostly confined to England, but they were doing some foreign work, though not much, as they found it better to stick to that which was at hand rather than go abroad for less safe business, and business that was more difficult to carry out.

The retiring directors (Mr. Henry Drake and Mr. D. P. McEuen) were re-elected, as also was the auditor, Mr. J. Worley, F.C.A.

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Mayence.—Tenders for the supply of 300 tons of galvanised iron wire will be received at Mayence on June 24 by the Grand-Ducal Railway and Telegraph Authorities.

Madrid.—The Spanish Government Post and Telegraph Departmental Authorities will receive tenders at Madrid on July 12 for 20,000 battery zincs for telegraph work.

Bucharest.—Tenders will be received at Bucharest on June 25 by the Roumanian State Railway Departmental Authorities for the supply of Morse telegraphic paper strips.

Louvain (Belgium).—Tenders will shortly be receivable at the office of the Postmaster, Louvain Centre, for the completion and maintenance of a post, telegraph, and telephone building.

Wigan.—The Baths Committee require tenders for repairing and renewing the electric bells at the public baths. Particulars may be obtained from Mr. J. J. Charnock, town clerk, Wigan.

Willemsoord (Holland).—Among a large number of other stores, tenders for the supply of telegraphic instruments will be received at Willemsoord on June 23 by the Dutch Navy Authorities.

Lyons.—Tenders will be received on June 23, at the Prefecture of the Rhone, Lyons, for the installation of the electric light at the lunatic asylum at Bron. There are two contracts of about £4,000 each (estimate).

Barcelona.—Tenders are required for the supply of hydraulic motors and accumulators for the harbour works. Particulars of the Harbour Board, Junta del puerto de Barcelona, or the Casa Lonja, Barcelona.

Ghent.—The city of Ghent has put out for competition the electric tramway service. Particulars are obtainable on application to le secretariat de la ville de Ghent, Belgium, and tenders must be in by July 2.

London, E.C.—Tenders are required for the supply, delivery, and erection of four separate duplicate electric lighting plants. Lighting capacity, 2,000, 4,000, and 5,000 lights. Delivered at Sydney, N.S.W., Australia. Apply to Mr. Henry Goodwin, Anderton's Hotel, Fleet street, E.C.

Blackpool.—The Tramways Committee require tenders for supplying two bogie tramcars. Specifications can be obtained, and cars of the type required can be seen, on application to Mr. John Lancaster, manager, Tramway Depôt, Blundell-street, Blackpool. Tenders to be sent in, addressed to the Chairman, Tramways Committee, by June 21.

Neath.—The Corporation invite tenders of rental for the working by horse or mechanical traction of the existing line of tramways about to be reconstructed by the Corporation, extending from Skewen to Briton Ferry, through the market town of Neath, a distance of about 4¼ miles. Tenders, marked "Working of Neath Tramways," are to be delivered by 28th inst. to Mr. Edwin C. Curtis, town clerk.

Rio de Janeiro.—The Secretary of State for Foreign Affairs has received a despatch from H.M. Consul-General at Rio de Janeiro enclosing a translation of an official notice setting forth the conditions under which tenders are invited for the telephonic service of that city and its suburbs. The tenders are to be presented by June 30, and the conditions may be inspected at the Commercial Department of the Foreign Office any day between 11 and 6.

Dover.—The Town Council invite tenders for the erection of a car-shed at Buckland. Forms of tender, specification, and schedule of prices may be obtained on payment of £2. 2s. (returnable on receipt of a bona fide tender), and conditions and drawings inspected at the office of the borough engineer, Mr. Henry E. Stilgoe, A.M.I.C.E., Town Hall, Dover. Tenders, endorsed "Tender for Car Shed," to be sent to Mr. E. Wollaston Knocker, town clerk, Castle-hill House, Dover, by 12 noon on 29th inst.

Treeton (near Rotherham).—The following contracts are advertised by the Treeton Parish Council: (1) a contract for the supplying and fixing plant, apparatus, and materials for lighting certain streets and roads in the parish of Treeton by means of electricity; and (2) a contract for the supplying electricity for 1,000 hours per annum, and working, repairing, and renewing the plant for 30 years. Any persons or companies willing to undertake the said contracts, or either of them, may make proposals for that purpose, which will be considered by the Parish Council on 24th inst. The proposals should be delivered or sent in writing to Mr. S. Fiske, clerk, Treeton, near Rotherham, before 24th inst.

Hull.—Tenders are required by the Corporation for the following works in connection with the electric lighting extension—viz., (Contract No. 10) foundations and buildings; (11) steel roofs, tanks, etc. The weight of steel in roofs is about 20 tons, and the capacity of tank (which is of steel plates) is 30,000 gallons. Forms of tender, specification, and quantities may be obtained of Mr. A. E. White, borough engineer, Town Hall, Hull. A limited number of blue prints of the three contract plans for Contract No. 11 will be supplied on payment of 10s. (not returnable). The prints will not be ready before 12th inst. Tenders, endorsed as directed on the form of tender, are to be addressed to the Chairman of the Electric Lighting Committee, and delivered at the Town Clerk's Office before 10 a.m. on 24th inst.

Inverness.—The Highland Railway Company require tenders for the following among other articles, in such quantities as they may require, from July 1, 1897, to June 30 1898, delivered free of all charges, viâ Dunkeld, at the company's storehouses, Inverness: galvanised telegraph wire, telegraph instruments and fittings, and telegraph construction material. Forms of tender may be obtained on application to Mr. J. G. Bulmer, stores superintendent, Inverness. Tenders, properly endorsed, sealed, and addressed to the Directors, must be lodged with Mr. Wm. Gowenlock, secretary, Inverness, by 19th inst Separate forms of tender will be provided for each contract; parties are therefore requested to specify the particular contract or contracts in respect of which they propose to submit tenders. Patterns can be seen at the stores warehouses, Inverness, but cannot be sent away for inspection.

London, S.W.—The Metropolitan Asylums Board require tenders for lighting the Grove Hospital, Tooting-grove, Lower Tooting, S.W., by means of electricity, according to drawings, specification, and conditions of contract prepared by Mr. A. Hessell Tiltman, architect, of 6, John-street, Bedford-row, W.C., where the drawings may be seen, and a copy of the specification and form of tender obtained, on and after 12th inst., between 10 a.m. and 5 p.m., upon payment of a deposit of £10 in gold or Bank of England notes, which amount will be returned to persons sending in bona fide tenders and returning the specifications. Tenders, sealed and endorsed "Tender for Electric Lighting, Grove Hospital," must be delivered at the Chief Offices of the Board, Norfolk House, Norfolk-street, Strand, W.C., by 10 a.m. on 23rd inst. Mr. T. Duncombe Mann, clerk, Norfolk House, Norfolk-street, Strand, W.C.

RESULTS OF TENDERS.

St. Pancras.—The Vestry have accepted the tender of Messrs. Benham, Limited, Wigmore-street, W., at £425. 14s. 6d., for carrying out the electric lighting at Whitfield-street Baths. The Vestry have also accepted the tender of Messrs. Ingles and Warner, of Sett-street, Stalybridge, in the sum of £500, for the supply of boiler seatings, main flues, etc., in connection with the two additional boilers to be supplied to the King's-road electric station.

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BUSINESS NOTES.

Erratum.—The paragraph headed "Blackburn" in last week's issue related to Rochdale.

Nuneaton.—The works of the Nuneaton Electric Light Company have been formally opened, and current is now being supplied.

Southampton.—The Town Council have appointed a deputation of three members to attend the Municipal Electrical Engineers' meeting at Manchester.

Obituary.—The announcement that Mr. W. S. Graff Baker died suddenly on 1st inst. will be received with a great deal of regret by a large circle of friends.

Jubilee Holiday.—The Edison and Swan Company have decided to close their works on Jubilee Day and give a full day's pay to all the men and girls they employ.

The Brussels Exhibition.—The British section of the Brussels International Exhibition was opened on Friday, in the presence of Sir Francis Plunket, British Minister to Belgium.

National Telephone Company, Limited.—This Company are issuing 130,766 5 per cent. non-cumulative third preference shares of £5 each by tender, at the minimum price of £5. 15s. per share.

Price List.—Messrs. Miller and Woods, of 2, Gray's-inn-road, have sent us a useful price list of transformers of which they are the original designers, patentees, and sole makers. The illustrations are very effective.

Coatbridge.—A copy of the electricity company's statement of accounts was submitted by the secretary at the meeting of the Town Council, and Councillor Lavell and the Chamberlain were asked to examine it as formerly.

Telegraph Staff Grievances.—The Duke of Norfolk has arranged to receive a deputation from the Central Telegraph Office to hear the objections raised by the staff respecting the recommendation of Lord Tweedmouth's Committee.

Hastings.—The electric light company have confirmed the resolution approving of the sale of the undertaking to the Corporation. A report of the meeting appears under the heading "Companies' Meetings and Reports."

Madras.—The overhead system having been sanctioned on the section of the Madras Electric Tramway line extending from the beach to Egmore, the materials for carrying out the same have arrived and the work is being taken in hand.

Liverpool Overhead Railway.—The traffic receipts of this railway for the week ended June 13 (including Whit Monday) amounted to £1,857, as compared with £1,176 in the corresponding week of the previous year, being an increase of £618.

Bristol Tramways and Carriage Company, Limited.—The traffic returns for the week ended June 11 were £3,365. 1s. 5d. (Whitsuntide) compared with £2,146. 3s. 11d. for the corresponding period of last year, being an increase of £1,218. 17s. 6d.

Peerless Accumulator Syndicate, Limited.—This Company has been registered, with a capital of £15,000 in £10 shares, to adopt an undescribed agreement, and to carry on the business of motor cycle, motorcar, and carriage manufacturers, electricians, etc.

Keighley.—The Town Clerk reported at the Town Council meeting that, under instructions from the Gas Committee, he had informed a private company that the Corporation would strongly oppose all attempts by outsiders to seek powers to supply electricity within the borough.

Leamington.—At the Town Council meeting a letter from the Midland Electric Lighting Company, intimating that they were about to apply to the Board of Trade for a provisional order in regard to the lighting of Leamington, was referred to the General Purposes Committee.

Mexico.—According to a recent dispatch from Cordova, Mexico, the electric railway between that city and Jalapa is approaching completion, 2,000 men now being employed on the work. This, it is stated, will be the first electric railway in Mexico, and it is to be 75 miles in length.

City and South London Railway.—The returns for the week ended June 13 were £880 compared with £877 for the corresponding period of last year, being an increase of £3. The total receipts for the half-year 1897 were £24,215, compared with £22,342 last year, being an increase of £1,873.

Bristol.—At the Town Council meeting, Councillor Pearson moved the adoption of a report from the Electrical Committee recommending that the salary of Mr. F. W. Prosser, the secretary and accountant of the committee, be increased by annual instalments of £25 until it amounts to £250 per annum. This was carried.

Cable Construction.—It is announced in San Francisco that the Hawaiian Government, having refused to renew Mr. Spaulding's contract for the construction of a cable to the United States coast, is now anxious to treat with any parties making a definite proposal. It is hoped that a cable link may be formed between Canada and Australia.

Halifax.—At the meeting of the Town Council, the salary of Mr. T. P. Wilmshurst, electrical engineer, was advanced from £250 to £300. The Tramways Committee reported that they had instructed the borough engineer to prepare specifications for steel rails, etc., and had also resolved to invite tenders for the supply of car frames and electrical equipment.

Presentation.—A few evenings ago the members of the Brighton and Preston Constitutional Club gave a complimentary dinner to Mr. F. Cox, who has been promoted from the post of superintendent of the Brighton Telegraph Department to that of postmaster of Newark. They also presented him with a gold-mounted umbrella and drinking flask and a meerschaum pipe.

Poplar.—Mr. F. J. Warden-Stevens, we announced last week, is the consulting engineer for the electric lighting, etc, of the Poplar Workhouse. Since his appointment he has been requested to combine in his report the subject of steam and hot-water arrangements for an extra fee of £10. 10s. This is not the fee for the full report, as might be understood from last week's notice.

Norwich.—At the meeting of the Eastern Highways Committee, the Clerk reported that the promoters of the Norwich Electric Tramways Bill had withdrawn Tramways 2 and 3, which were those in Thorpe, and which the Highways Committee had intended to oppose. The tramways company would pay £15 as costs, and he hoped the excess of costs for the county to pay would be very small.

Walsall.—On the recommendation of the Electric Lighting Committee, and with the view of meeting the increasing demand for electric current, the Town Council have agreed to provide an additional transformer and transformer station, with all necessary cable, in Park-street, and also a condensing plant for the generating works in Wolverhampton-street, at a total estimated cost of £1,850.

Newington.—At the next meeting of the Vestry Mr. Hester will move, "That as the returns of the Vestry election show that the majority of the electors in the compulsory area are opposed to the electric lighting scheme, this Vestry does not deem it advisable, in the face of such opposition, to run counter to the expressed views of the electors, and therefore declines to proceed with the electric lighting scheme."

Torquay.—The Ratepayers' Union have held a special meeting and passed the following resolution: "That this meeting is strongly of opinion that the introduction of the proposed electric tramway along the Torbay-road will be injurious to the town, and that steps be taken to oppose the same should it be determined to proceed with it; and that it be left to a committee to decide on the measures to be taken."

Weston-super-Mare.—At the Urban District Council meeting the Chairman remarked that three more applications had been received for the appointment of consulting engineer to the Council. It was unanimously resolved that a meeting be held to consider such applications at the earliest possible date, Councillor Clark remarking that if the Council did not arrive at a speedy decision they would be receiving applications from all the "scum and ragtag" of the electric lighting profession.

Llandudno.—An exhaustive report was read at the Urban District Council meeting from Mr. A. H. Preece and the Electric Light Committee as to the proposed scheme for lighting the town by electricity, and the provision of a refuse destructor. The committee recommended that application be made to the Local Government Board for sanction to borrow £25,000 to carry out the proposed works. Mr. Marks moved the adoption of the report. Mr. Bevan seconded, and it was carried.

New Showrooms.—Messrs. S. Newton and Co. inform us that they have now opened showrooms at 1, High-street, Clapham, S.W., and in future all business will be conducted from this address, instead of from Clapham-road. They have been appointed South London agents for Messrs. Crompton and Co., Limited, London and Chelmsford, and they will keep a stock of their goods, and be able to give to the trade the full discounts on their supplies. They also keep a varied stock of fittings, etc.

Aberdeen.—At the meeting of the Police Workshops Committee of the Town Council, the question was discussed whether gas fittings or wiring for electric lighting should be introduced. Gas fittings would cost about £100, and electric fittings, including four standards for the courtyards, were estimated to cost about £250. It was resolved to instruct Mr. Lynam, assistant burgh surveyor, to have specifications drawn up, and to invite estimates for electric lighting before a decision was come to.

Outing.—The members of the Ediswan Fire Brigade spent Whit Monday at Hardwick, Bury St. Edmunds, where, in a series of fire brigade competitions, arranged in connection with a grand fête and gala, they carried off practically all the prizes which it was possible for one brigade to obtain. The competitions were open to brigades in Suffolk, Norfolk, Essex, Cambridgeshire, and Middlesex. The Ediswan Brigade is one of those chosen to appear in the fire brigades display before her Majesty the Queen at Windsor, on the Friday following Jubilee Day.

The Trans-Pacific Cable.—According to an interview published in the *Daily Mail*, a Canadian says: "Our people are desirous that this should be an entirely British business. They earnestly appeal, in fact, to British enterprise not to neglect the opportunity of forging what will in British hands be another link in the Imperialistic chain of mutual interest. We believe that if Mr. Laurier and Mr. Chamberlain discuss this matter together they may be able to devise some method for placing the whole question in its true light before the British people."

Personal.—Mr. Chas. Downie, who six months ago resigned his position as manager with the Edison-Swan Company, has now, in conjunction with Mr. F. W. G. J. Adams, commenced business at 24, Newman-street, Oxford-street, under the style of Downie and Adams. The business will be that of electrical suppliers, but their special lines will be incandescent electric lamps, electricity meters,

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electric safety lamps, and primary batteries. They have associated with them in the business Mr. G. C. Murray, who has been with the Edison-Swan Company for many years as London salesman.

Yarmouth.—Mr. C. H. Wiltshire, at the Town Council, said he observed that last year there was a deficit on the electric light works for the year ending March 31 of £726, and in the previous year it was £766. Was there to be a constant loss of £700 a year? He complained that the Council were furnished with no details as to the position of the undertaking. If the chairman of the committee would promise a return he would be satisfied. Mr. R. Martins said that full particulars were always furnished in the monthly reports. Up till this month they had always been given.

Acton.—Our announcement last week to the effect that Mr. Warden-Stevens had offered to prepare a full report for the District Council on electric lighting and refuse destruction for a fee of £15 was not quite correct. We understand Mr. Warden-Stevens has proposed to prepare a report advising the Council as to the best course to pursue *re* establishing electric lighting and refuse destructor works for a fee of £15. 15s. This report would embrace particulars which would be sufficient to assist the Council in coming to a decision as to the advisability of proceeding with a scheme.

Bradford.—At the meeting of the Town Council, Mr. C. Crabtree (chairman of the Parks Committee) moved the adoption of the minutes of that committee, which was seconded by Mr. H. Duckworth, and carried. The minutes showed that the committee had "considered a largely-signed requisition from ratepayers in the borough asking that the band-stand, conservatories, and promenades at Lister Park might be illuminated with electricity, and an offer by the Lister Park Band Committee to contribute £100 towards the cost of the installation; whereupon it was resolved that the requisition be not entertained."

Nottingham.—At the Town Council meeting Alderman Brownsword moved the adoption of a report of the Parliamentary Committee for the purchase, at a cost of £80,000, of the Nottingham tramway undertaking upon terms which have already been published. He did not consider it necessary to make any remarks upon the matter, because the whole of the circumstances had been laid before them, and the vote had been unanimously adopted. He, therefore, formally moved the acceptance of the report. Mr. McCraith seconded, and the resolution was adopted without discussion.

The Birkenhead Tramways.—The special committee appointed by the Birkenhead Corporation to consider the question of the tramways have presented a lengthy report in favour of the overhead trolley system, and recommending the Council to accept the terms offered by Mr. Ross to work the tramways. At to-day's meeting of the Council a communication will also be submitted from the secretary of the Simplex Electric Tramway Conduit Syndicate, Limited, Castle street, Liverpool, containing certain proposals in respect of leasing the tramways and equipping the same on the Simplex system of electric traction.

The Barcelona Trams.—The Madrid correspondent of the *Times* says: "After a keen competition at a public tender, principally between an English and Belgian firm, a concession has been granted to the former to lay a network of tramways, to be worked by electricity, uniting Barcelona with the surrounding districts. The total length will be about 40 miles, and the capital involved about £1,000,000. This, I understand, is the first concession granted in Spain for the establishment of a new line of tramway by electric traction. It is to be worked on the overhead system—a rather bold innovation for a populous city like Barcelona."

Bath.—At the meeting of the Surveying Committee, Alderman Sturges said the Electric Lighting Committee met that afternoon and would take into consideration the suggestion contained in the report as to the hours of lighting. At present they had a table under which the light was switched off and on at definite times each night. It often happened that some nights and mornings were darker than others, so that it was desirable Mr. Metzger's representative at the works should have authority to vary the time of lighting up and turning off the light according to circumstances. He could see no difficulty in adopting such a course.

Colwyn Bay.—Letters were received at the District Council meeting from Mr. Bennett and Messrs. Fawcus and Clirehugh, both of Manchester, respecting their schemes for lighting Colwyn Bay by electricity and providing a refuse destructor. Mr. Blud moved that Messrs. Fawcus and Clirehugh, Manchester, be appointed, subject to their terms being satisfactory. He wished to state publicly that the time during which the Council received schemes from rival competitors had not been extended through the action of any of the officials, as certain competitors had intimated. Mr. Bevan seconded the resolution, and it was carried.

Maidenhead.—At the meeting of the Town Council it was reported that a letter had been received from Messrs. Pritchetts and Gold, electrical engineers and contractors, asking whether the Council would be willing to consent to their application to the Board of Trade for a provisional order for electric lighting, and intimating that they were prepared to apply, with the consent of the Council, for electric lighting powers, or in the event of the Council deciding to obtain a provisional order to negotiate with them for a transfer of their powers thereunder. The town clerk was directed to inform Messrs. Pritchetts and Gold that the Council intend to apply for a provisional order; and that, at present, the question of transferring their power, if such order be obtained, cannot be entertained.

Electric and General Investment Company, Limited.—The directors have decided to recommend to the shareholders the payment of a further dividend upon the ordinary shares at the rate of 40 per cent. per annum for the six months ended May 31 last, making, with the interim dividend at the rate of 10 per cent. per annum already paid, a total dividend of 25 per cent. for the year, and also to recommend a dividend of £30 on each founder's share for the year. The trustees for the founders' shares reserve fund propose to distribute to the holders of such shares a sum of £20 per share for the year, out of the proceeds of investments sold, and dividends received in respect of the founders' reserve fund, making, with the before-mentioned dividend, a total distribution of £50 on each founder's share. The dividends, etc., to be payable on July 3.

Burslem.—A communication was received at the Town Council meeting from the Board of Trade enclosing a copy of an application which had been received from Mr. Godfrey, acting on behalf of the North Staffordshire Tramways Company, for the consent of the Board to the use of steam power on the above-named tramways for a further period of one year, and the Corporation were requested to state whether the Burslem Corporation had any objection to the time being extended. Alderman Lawton said the tramways company were taking steps to give a service of trams to be worked by electricity. It would be awkward to prevent them running by steam till they completed their arrangements for working by electricity. He moved that the consent of the Corporation be given for the extension of the use of steam for another year. Mr. Edwards seconded the resolution, and it was passed.

Leatherhead.—At the Urban District Council meeting the Fire Brigade Committee recommended that the National Telephone Company's offer to erect electric communication between the fire station and the residences of the firemen in consideration of a payment of £12 a year for five years be accepted subject to the Council being satisfied as to the terms on which the company will make communication with houses of any other men who may join the brigade during the currency of the contract. The Clerk read a letter from the company as to the rates for making additional connections to the fire alarm circuit, stating that the cost would entirely depend upon the necessary work in each case. Providing the new residence was within 200 yards of the existing main circuit, the charge would not exceed £1 per annum per bell. On the motion of Mr. Dearle, seconded by Dr. Davis, the recommendation was adopted.

Cardiff.—The Town Clerk raised the question at the County Borough Council whether, in view of the fact that they would have to promote a Bill to acquire Cathays Park, and would have to obtain a provisional order from the Local Government Board to extend their boundaries, it would not be policy to drop the electric tramways scheme for another year, as it would be very difficult for the staff to carry out all three schemes at the same time. Alderman Carey suggested that the town clerk should bring the matter up in the form of a report. They wanted to push the matter of electric traction on as speedily as possible. The extension of the boundaries scheme would, he was afraid, go on much longer than the electric traction. The Town Clerk thought it would be better not to overload themselves, as they might find at the last moment they would have to drop one of the schemes, and that would not be satisfactory. No resolution was come to.

Liverpool.—The *Courier* says it is evidently not the intention of the City Lighting Committee to unnecessarily delay the introduction of a new system of traction on the tramlines. As the result of their visit to some of the principal cities on the Continent, the deputation representing the Corporation have a considerable amount of knowledge of the various systems to guide the committee in their deliberations. From the information thus obtained of the relative value of the different kinds of traction in use, Liverpool should derive a great deal of benefit. At the meeting of the Lighting Committee, a communication was received from the Tramways Committee requesting the committee to report as to their ability to provide the necessary electric power for the proposed experiment of an electric tramway line on the Prince's-park and Dingle route. The request was acceded to, and the city electrical engineer was instructed to report fully upon the subject.

Cardiff.—Mr. Appelbee, chief electrical engineer, has reported to the Lighting Committee that the demand for electric lighting in the borough was continually increasing. There were now 1,123 lamps ordered waiting connection. The demand thus exceeded the supply, and the present generating machinery was taxed to the utmost. The contractors, however, are pushing forward the new plant. At present there are 14,113 lamps supplied, an increase of 1,601 over the number of the corresponding month in last year. The electricity supplied last month was represented by 28,806 Board of Trade units, an increase of 7,483 units over that in May, 1896, while the estimated revenue for the past month was £429. 19s. 6d., as against £340. Mr. Appelbee estimated that the union workhouse could be supplied with electric lighting by the Corporation at a cost of £420, which was but £70 more than was now paid for gas at the institution. The engineer's estimate was gone into in detail and approved.

New Electric Railway.—According to a contemporary, there now seems to be every probability that the projected underground electric railway from Moorgate-street, London, to a point near Finsbury Park, where it would effect a junction with the Great Northern Railway, will be carried out. The scheme was originally brought forward in 1894, but was not proceeded with, on account of the death of the contractor. Since then, however, an arrangement has been made for the construction of the line, and with this object in view the promoters have introduced a Bill to authorise an extension of time for the execution of this project. The preamble

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of the Bill has already been proved before a Select Committee of the House of Commons. Among other matters in connection with the Bill is to be noted the proposal to partially substitute brick or other materials for lining the tunnels in lieu of the use of iron tubes. The gauge of the line will be the same as that of the Great Northern Railway, and the trains of the latter will travel over the new electric railway.

Islington.—At the meeting of the Vestry last week Mr. Pontin asked the chairman of the Electric Lighting Committee to state the number of private householders and shopkeepers who had availed themselves of the electric lighting installation. Mr. Lambert replied that in the compulsory area—from The Angel to Finsbury Park—there were 870 business premises. Out of that number 161 had been connected with the mains. There were in the same area 120 private houses, and of that number nine had been connected with the Vestry's mains, or 17 per cent. An extraordinary meeting of the Vestry is to be held to-night to consider the following resolution to be proposed by Mr. J. T. Johnson: "That the original plan for the decoration and illumination of the Vestry Hall on the 22nd inst. prepared by Mr. Gay, the electrical engineer, and submitted to the Parliamentary and General Purposes Committee on the 11th inst., be approved and adopted, and that he be authorised to carry out the same, or so much thereof as the time will allow of."

Hartlepool.—Messrs. T. Richardson and Sons, marine engineers, of Hartlepool, have added an electric power branch to their already extensive business, and have concluded an arrangement for the sole representation of Messrs. Brown, Boveri, and Co, of Baden, Switzerland, in this country. Messrs. Richardson will be advised on all electrical matters by Mr. C. E. L. Brown, head of the firm of Messrs. Brown-Boveri, who is well known in connection with the electrical exhibition at Frankfort in 1891, when he designed and executed successfully the scheme for transmitting power on a commercial scale from a water-power station at Lauffen-on-the-Neckar to Frankfort, a distance of 100 miles. Mr. Brown has also designed and executed power plants of upwards of 100,000 h.p. in all parts of the world. Arrangements have also been made whereby Messrs. Richardson are licensed to manufacture under the various patents of Mr. Nikola Tesla. The electrical department will be managed by Mr. C. F. Higgins, late chief electrician to Messrs. Brown-Boveri, and who is at present superintending the completion of the installation by which Messrs. Richardson's works at Hartlepool will be driven.

Plymouth.—The Tramways Committee have had under consideration a report by Mr. J. H. Rider, the Corporation electrical engineer, on the equipment of the tramways for electric traction. The distance from the Theatre Royal to Laira Bridge-road is 2,725 yards, equal to 5,450 yards of single track. The estimated cost of equipment of this section is £7,500. Of this sum £3,300 is for the overhead construction, £3,750 for five cars fitted with motors, and £450 for bonding the rails. The latter work has already been done. To equip the line from Compton to the Promenade Pier, which has a length of 9,620 yards (5½ miles) of single track, and for which nine additional motorcars would be required, would cost about £12,500 more. The cost of working the Prince Rock section alone works out at 5d. per car per mile, and of the whole system at 4d. per car per mile; or, if the capital charges are included, at 6¼d. and 5¼d. per car per mile respectively. The Tramway Committee recommend that the Prince Rock section be equipped for overhead electrical traction, and that application be made to the Local Government Board for power to borrow £7,500 for the purpose.

Mont Cenis Power and Land Company, Limited.—This Company was registered on May 28, by Burn and Berridge, 11, Old Broad-street, with a capital of £200,000 in £1 shares, to assume as its first operation the concession for the deviation of water from the Mont Cenis Lake in Italy, in view of the utilising of the same for the development of electrical energy in conformity with the demand of concession presented to the Prefecture of Turin, Italy, on December 28, 1896, by Commendatore Luigi Della Beffa, in the name and on account of the Continental Water and Electrical Power Syndicate, Limited, and to carry on the business of an electric supply company in all its branches. The signatories are: C. Luff, Woodham, Addlestone, Surrey; G. Beeson, 2, Clarendon-terrace West; E. Sorrell, 50, Idmiston-road, Stratford, E.; W. Johnson, 87, Edith-grove, Chelsea; G. O. Roas, 167, Cromwell-road, S.W.; S. E. Newman, 72, Romilly-road, Finsbury Park; R. Humphreys, 39, Berger-road, South Hackney. The number of directors is to be not less than two nor more than seven; the subscribers are to appoint the first. Qualification, £500. Remuneration, £200 each per annum. Registered office: 65, New Broad-street, E.C.

Worcester.—At a meeting of the County Council the Chairman (Mr. Willis Bund) said negotiations were still proceeding relative to the agreement proposed to be made with the City of Birmingham Tramways Company regarding the tramways which the company were desirous of constructing along certain of the county main roads in the parishes of King's Norton and Northfield. The Highways and Bridges Committee were substantially in agreement with the promoters of the scheme, but having regard to the alterations made in the Bill in the House of Commons, it would be necessary to modify the agreement which had been arrived at, and the committee, therefore, recommended that steps be taken to safeguard the interests of the County Council when the Bill went to the House of Lords. The chairman added that he hoped they would arrive at an understanding, not only with the promoters of the Bill, but with the King's Norton authorities. They only differed on questions of detail, such as the mode of traction, the levels, and the repaving of certain roads. He asked the Council to leave the matter with the committee to settle on the best possible terms they could make, feeling very little doubt that a satisfactory settlement would be arrived at. The Council assented.

Paisley.—The order for the 61 arc lamps for the Paisley Corporation street-lighting has been placed with the Brockie-Pell Arc Lamp Company, Limited, who are also supplying the switches and accessories. The pillars are being made by Messrs. Walter McFarlane, of Glasgow. One sample pillar is being fixed outside the town hall, and on Jubilee night it has been arranged to supply it with current from the gas-engine plant at the town hall; this is appropriate, as the design of the pillar is suggestive of the Jubilee, it being surmounted by the letters V.R. and a crown, with the date 1897. Mr. Teague, the electrical engineer, is busy with the plans for the new station, and it is hoped that within the next week or two the schedules will be in the hands of the builders. The plant on order at present consists of two 200-unit and one 100-unit steam alternator, and the present building is to be arranged to take another 600-unit set; and it is probable that if the supply is taken up in the manner that appears likely, this further set will have to be ordered before the station is opened. The engine and boiler room are to be so arranged as to allow of easy extensions, and the chimney shaft is to be built to take another battery of boilers of the same size as that now going down.

The Birmingham Tramways.—The protracted negotiations between the Public Works Committee and the City of Birmingham Tramways Company concerning the method of traction to be adopted under the scheme of reorganisation proposed by the company have failed to result in such an agreement as to warrant the Corporation consenting to the Bill promoted by the company now before Parliament. Under the circumstances the Bill is withdrawn. The following official report has been supplied to the newspapers: "A meeting of the Public Works Committee was held yesterday (Monday) morning, at which Mr. Ross and Mr. Milward and other representatives of the City of Birmingham Tramways Company attended. The committee, having regard to the many points upon which they and the tramways company were still unable to agree, and having regard to the present period of the parliamentary session, instructed the town clerk to call upon the company to withdraw from their Bill all powers within the city, in accordance with Messrs. Milward and Co.'s undertaking. In consequence of this decision, it was not thought necessary to call a special meeting of the Council for Friday next, but the committee will report on the subject to the Council, at a meeting to be held on Tuesday, the 29th inst."

The Collision on the Liverpool Overhead Railway.—Lieutenant-Colonel Yorke's report on the collision that recently occurred at the Dingle Station, on the Liverpool Overhead Railway, by which three passengers were injured, has been issued. He states that the primary cause was Signalman Orford's deliberate breach of the block rules, whereby he permitted the 10 o'clock train to start from the up platform at the time the other train was approaching the station on the up line. This was by no means the first occasion on which the same thing had been done by him. It was manifestly useless for railway companies to incur expense in providing modern appliances for ensuring the safety of the travelling public if a signalman was to be permitted with impunity to render all such safeguards nugatory, and to expose passengers to unnecessary danger. As soon as Orford had accepted the empty train, it was his absolute duty to have allowed it to run into the station up the down platform before he let the 10 o'clock train start. Lieutenant-Colonel Yorke regards his offence as exceedingly serious, and as one that should in future disqualify him from the responsible position as signalman. The report adds that Driver Thomas Middlebrook was also largely responsible for the occurrence, inasmuch as he ran past the home signals, which were at danger.

Glasgow.—The Corporation will shortly be busy altering their street lamps. The original type decided upon when the town was first lighted consisted of lanterns with Brush lamps, similar to those at present used in the City of London. However, during the past winter, owing to the unsatisfactory lighting of the streets, the electrical department made extensive trials of various lamps and methods of suspension, and finally decided to adopt the hanging type of lamp column, with lamps of the Brockie Pell make. As far as the lamp pillars themselves go, these are to remain as they are, the lanterns being removed and replaced by an overhanging bracket supplied by Messrs. Walter McFarlane. The order for the lamps was placed with the Brockie-Pell Arc Lamp Company, Limited. The lamps are to be run four in series off the 220-volt mains. Negotiations are proceeding apace for the two new electric supply stations that the Corporation propose to lay down, one in the Port Dundas district, and the other on the south side of the river near Eglington-street. It is intended to have them ready for the winter of 1898-99, seeing that they will only manage to meet the coming winter's demand by a call on the full capacity of the two large sets of storage cells recently ordered. The fiat has gone forth that no more connections will be made on to the 100-volt mains, all future consumers having to go on to the 200-volt distribution. The present consumers, particularly in the west end of the city, are also being transferred as quickly as it can be arranged.

The Post Office and the City Commission.—The Clerk read a letter at the meeting of the Commissioners of Sewers from the Postmaster-General in reference to the question of laying underground telegraph wires in the City, and expressing a hope that the explanation made in his previous letter would be satisfactory to the Commission, and that the necessary permission would be speedily given, so that the work could proceed. The Clerk mentioned that he had written stating that the matter was under

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the consideration of the Commission. Applications were read from the Post Office authorities for permission to take up the footway and roadway across the west end of Ludgate-hill for the purpose of laying a 3in. telegraph-wire pipe and for similar work on the east side of Old Bailey. The Clerk stated that he had written stating that the necessary permission would be given on the usual conditions, which up to the present had not been accepted by the Post Office authorities. A letter was read from the Glasgow Police Department enclosing a copy of a resolution passed by the Glasgow Corporation relative to the laying of telegraph wires by the Post Office in similar terms to those already adopted by the Commission. Mr. Morton moved that the clerk should write to the Glasgow Corporation, thanking them for their co-operation. Mr. Wallace seconded, remarking that it was gratifying to find the second city of the Empire supporting the action of the first. The motion was agreed to.

Dundee.—Mr. Walter H. Tittensor, the city electrical engineer, has issued a long and interesting report to the members of the Town Council on the "Wright" system of rebate charging for supplies of electrical energy. In order to fully realise the conditions under which electrical supply stations have to work, he states figures may be taken from the actual working of the generating station of the Dundee Gas Commission: "For the financial year ending 1897 the total number of units sold was 265,000; the maximum capacity of the station at full load is 620 kilowatts, or, in other words, the maximum output from the station equals 620 Board of Trade units per hour; the standing charges amounted to £3,262. 7s. 7d. = 2·954d. per unit, or £5. 5s. 3d. per annum per kilowatt; the running charges amounted to £1,598. 4s. 2d. = 1·447d. per unit—total costs, £4,860. 11s. 9d. = 4 401d. per unit. The revenue amounted to £5,533. 13s., at the rate of 5d. per B.T. unit; the revenue per kilowatt installed, £8. 18s. 6d. We will now consider the capabilities of the station working under the same conditions as ordinary manufactories—viz., at full load all the year round. Expenditure for one year: the units sold would be 4,000,000. The standing charges would be practically the same—viz., £3,536 = ·212d. per unit sold. The running charges would be £11,883 = ·684d. per unit sold; total expenditure, £15,369 = ·896d. per unit sold. Current could be sold at 1d. per unit, and yield a revenue of £20 833, leaving a profit of £5,464 per annum. Therefore, if the electrical undertaking were working under the same conditions as the gasworks, the former would have to reduce its charge to 1s. per 1,000 cubic feet, in order to sell at the same price." The report is a valuable one.

Wolverhampton.—At the meeting of the Town Council a report was submitted by the Electric Lighting Committee which showed that the operations of the year had resulted in a net profit of £225. 14s. 5d., which amount has been applied to the deficiency on the working of the previous years, reducing the same to £1 177. 14s. 10d. As the undertaking has now, the report states, become a paying concern, the committee have no doubt that with the further extensions in the Chapel-Ash district this deficit will be speedily reduced. The report also shows that the expenditure during 1896-97 has not been excessive, the largest item being £1,413. 8s. 9d. for transformers. Machinery has swallowed up £877 odd, and electrical instruments over £505. The income from the sale of the current totals up to £5,021. 3s. 6d., which includes the sum of £1,242. 5s. received for the lighting of the street lamps. The quantity of electricity generated in Board of Trade units was 287,507, the quantity sold to private consumers was 151,243 units, the total sold being 224,709 units. The ex-Mayor (Alderman C. T. Mander), in moving the adoption of the report, referred to the gas charges, and said the committee hoped to squeeze a discount out of the company regarding their account, for if they did not have their gas cheap they would put up the electric light instead. Although the Electric Lighting Committee had not borrowed £5,000 which had been sanctioned, they owed £9,000 to their bankers, £6,000 odd on capital account, and £3,000 odd on revenue account. They would be in the same position as the team and other earning departments. They had to lend money to a certain extent, for it was not possible to collect accounts precisely at the end of the quarters. Their gross profit during the past year was equivalent to 6·32 per cent. on their capital employed. Out of that there had to be paid 5·10 per cent., therefore their profits were very small. They had no doubt turned the corner, and now practically the electric lighting scheme was a paying concern. The report was approved.

Business Activity.—Messrs. P. R. Jackson and Co., Limited, of Salford Rolling Mills, Manchester, have recently secured a large number of orders, among the larger of which may be mentioned: three dynamos of 380 kilowatts each, at 200 revolutions per minute, direct-coupled to compound vertical engines, one motor-generator for an output of 75 kilowatts, one balancing transformer of about 55 kilowatts capacity and the necessary steam, exhaust, and other pipes, condensers, feed-water heater, electric boiler-feed pump and electric centrifugal pumps for condensers, for the new Ashton-under Lyne lighting and power station; a complete electric haulage plant for Breightmet Colliery, consisting of a double continuous-rope hauling engine, with 90-h.p. motor and two single-drum hauling engines of about 40 h.p. each, which will be driven from the continuous ropes, and a generating dynamo of 75 kilowatts. The plant at Breightmet Colliery also comprises an electric lighting installation with 10-kilowatt dynamo and vertical engine. They have also secured an order from the Glengarnock Iron and Steel Company, Limited, for a complete electric pumping plant, consisting of one pump for a head of 480ft. with 95-h.p. motor, and another for a head of 240ft. with 28-h.p. motor, a generating dynamo for an output of 110 kilowatts, and an overhead line of about 1,600 yards length. Other orders are for two dynamos, one of 16 and the other of 25 kilowatt capacity, for lighting Howbery Hall (Mr. Wingfield Bowles being the consulting engineer); also for one dynamo of 160 kilowatts and several motors for Messrs. Tweedales and Swalley, of Castleton; and three motors of about 7 h.p. each for the Dowlais Iron Company, Limited. The order which Messrs. Jackson have had in hand for the Electro-Chemical Company, of St. Helens, for eight 275-kilowatt dynamos is now nearing completion. The first pair of dynamos have been working almost continuously for the last six months, each with a load of 1,500 amperes at about 200 volts, without a mishap of any kind. The members of the Municipal Electrical Association will visit Messrs. Jackson's works on the 30th inst.

Gravesend.—A letter was received at the Town Council meeting from Messrs. Crompton and Co., Limited, of Mansion House-buildings, E.C., and Chelmsford, stating that they were proposing to apply for a provisional order for an electric lighting supply, and asking for the support of the Council. Councillor Layborn moved that the town clerk be requested to write Messrs. Crompton to the effect that the Council would acquiesce, subject to suitable arrangements as to charges, and an understanding that at the expiration of 21 years the Corporation should have the option of acquiring the plant if thought advisable. Some years ago, this question came under discussion, and the application was refused, because, while electric lighting was deemed desirable, it was thought the promoters should be the Town Council. Indeed, the Court did go for a provisional order, but at the last moment, through one of those inconsistencies of which the Court was guilty, it was upset, the town put to an expense of nearly £200, and the subject relegated to the present time. Complaints were frequently made that Gravesend did not keep up to the times, and that was certainly true in regard to electric lighting. He felt after the recent vote of the town it would be useless to ask the Corporation to take up the matter, because the vote of the ratepayers might be adverse to such a course; therefore he thought they should grant facilities to Messrs. Crompton in regard to the provisional order they proposed to apply for, at the same time making suitable provision that at the expiration of 21 years the town should be at liberty to acquire the plant if they thought it desirable, and also seeing that their charges were reasonable. Councillor Clinch seconded. In many country towns, not half or one-fifth the importance of Gravesend, the electric light was in operation. He felt that the public enterprise, the public spirit which they as a Council ought to promote, should prompt them in the course now proposed. Alderman Cooper moved that the application be submitted to either the Works Committee or the Parliamentary Committee, in order that full opportunity might be given for its consideration. Councillor Penney seconded it, and remarked that he was anxiously looking forward for the report of the chairman of the committee, which would prove that electric light was not wanted. Another councillor had said that those who wanted the electric light should have the opportunity of procuring it. He said the same, and would never agree to one section of the town having electric light at the expense of the whole of the town. If people wanted electric light they could have it at a small cost, and he quoted figures from a firm he had written to showing that they were prepared to supply a dynamo from 14s. 6d., and a gas-engine from 28s. 6d. That communication was received only four months back. He trusted the Corporation would not rush into this matter, but give it the fullest consideration. After further discussion, Councillor Layborn said his purpose had been gained. Inasmuch as he had elicited expressions of opinion which were favourable to the introduction of the electric light, he was quite willing now that it should be sent to a committee. The amendment was carried, and the town clerk directed to write to Messrs. Crompton and acknowledge the receipt of their letter.

PROVISIONAL PATENTS, 1897.

JUNE 8.

13937. Electrical and automatic registering indicator and recorder. George Brown Hamilton, 462, Crown-street, S. Side, Glasgow.

13938. Improvements in holders for shades and the like applicable to gas and electric light fittings. Frederick Small and Thomas Clarke, 6, Clayton-square, Liverpool.

13952. A channel arm for telegraph insulators. Alfred Willmot and Francis Hare, 37, Willow-road, Balsall Heath, Birmingham.

13959. Improvements in electric ship-log apparatus. Alfred George Brookes, 55, Chancery-lane, London. (Warren Henry McCurdy, United States.)

13970. Improvements in and relating to dynamo-electric machines and rotary converters. The British Thomson-Houston Company, Limited, 70, Chancery-lane, London. (Edwin W. Rice, jun., United States.) (Complete specification.)

13971. Improvements in and relating to controllers for electric motor circuits. The British Thomson-Houston Company, Limited, 70, Chancery-lane, London. (Edward D. Priest, United States.) (Complete specification.)

13972. Improvements in and relating to controllers for electric motor circuits and in blow-out magnets for use with same. The British Thomson-Houston Company, Limited, 70, Chancery-lane, London. (William B. Potter and Frank E. Case, United States.) (Complete specification.)

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13973. Improvements in and relating to pneumatically actuated "open circuit" controllers for electric motors. The British Thomson Houston Company, Limited, 70, Chancery-lane, London. (Edward D. Priest and Frank A. Merrick, United States.) (Complete specification.)

13974. Improvements in lightning arresters. The British Thomson-Houston Company, Limited, 70, Chancery-lane, London. (Axel Ekstrom, United States.) (Complete specification.)

13975. An improved electrical bond or connection for railway and like rails The British Thomson-Houston Company, Limited, 70, Chancery-lane, London. (William B. Potter, United States.) (Complete specification.)

13976. Improvements in or relating to induction motors. The British Thomson Houston Company, Limited, 70, Chancery-lane, London. (Charles P. Steinmetz, United States). (Complete specification)

13977. Improvements in three-phase alternating-current induction meters. The British Thomson-Houston Company, Limited, 70, Chancery-lane London. (Charles P. Steinmetz, United States.) (Complete specification.)

13992. Improvements in anodes for electrolytic cells. William Mather, 28, Southampton-buildings, Chancery-lane, London.

14024. Improvements in or relating to direct-current dynamos and electromotors. Francis Henry Davies and Charles Orme Bastian, 31, Southampton-buildings, Chancery-lane, London.

14033. Improvements in electric regulators. Christopher C. Gartland, 322, High Holborn, London. (Complete specification.)

JUNE 9.

14077. Improvements in and relating to electric traction. Henri Victor Moreau, 6, Bream's-buildings, Chancery-lane, London.

14085. Improved means for producing continuous-current effects from alternating electric current generators. Oskar Béhrend, 47, Lincoln's-inn fields, London.

JUNE 10.

14111. Electric contact devices for automatic regulators. George Keith Buller Elphinstone, 101, St. Martin's-lane, London.

14136. Improvements in or relating to coin-freed mechanism and machines for giving electric shocks. Frederick Ashburner, 27, Martin's-lane, Cannon-street, London.

14187. Improvements relating to telephonic conductors. Henry Harris Lake, 45 Southampton-buildings, Chancery-lane, London. (Emil von Szvetics, Hungary.)

14196. Improvements in or connected with electric arc lamps. Frederic Stanhope Worsley, 47, Lincoln's-inn-fields, London.

JUNE 11.

14207. A new or improved electricity supply meter. Rankin Kennedy, 33, Gladstone-street, Bradford, Yorks.

14222. Improved method of transmitting so-called electrical energy through non-conducting media without intervening conductors for signalling or otherwise. David Rhys Jones and Joseph Henry Jackson, 19, Paget-street, Cardiff.

14247. Improvements in and relating to electric furnaces. William Phillips Thompson, 322, High Holborn, London. (La Società Italiana dei Forni Elettrici, Italy.) (Complete specification.)

14252. Improvements in mechanism for electric traction systems in which the electric current is supplied to the cars or locomotives from studs, sections of rails, or the like laid in the road. Silvanus Phillips Thompson and Miles Walker, 6, Lord-street, Liverpool.

14253. An improved alternating-current meter. Carl Raab, 6, Lord-street, Liverpool. (Complete specification.)

14254. Improvements in or relating to ampere-hour electric meters. Georg Hummel, 28, Southampton-buildings, Chancery-lane, London.

14272. Improvements in the manufacture of casein compounds for electric insulating and other purposes. Peter Holger Hansen and Johannes Knud Westengaard, 77, Chancery-lane, London. (Complete specification.)

14278. An improved electric arc lamp. Arthur Lehmann and Alfred Mann, 18, Southampton buildings, Chancery-lane, London.

JUNE 12.

14330. A method of producing a magnetic current of force having a displacement of phase equal to 90deg. or more relatively to the tension of the magnetising current. James Yate Johnson, 47, Lincoln's-inn-fields, London. (Messrs. Hartmann and Braun, Germany.) (Complete specification.)

14340. Improvements in or relating to incandescent electric lamps. Hiram Stevens Maxim, 45, Southampton-buildings, Chancery-lane, London.

14341. Improvements in machines for making carbons for electrical purposes. Henry Harris Lake, 45, Southampton-buildings, Chancery-lane, London. (Thomas Brown Dooly, United States.)

SPECIFICATIONS PUBLISHED.

1896.

11133. Apparatus for the electrolytic decomposition of liquids. Bell and Bell.

11230. Electrical regulating apparatus for arc lamps. Pieper.

14157. Form of washer for use in connecting secondary battery lugs and other electrical conductors. Highfield.

14554. Buoy that can be sunk or raised electrically from a distance. Siemens Bros. and Co., Limited. (Siemens and Halske.)

15176. Dynamo-electric machines for use in what is known as the three-wire system. Johnson. (The Electricitate Actien Gesellschaft vormals, W. Lahmeyer und Co.)

16019. Electric regulating switches. Crompton and Pochin.

16270. Secondary electric batteries. Garreau.

22820. Method of constructing, mounting, and arranging the under frame and driving appliances of electric and other road motorcars, and means or apparatus for reducing vibrations and oscillations, and to facilitate ease of action in starting such cars. Carmont.

28610. Electric signalling apparatus for fire-damps. Cohn.

1897.

1487. Telephone and other electric switches. Ries. (Date applied for under International Convention, June 26, 1896.)

6428. Electrical switches and cut-outs. Gover, Proctor, and Bate.

7012. Supplying electrical energy to electrically-propelled aerial machines and balloons. Diesel.

7497. Regulable transformers and regulating alternating-current dynamo-electric machines. Lake. (General Electric Company.)

9091. Distribution of electricity. Parshall.

9563. Plates for secondary batteries or accumulators. Cheswright.

9913. Manufacture of electrodes for electric accumulators. Marckwald.

9914. Manufacture of electrodes for electric accumulators. Marckwald.

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	9¼-9½
Brush Company, Ordinary	3	1¼-1⅝
—— Non. Cum., 6 per cent. Pref.	2	1¼-1½
—— 4½ per cent. Debenture Stock	100	104-108
—— 4½ per cent. 2nd Debenture Stock	100	95-99
Callender's Cable Company, Debentures	100	110-115
Central London Railway, Ordinary	10	9¾-10¼
——	6	5¾-6¼
Charing Cross and Strand	5	13¾-14½
Chelsea Electricity Company	5	9¾-10
—— 4½ per cent. Debentures	100	112-115
City of London, Ordinary	10	23½-24½
—— 6 per cent. Cumulative Pref.	10	17-18
—— 5 per cent. Debenture Stock	100	131-136
City and South London Railway, Consolidated Ordinary	100	58-60
—— 4 per cent. Debenture Stock	100	137-139
—— 5 per cent. Pref. Shares	10	15½-16
County of London and Brush Provincial Co., Ordinary	10	12¾-13¼
—— 6 per cent. Cum. Pref.	10	15-15½
—— 4½ per cent. 2nd Debenture Stock	10	14¾-15½
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	1¾-2¼
—— 5 per cent. Debentures	—	90-95
Edison and Swan United Ordinary	3	2-2½
—— 5 per cent. Debentures	5	3¾-4¼
—— 4½ per cent. Debentures	100	106-110
Electric Construction, Limited	2	1¾-1¾
—— 7 per cent. Cumulative Pref.	2	2¾-3¼
Elmore's Copper Depositing	1	¾-1
Elmore's Wire Company	2	2-2¼
W. T. Henley's Telegraph Works, Ordinary	10	18¾-19¼
—— 7 per cent. Preference	10	18¾-19¼
—— 4½ per cent. Debentures	100	108-113
House-to-House Company, Ordinary	5	8¾-9
—— 7 per cent. Preference	5	9¾-10¼
India Rubber and Gutta Percha Works	10	20¾-21¼
—— 4½ per cent. Debentures	100	104-107
Kensington and Knightsbridge Ordinary	5	12¾-13¼
—— 6 per cent. Pref.	5	8-8¼
London Electric Supply	5	1¾-2¼
Metropolitan Electric Supply	10	16¾-17¼
—— 4½ per cent. First Mortgage Debenture Stock	100	120-124
National Telephone, Ordinary	5	6¾-6¾
—— 6 per cent. Cum. First Pref.	10	15-17
—— 6 per cent. Cum. Second Pref.	10	15-17
—— 5 per cent. Non. Cum. Third Pref.	5	6-6¼
—— 3½ per cent. Deb. Stock	100	105-109
Notting Hill Company	10	15-16
Oriental, Limited, £1 shares	1	1¼-2
—— £5 Shares	5	8¼-8¾
—— £4½ shares	4½	7¼-7¾
Oriental Telephone and Electric Company	1	¾-1
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	102-104
St. James's and Pall Mall, Ordinary	5	15¼-16¼
—— 7 per cent. Pref.	5	10-11
Telegraph Construction and Maintenance	12	36-39
—— 5 per cent. Bonds	100	103-106
Waterloo and City Railway, Ordinary	8	10¾-11¼
Westminster Electric Supply, Ordinary	5	14¾-15¼
Yorkshire House-to-House	5	8¼-8¾

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NOTES.

Physical Society.—In the report of the meeting of the Physical Society on June 11, which appeared in our last issue, the two η's in the fifth and sixth lines from the end of the first paragraph should be t's. At to-day's meeting the following papers will be taken: "A New Theory of the Earth's Magnetism," by Mr. Sutherland; "Experiments in Critical Phenomena," by Dr. Kuenen; "On the Attenuation of Electric Waves in Wires," by Dr. Barton; and "On the Steady Motion of an Electrified Ellipsoid," by Mr. G. F. C. Searle.

Ozonisers.—Over the initials "E. A.," which probably stand for the name of Mr. E. Andréoli, *L'Electricien* has had a long article calling in question the claims made as to the efficiency of most of the apparatus for the production of ozone by the action of an electrical discharge, and pointing out the absolute absurdity of some of them. "Three years ago an important technical paper in Paris declared that a German electrician had produced 95 per cent. of the theoretical possible production." There was a little difference in the figures of 1,030 grammes or 196 grammes, and the author says that to get the figures really right it would be necessary to subtract 180 grammes more from this last amount.

The Queen's Telegram.—The Queen's telegram to the English beyond the seas was short and to the point, as such a message should be. It was sent, before the procession started, over the private wire from Buckingham Palace to the Central Telegraph Office in Aldersgate. That unemotional institution sent it at once to the cable companies, and it was little after 11 before the messages were on their way, and, in some cases, the replies began to come back within a quarter of an hour. The Seychelles answered within three-quarters of an hour, and New Zealand within the hour. Some very out-of-the-way places were reached. On the other hand, there are some of our transmarine possessions, small ones it is true, that cannot be reached telegraphically in any amount of hours, for the simple reason that there is no cable.

Decimalisation of the Hour.—The French Society of Civil Engineers has had a long debate on the "decimalisation" of the hours and minutes. Naturally the society cannot bring itself to accept the wholesale proposals of the commission. On the other hand, it has a disinclination to throw over, once and for ever, Laplace's division of the circumference into 400 grades which used to find a place in the second chapter of works on elementary trigonometry, and nowhere else in the world except in the scales of a few French tachymeters. The best way out of the muddle would simply be to enlarge the minute of arc to correspond with the minute of time; but it is the astronomers who must begin, and it would not please the decimalists. It is easy to renumber a scale or read it in the new numbers, but regraduation is a different matter; and similar considerations apply to tables.

Explanatory.—Some time ago, in a note on the persistent way in which investigators keep up the hitherto hapless quest of the carbon-consuming battery, or some equivalent method of eliminating the steam-engine and dynamo as connecting links between the coal heap and the current, it was incidentally remarked that the "digest" of electrical literature in the New York *Electrical World*, "though a very good one," did not include every electrical publication that appears in the whole world. It has come to the knowledge of the writer that this innocent remark has been misconceived on the other side of the Atlantic, and therefore there is no harm in saying that the digest for which Mr. Hering is responsible is not only the best thing of its kind in the English language, but that if the writer had not thought that it came as near to covering the whole field as is practically possible, he would hardly have taken the number of abstracts in that digest relating to a given subject as a fair measure of the attention which is being paid to it.

Motorcarts.—As was anticipated, the Royal Agricultural motorcart trials followed much the same course as the *Engineer* competition. In this case, however, the prize had not the substantial value of that offered by our contemporary. Three judges were appointed—Sir W. Anderson, Mr. F. W. Webb, of Crewe, and Mr. Bryan Donkin. There was to be a run of 50 miles out from Crewe and back again. Only three firms entered, the Anglo-French Motor Carriage Company, Birmingham; T. Coulthard and Co., Preston; and the Lancashire Steam Motor Company, Leyland; and on the day appointed not a van had put in an appearance until 6 p.m., when the exhibit of the Lancashire Steam Motor Company, Leyland, turned up. The other two machines never appeared. Under these circumstances the judges did not think it necessary to go through the prescribed trials, but decided to have a run of about 15 miles. The van started and ran very steadily to at about seven miles an hour. It secured a "highly commended," but no prize was awarded.

An S or a G.—Some time ago the *Times* got a telegram from the United States in which the currency policy of that country was spoken of as to be "sold." The *Times* naturally sub-edited this as "gold" (it should have been "solid"), whereupon the *Financial News* takes the first journal in the world to task in a fine high-handed style. "Before the *Times* conjecturally emendates any more telegrams about the American currency it should discover what President McKinley has been pledged to, etc. . . . . and also what letters in the telegraphic code are most likely to be substituted for one another by errors in transmission. An 's' for a 'g' is not a probable mistake." One might add that before taking the *Times* to task, it is just as well to be quite sure of what one is talking about. The signalling is not usually done the whole way by cable, and the writer in the *Financial News* may be assured that there is a not actually unknown telegraphic instrument, though it is not used on cables, in which with hurried sending he would find it quite easy to make the mistake which is considered so improbable.

Pumping from Shafts.—In a paper on "Water in Deep Shafts," which was read at the engineering conference of the Institution of Civil Engineers, Mr. Henry Davey said that where water had to be pumped in small quantities from several distant points the system of electric transmission of power was a useful one, but for purposes embraced in that discussion it could scarcely be seriously considered. A good system of surface engine and pumps would give a mechanical efficiency of 85 per cent. with simple slow-working mechanism; whereas the loss in electric transmission must necessarily be very great; for example, dynamo efficiency, 95 per cent.; motor efficiency, 95 per cent.; gearing efficiency, 80 per cent.; engine efficiency, 85 per cent.; giving a combined efficiency of 60 per cent. It was not, however, so much an electrical as a mechanical problem, and the necessary conditions of mechanical application precluded its adoption except in special cases. As to this, if you have simply a straight lift and a slow engine, a rod will convey the power cheaper than dynamo, cable, and motor. The advantage of the electric system is its flexibility. The power can be conveyed anywhere, and a different kind of engine can be used and can be placed anywhere that happens to be convenient.

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Van t'Hoff's Constant.—A paper, which, however, there was not time to read, has been contributed by Dr. Meyer Wildermann to the *Proceedings* of the Chemical Society, on the "Experimental Verification of Van t'Hoff's Constant in Very Dilute Solutions." In Van t'Hoff's thermodynamic argument, the solutions are assumed to be very dilute, and the same assumption is made in the deductions from it of Planck, Riecke, Lorentz, Bolzmann, and others. The experimental verification in dilute solutions of Van t'Hoff's law is, therefore, especially important. The freezing-point method has been worked out with greater accuracy for the purpose of the present investigation. The author has determined Van t'Hoff's constant in dilute solutions with thermometers graduated to $\frac{1}{100}$deg. and $\frac{1}{1000}$deg. respectively, simultaneously for a series of compounds—cane sugar, alcohol, urea, acetone, aniline, phenol, dextrose, resorcin, maltose, milk sugar—at converging temperatures above and below the freezing points, using different parts of the scale of both thermometers. Small deviations only from the theoretical value of 1·87 are found, due to the different sources of experimental error, Van t'Hoff's constant being thus confirmed in dilute solutions. It is evident that if we do not come to some conclusion as to the dissociation question, it will not be for want of work on the matter.

Interference Mirror Instruments.—The little mirror on the galvanometer needle which practically gives us a massless pointer of unlimited length was a great invention, and many people will imagine that as a rule you can get in this way a much greater multiplication of the deflection than you know what to do with. Mr. Wadsworth, of the Yerkes Observatory, is, however, going to measure actual deflections of the needle to a much greater degree of accuracy—in fact, to a fraction of the length of a light wave—without multiplying them. His instrument is not completely constructed yet, but he uses two mirrors, one on each end of the needle, and an arrangement of other mirrors which will produce interference fringes in the light from the needle mirrors whenever these are displaced in the smallest degree. The damping of the swings is done by the action of a magnetic field on a piece of foil. As has been said, the instrument proposed is a galvanometer, but the principle is equally applicable to any instrument in which a needle hangs on a torsion filament, and auxiliary means might be used to get close to the point where the fringes become visible. For the problems which Mr. Wadsworth wants to attack, this is not necessary. Mr. Wadsworth's preliminary apparatus are illustrated and the whole thing described in the current number of the *Physical Review*.

The Jubilee Honours.—Mr. A. R. Binnie, the engineer to the London County Council, and Prof. Crookes are in the list of those who are to be knighted on the occasion of the Queen's Diamond Jubilee. The spectroscope comes a degree better off than the vacuum tube. Mr. Norman Lockyer and Mr. Huggins are to have not only the "Sir" in front, but the K.C.B. afterwards. Mr. J. Wolfe Barry and Dr. Frankland are in the same list. Mr. Christie, the Astronomer Royal, is to be C.B. only. Not merely distinction, but a fortune is in most cases necessary for hereditary rank. Mr. James Pender and Mr. Cuthbert Quilter get baronetcies. Mr. Quilter has had something to do with telegraph companies, and at one time a great deal to do with the Telephone Company. But he does other things as well—for instance, buys pictures and sits in Parliament for a curious corner of Suffolk. Seven provincial mayors get knighthood. The precise number of provincial mayors that have got disappointed is unknown. Among the new K.C.M.G.'s occurs the name of Major Marindin, of the Board of Trade. The Colonial Premiers are to be sworn of the Council, which puts them immediately after the "Lords" and before all the "Sirs." Unfortunately, it is only collectively and not individually that we address the "Lords of the Council" as "My lords"—a thing perplexing to foreigners, so that even in Germany, where they make a study of that sort of thing, and even electrical papers understand it, they sometimes get mixed over English titles.

The Higher Education in the States.—We have received the "Catalogue" for this year of the University of Wisconsin, at Madison, an institution which has been noticed before in these columns. There are about 400 pages in the catalogue, as the university embraces about six "colleges" (we should call them faculties on this side), and there are on the average about half a dozen optional courses in each "college." The writer has looked through the syllabus of the electrical engineering course of the "college of mechanics and engineering." It seems full and practical. Prof. Jackson, Mr. Fortenbaugh, and three assistants look after this. The university is exceptionally well supplied with laboratories and workshops. The point of the university appears to be that while you can have a purely classical education there if you choose, each of the special courses of education necessary and proper for all the liberal professions is placed on a footing of equality with the others. But this is only the writer's idea; it is not so stated specifically in the catalogue, and he was never entered at Madison, and therefore cannot speak from experience.

The Lighting of Magazines.—At the beginning of the present year the French Minister of War addressed a letter to the Académie des Sciences asking them to "inform him what were the precautions which ought to be taken in the erection of conductors of electricity in the neighbourhood of powder magazines." Regulations on the subject were drawn up and issued by that body and the then Minister in 1858. Now, the laws of nature do not alter, but one learns more about them as time goes on, and the present Minister might reasonably consider that the regulations of 1858 were possibly by this time somewhat out of date. The Académie duly referred the matter to a committee, which has reported, and its report, which has been unanimously adopted, is published in the *Revue Industrielle*. The committee recommends the use of the incandescent electric lamp as the safest artificial illumination, if the latter is absolutely necessary. It does not consider anything beyond the ordinary telegraphic lightning arresters necessary where an overhead line enters the magazine, and recommends only three alterations in the 1858 regulations. One of these is to strike out a regulation as useless, and another is purely formal, so that all that is required to be done to bring these regulations of 39 years ago up to date is to prescribe that other people's lines shall be kept 22 yards off the magazine if they are overhead and 11 yards if underground. Gas and water pipes and underground metal work generally are to be served the same. It is not in the regulations, but the opinion is expressed that for artificial lighting the electric light is practically absolutely safe if double glasses are used, and the conductors taken through metal conduits. Only fixed lamps must be used, and "flexible" is, of course, barred.

Illuminations.—Someone said in his haste that the incandescent electric lamp was not adapted for outdoor illuminations, and the statement secured the endorsement of an influential daily paper. It was too steady, and did not flicker. (It has been supposed that it was within the capabilities of the electric engineer to make his light unsteady, but he thought people did not like it so.) One had a good opportunity of testing the value of such off-hand statements

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in Piccadilly last Tuesday, where the incandescent lamp, the line of gas-jets, and the squat candle in a coloured glass were to be seen in strings. Curiously enough, it was not the extra brightness of the electric light, but the very steadiness which was complained of which singled it out in a moment from all the others. The superiority of the effect, particularly when it was desired to line out the main features of a building, could not be for a moment in doubt. Unfortunately, when it is installed for a single night only, the electric light is not cheap as compared with the candle in a glass hung up with a bit of bent wire. But then, with the latter, you may get your decorations on fire when you try to light up, as happened at one place in Fleet-street, at least, and the least drop of rain is fatal. How the incandescent lamp compares as to cost with the iron gas-pipe with a burner screwed into it about every inch or two the writer does not know. As to fire risks, about which some people at times make an undue fuss, it would be interesting to calculate how many years of ordinary lighting, even with careless and uninspected workmanship, are equivalent to one night's illumination of this sort so far as risk is concerned. But all London illuminated, and, though in one or two cases a few bits of paper decorations were burned, nobody was burned down.

Cables and Earthquakes. — Prof. Milne keeps pegging away at his scheme for a "seismic survey" of the world, or as large a slice of it as he can get. In a lecture last Friday before the Royal Geographical Society on the subject of "Sub-Oceanic Changes" he said: Because earthquake origins were more numerous beneath the sea than upon the land, it was fair to assume that the bradyseismical operations (this ugly word merely means slow earth movements) resulting in the folding, bending, crushing, faulting, and thrusting of rock masses were more active in the recesses of the ocean than they were upon our continents. The most important evidences of sub-oceanic change was to be found amongst the archives of the cable engineer. The routes chosen for cables were carefully selected as being those where interruptions were least likely to occur; and yet, as it had been shown, something which was often of the nature of a submarine landslip took place, and some miles of cable might be buried. Here seemed to be proof positive, especially along the submerged continental plateaus, of sudden sub-oceanic dislocation. Beneath the oceans certain important geological changes were more rapid than they were upon land, whilst new sources from which information respecting these changes might be obtained were pointed out to the student of dynamical geology. The more important of these sources were the experiences of the cable engineer and the records of seismographs. When a number of these instruments had been established round the world, on the borders of great oceans, and on oceanic islands, it was difficult to overestimate the practical and scientific results which would follow. The greater number of records would refer to disturbances which originated beneath the sea. From the times at which earth waves arrived at different stations, as, for example, on the two sides of the Atlantic, it would be possible to localise their origins, and in time districts would be indicated which it would be well for those who laid cables to avoid.

The Technical Education Conference.—From our point of view the most important matter discussed at the International Congress on Technical Education last week was the teaching of chemistry, for just at present chemistry is the field which is selected for the fight as to the object, method, character, and importance of education in physical science generally. Why it should be so is not clear, but so it is, and what is decided there will also decide what is done about physics and engineering. All that is dealt with in another note. After the opening, the congress sat in sections. Sir Philip Magnus, in a paper on "Theory and Practice in Trade Teaching," said the Technical Instruction Act expressly forbade the teaching of the practice of a trade in any technical school. Mr. S. H. Wells, of the Battersea Polytechnic, pointed out that the greatest of all difficulties in connection with technical classes was the provision of satisfactory and efficient teachers. Prof. Ayrton gave an account of the Central Technical College, South Kensington. Its students were practically limited to 200. There was an entrance examination, and what counted in the classes was not wealth nor position but talent. Technical classes were turning out a greater and greater number of young men and women with a certain amount of technical and scientific knowledge. It might therefore be supposed that the students trained by the Central Technical College would experience a growing difficulty in finding paying situations. But the contrary was the case, the students of the college receiving offers of salaried posts before the completion of their training. Prof. Silvanus Thompson urged the co-ordination of educational institutions from the highest to the lowest. Prof. Garnett, of the Technical Education Board, said that if artisans were to be attracted to technical classes the teachers must be acquainted with the practical details of the trades to which the artisans belonged. Prof. Reynolds (Manchester) referred to the wasteful overlapping that prevailed in connection with technical instruction. The Technical Instruction Act, which forbade the practice of a trade being taught in technical schools, was practically a dead letter in Lancashire, and deserved to be. On the third and last day's proceedings of the congress, in Section A the chair was taken by Mr. Mundella, M.P. There was a large attendance, among those present being Mr. Bryce, M.P., Lord Kelvin, Sir Joshua Fitch, Dr. J. H. Gladstone, and Sir Owen Roberts. Sir John Gorst, M.P., took the chair in Section B at the rooms of the London School of Economics; and in the afternoon Sir Owen Tudor Burne was chairman. Section A was very much given up to the ladies. Miss Alice Mitchell, B.Sc., read the first paper, in which she described the teaching of domestic economy in girls' secondary schools as being eminently unsatisfactory. It was useless to attempt anything like scientific precision in the training of young girls. (Youth was subsequently specified to mean 14.) A paper on "Technical Education in Rural Districts" was read by the Countess of Warwick. Lady Warwick is going to "relieve the depression from which our rural districts are suffering so keenly" by technical instruction administered to the children of agricultural labourers. It is doubless well-intentioned, but Lady Warwick may fairly be referred to Dr. Lunge, who comes from a country where they know what technical education means. There were papers by Miss Fanny L. Calder, Miss Pycroft, and Miss Edna Walter. The last, in a paper on the "Treatment of Domestic Science as an Element in Girls' Education," said that a movement, led by Dr. Armstrong, had been on foot for some years to teach fundamental science in a sensible way. Miss E. P. Hughes, member of the Cambridge Town Council Technical Committee, contended that after a girl left school she should, as a matter of course, take six months in a technical institute and study sewing, cooking, nursing, the principles of the management of a healthy home, and the general principles of the training of young children. (All very useful and necessary knowledge, no doubt, but hardly what one would call technical education.) Ladies first; next came the Colonies and India—but really this must be enough. A permanent

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bureau was elected, with the Duke of Devonshire as honorary president.

The Teaching of Chemistry.—At the meeting of the International Congress on Technical Education at the rooms of the Society of Arts, London, last week, there were four papers on the subject of the teaching of chemistry. Dr. Otto N. Witt (Professor of Chemical Technology at the Royal Polytechnic School at Berlin) had a paper on "The Relations Existing Between the Teaching of Pure Chemistry and Applied Chemistry." The highest object of all chemical instruction was to show the way to chemical research. No matter what the ultimate career of the young chemist might be, whether he devoted his energy to pure or to applied science, patient research would always be his only way to success. Whether his object were to create a new industry, starting from a new raw material, or whether his task were to improve old processes or to find the causes of troublesome difficulties, the way to success in all these different tasks was always the same—it consisted in a logical application of the old, well-known, and time-honoured methods of experimental research, either analytical or synthetical. Dr. H. E. Armstrong followed with a paper with a queer title. He expressed his satisfaction at the progress that had been made in recent years in the cause of constituting physical science an important part of every branch of education. But one drawback to progress in this direction of scientific teaching was the execrable system of examination that they had allowed to grow up, and that had engendered an altogether false conception of what a child was, and what it could do and should do. Teachers were fast coming to regard the pupils as a kind of animated set of pigeon-holes, into which every sort of fact could be crammed and taken out again when required. Experience showed, however, that the child behaved much as pigeon-holes did, taking in and giving out information more or less readily, but without digesting it—without learning to properly apply it. Steps should certainly be taken to stamp out the disease of certificate hunting and prize taking which was gradually spreading over all classes – a higher moral purpose should dominate both teachers and students. (Would there were any signs of it.) Science and Art Department examinations had, no doubt, in their day, served a useful purpose, but for the most part they had long since ceased to be otherwise than a hindrance to educational progress, a fact which was gradually but all too slowly being recognised. Dr. Gladstone, in a paper on "The Teaching of Chemistry in Evening Continuation Schools," described the system at Manchester. When the evening school was situated in the neighbourhood of factories it would be allowable, and even desirable, that the illustrations should be chosen with some reference to the prevailing industry. Sir Henry Roscoe opened the discussion. What England suffered from was that manufacturers did not see at present as they ought the importance of the highest scientific training for their workpeople. The other day he visited a large colour works near Frankfort, and saw there a place of which there was nothing of the kind in England. More than a hundred scientific chemists, highly trained, who had devoted years to original research, were employed in those great works for the obtaining of new results. The salaries paid to these men were high. One of them, who received £1,000 a year, had worked in the laboratories for years without bringing out any result that proved of commercial value. (The paradise of the chemist would be £1,000 a year and a laboratory and no questions asked.) But eventually he made a discovery which repaid them 10 times over, and which placed a new branch of manufacture entirely in their power. English manufacturers were not yet in as good a position as the Germans in that respect; they had not encouraged scientific research so fully, but at the same time England had been the home of the great discoveries in industrial chemistry in the past, and he believed she would be so in the future. (If our manufacturers have not the enterprise for this sort of thing, it seems pretty hopeless for the State to attempt to supply it.) Then there was another paper on "The Teaching of Chemistry," by Prof. G. Lunge, of Zurich, which was read by Sir H. Trueman Wood. To raise English chemical industry to the foremost rank it was necessary that the technical management of chemical factories should not be left in the hands of "rule-of-thumb" men, but should be intrusted to real chemists. These men should have a much fuller education than the majority of chemists seemed to obtain at present in Great Britain. At college the student should receive a thorough training in scientific chemistry, taking this in its widest meaning, not merely as a "testing" business. Next to this, but not to the same extent, he should be taught physics, mineralogy, technology, mechanics, and the elements of engineering. Everything else was more ornamental than useful; but the student should not confine himself only to the latter. As to whether foremen or even the common workmen should possess a certain knowledge of chemistry and technology, such as may be imparted at Board schools or at night classes for adults, Prof. Lunge was afraid that such knowledge was quite useless to ordinary workmen, who had simply to do as they were told, and who might do more harm than good by trying to apply a superficial idea of the nature of the operations which they had to perform, without possibly having a real insight into them. He did not even think that, apart from isolated exceptions, such knowledge was much good to the foremen, whose duty it was to carry out their instructions and to see that the men did their work as prescribed by the staff, but who were not to meddle with the chemical process itself. It seemed a great waste of time and means to give some superficial chemical teaching to tens of thousands of workmen on the remote chance that one of them might have some real benefit of it, while at the same time many hundreds of educated men were receiving a really efficient training in the same direction, many of whom could not find properly remunerated places owing to a great extent to the cheap labour of "bottle-washers." (This is true doctrine, but the other is more pleasing for two reasons to most of the people who have the administration of the really considerable funds which are available for technical education purposes.) Prof. Silvanus Thompson started the discussion anew. There should be a distinction between the different branches of the subject. Chemistry might be taught in schools as part of a general scientific training; secondly, as a preliminary scientific training, not for the chemical industries, but for such professions as medicine and pharmacy; thirdly, to train the chemist to take his part in chemical industries; and, fourthly, there was scope for the teachings of a somewhat more specialised chemistry. Where there were localised great industries science should be applied to that industry, and an institute put there devoted to monotechnical rather than polytechnical instruction. Training in research was absolutely necessary. Mr. Hooper hoped that the prejudices of ignorant workmen would be removed if some scientific instruction were given them. Dr. Thorne said it was a mistake to suppose that men would be reared in monotechnical institutes who would develop new processes. (In other words, if you learn only one thing you will never be able to change it for another and a better.) Mr. Thomas Snape (Liverpool), Mr. E. H. Cook (Bristol), Dr. Dunn (Holloway), Dr. Kipping, and others also spoke.

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THE MECHANICAL CONSTRUCTION OF ELECTRICAL MACHINERY.

BY F. M. WEYMOUTH.

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THE DYNAMO.

(Continued from page 783.)

Bearings (continued).—The bearings we have hitherto touched on have for the most part illustrated cases where there have been only two, or perhaps but one, of these in a machine. Thus, Fig. 192 presented a type of bearing adopted in direct-driven plant, wherewith, inasmuch as the further end of the shaft is carried by the engine, it forms the only bearing being actually part of the dynamo. Belt-driven dynamos, however, are sometimes made with three bearings, arranged so that there is one each side the pulley. It is then usual, no doubt largely for the sake of good appearance and uniformity, to let all the bearings be similar, with the exception of such modification at the commutator end as is needful for carrying the brush rockers. A design suiting these conditions is thus represented in Figs. 230 to 233, though this particular pattern is not of the "swivelling" type.

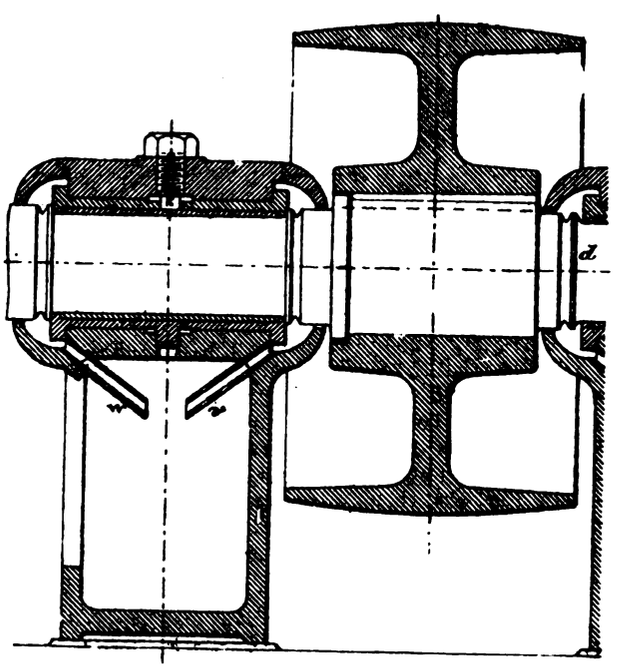

FIG. 230.

Fig. 230 shows, wholly and in part, a longitudinal section through the bearings for carrying the pulley end of a dynamo shaft, the bearing on the right in the view being precisely similar to that shown in full on the left. Some further features, however, are also here introduced. Thus, the drainage of the hoods is shown effected by means of two brass pipes, *w* and *v*, screwed into the cast iron; and an oil-can is placed in the chamber beneath to receive the drip. This approximates a method formerly used, for instance, by a now extinct firm, Messrs. Latimer Clark, Muirhead, and Co., Westminster. But the fitting of such pipes is an expense as compared with the more simple methods of merely coring out the drainage ways shown in Figs. 205, 216, and 228.

A feature, however, to be more particularly noticed here is the method of steadying or "registering" the cap sideways. This is again accomplished by projections rising from the base, but in this instance these take the form of two narrow ridges or lips, *r r* (Figs. 231 to 233), which continue along the outer edge only of the main casting, and are entirely outside the bolts. An exemplification of this method is to be seen in a Kapp thrust bearing, illustrated in Prof. S. P. Thompson's "Dynamo-Electric Machinery" (Fig. 253, fifth edition), though the vertical joint is there shown tangential to the bolts, instead of being clear of them. A little metal, however, beyond the bolt, as at *c* (Fig. 231), enables the hole in the cap to be carried down unbroken to the horizontal joint on *x y*: and the comparative thinness of the metal at this point is of less consequence owing to its small depth vertically.

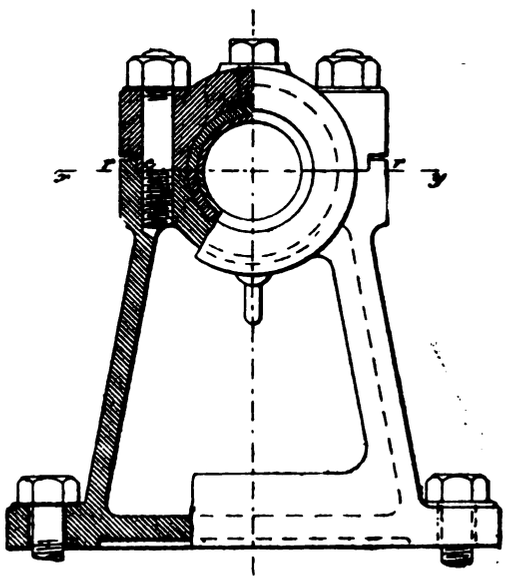

FIG. 231.

The placing of the lips, *r r*, so far out brings about a further advantage which is more easily discernible in Fig. 232. This latter is a half plan with the cap removed: and it will thus be seen that, owing to the ridges, *r r*, being so far from the shaft, the joint between the cap and the base where it passes through the oil-catching hoods is wholly in one plane through the horizontal centre line. There are therefore no small upstanding portions on the lips of the hoods, such as was shown at *j* (Figs. 209 and 210), easily liable to damage, and practically irreparable if broken or chipped.

It will be observed that the cap is bolted hard down, but bears on the base on the horizontal centre line, *x y*, only, gaps being left between the tops of the ridges, *r r*, and the cap over them. The holding down is shown effected by turned studs. These latter will fit drilled holes in the cap, and so serve to steady, or "register," the cap endways. Of course, turned tap-bolts may be used instead of studs. The several merits of these various fastenings were discussed on an early page. Lost nuts are more easily replaced than

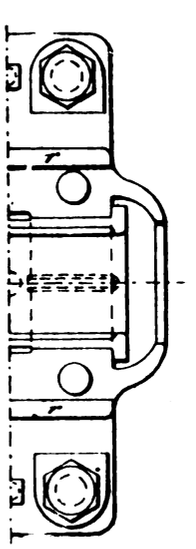

FIG. 232.

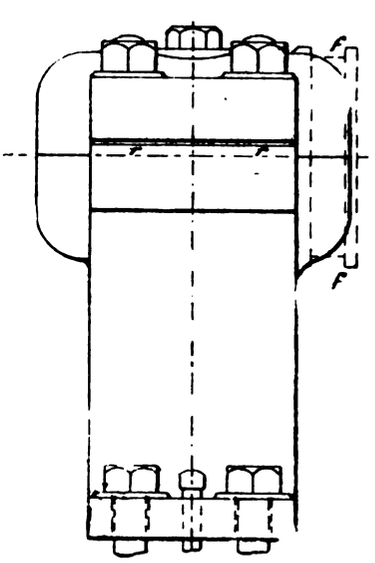

FIG. 233.

tap-bolts; but, on the other hand, it may be more convenient, when moving the shaft and armature in or out, not to have studs in the way. Accurate workmanship is required in any case to prevent end play of the cap and upper brass.

As in previous cases we have dilated upon, the two brasses here are bolted hard together, being what are

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termed "butt brasses," and so may practically be regarded as forming one solid bush, and the machining will need to be done largely from that point of view. It may seem not easy to bore three practically solid bearings and get them all accurately to line up with the shaft. Some remarks on this point, therefore, may not be out of place.

It will be noted in the first instance that the bearings, being similar in height, will stand on three facings on the dynamo or motor bed-plate, all of which will be planed in one operation, thus ensuring that they will be accurately level with one another. In machining the bearings, therefore, these will, of course, need to be planed on their bottom facings; and they will be planed on their tops to receive the caps, which latter will also need to be planed to a corresponding fit. The holes will then be drilled and tapped for the studs or tap-bolts for holding on the cap, and with these means the cap will be bolted on. The boring has now to be accomplished. In this operation two things are requisite. These are, firstly, to ensure in each case that the axis of the bore when finished shall be accurately parallel with the planed bottom facing of the bearing; and secondly, that the axes of the bores of the three bearings shall all be exactly the same height above their bottom facings.

To this latter end the bearings are now returned to the marking-off table, and a little bar of iron or hard wood having been knocked in tight across each end of their bores (as yet rough), the centres of the desired bore are truly marked on each of these bars. This is accomplished by first standing each bearing on its bottom facing, and then "scribing" a line all round it and across the bars which will be wholly in a plane at exactly the height above the base that the axis is required to be. The bearing is then tipped over, with its bottom facing exactly perpendicular to the table, and another line is scribed all round it which is in a vertical plane through the required axis. These two lines thus cross each other through the true centres on each little bar.

An "angle plate" is now bolted to the face-plate of the lathe to be used for boring. This is done so that one of its sides projects from the face-plate with a face always parallel to the axis of rotation; and also so as to be approximately the same distance from this axis of rotation that the centre of the dynamo shaft is to be above the bottom facings of the bearings. But the angle plate is not yet bolted tight to the face-plate. To the projecting face of the angle plate a bearing is now bolted. By means of the centres marked on the above-mentioned little crossbars in the bearings, these latter and the angle plate are so adjusted that the required axis of the bore shall exactly coincide with the axis of rotation of the lathe face-plate. The bolts are now all tightened up, and the boring proceeded with; and the bolts holding the angle plate to the lathe face-plate are not again loosened until all three bearings have been bored. Consideration, therefore, will now show that the axis of the bore of each bearing will be exactly parallel with its bottom facing; and all three axes will necessarily be at exactly the same height as required. The brasses being accurately turned and bored will maintain the same truth when in place in the bearings.

Sideways alignment is obtained subsequently. The three bearings are stood on their respective facings on the dynamo bed-plate, with the shaft laid in them: and the latter will thus naturally align the three bearings with itself. Holes in the bed-plate for the holding-down bolts of the bearings will have been already drilled and tapped: but the corresponding holes in the bearing foot are slightly larger than the bolts. Thus, after the bolts are in place, and before they are tightened, there is still a little play left permitting a final adjustment with all three bearings truly in line; and it will be well here also to rotate the shaft by hand to see that it runs free. The adjustment having been thus effected, the bolts are tightened down, and the holes for the taper steady pins are then rimmered out to receive the pins, which operation finally fixes accurately the position for each bearing. With the use of the steady pins the bearings may be accurately replaced after dismounting.

Another method, however, is to bore the bearings by means of a boring bar, when they are all properly bolted down to the dynamo bed-plate and taper steady pins fitted. The boring bar rotates in additional bearings at either end, and so bores all the dynamo bearings true to its own axis.

The end play of the shaft is taken up by the bearing shown in full in Fig. 230. An oil-throwing ridge is alone added at *d*, which does not bear against the end of the brasses. In the case here represented the flanges of the brasses are not cut back as was shown in Fig. 205, inasmuch as the diameter of the shoulders are not here relatively so large: though such cutting back, for the reasons then given, is more in consonance with the best workmanship and design. For carrying the brush rockers an end of one bearing will be as shown dotted at *f f* (Fig. 233), which it will be noted will not materially affect the general uniformity of the three bearings.

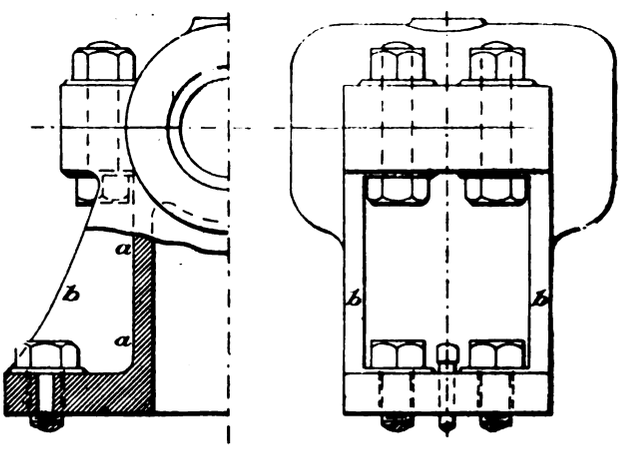

Fig. 234.

Figs. 234 and 235 are types generally similar to the foregoing, but showing the caps held down by bolts instead of studs or tap-bolts. The difference in the two designs is that due merely to the question as to whether these bolts are put in with the head above or below. In the latter case, shown Fig. 234, the side, *a a*, is carried down vertically so that the cap-bolt may be inserted from beneath, sufficient height being also allowed for this purpose. It will be seen that a cap-bolt could not thus be inserted with a bearing as illustrated in Fig. 235, where consequently the nut comes below instead. Ribs, *b b*, are added in Fig. 234, though perhaps many makers would omit them, and would prefer simply to make the metal a little thicker than would be required for the better shape in Fig. 235.

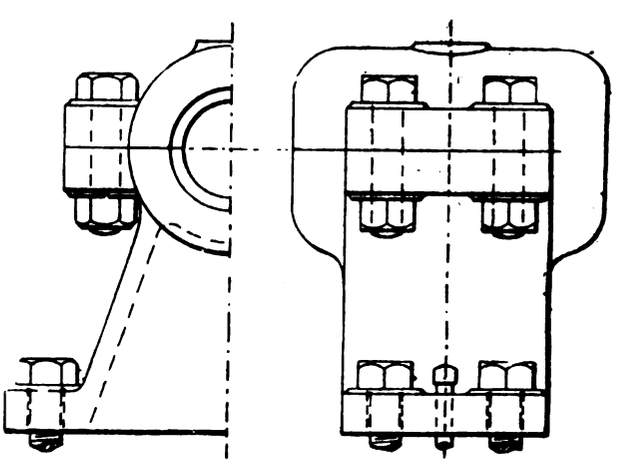

Fig. 235.

It is assumed in these that the waste oil drips from pipes as at *v*, Fig 230, into the pedestal below. The joint between the cap and the base is shown here in one plan: but it is of course optional to introduce the raised ledges as at *r r* in Fig. 231, which would make a "better job" though somewhat more expensive. An obvious advantage of the bolts, however, is that it is easy, by clamping the cap to the bearing, to drill through the flanges of both in one operation, and the bolts being turned to fit the holes, the registering of the cap is rendered simple. Tapping the cast iron is also avoided.

(To be continued.)

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THE LOCAL DISTRIBUTION OF ELECTRIC POWER IN WORKSHOPS, ETC.

BY ERNEST KILBURN SCOTT.

PART II.

(*Concluded from page 745.*)

TABLE XIII.—Comparison of Continuous and Alternating Current Systems.

—	Continuous.	Alternating.
Limiting pressure	About 2,500 volts.	About 15,000 volts.
Current	Flows in one direction.	Waves of current vibrating rapidly first in one direction and then in the other.
Generators ...	Dynamos of 2, 4, 6, or 8 poles, with expensive commutator.	Alternator with 12 or more poles and no commutator.
Parallel running, etc.	No difficulty however dissimilar the units. Series working is possible.	Difficulties, if too high or too low, an amount of self-induction, and, at high frequencies, synchronism becomes increasingly difficult the higher the number of phases. Series working not possible.
Frequency or periodicity	Not affected.	A most important factor; 20 to 60 periods per second for motors and 50 to 140 for lighting.
Phase	Not affected.	For motors, currents of two or more phases are necessary in order to give an initial torque.
Self-induction	Not affected.	Necessary to have concentric cables, or if single cables are employed they must be kept close together. There is also a difficulty in regulating pressure of supply.
Capacity	Not affected.	Capacity effect may cause complications at the higher pressures unless the E.M.F. curve is kept as near a sine curve as possible.
Skin effect ...	Not affected; heavy conductors carry current at the same current density in the centre as they do at the periphery.	With heavy currents and high frequencies, the conductors have to be subdivided, or made in the form of tubes, to get rid of this effect.
Insulation.....	Stress of insulation a minimum.	Stress on insulation about 50 per cent. more than with continuous currents for any particular voltage.
Ratio of weights of cables for equal power	Two wires, 70. Three wires, 20.	Single-phase two wires, 100. Single-phase three wires, 31. Two-phase four wires, 100. Three-phase three wires, 75.
Transformers.	Rotate. Consist of a dynamo and motor coupled together; they are expensive.	Stationary. Very cheap in construction. The largest sizes must rotate or have air-blast to keep them cool.
Motors	Extensively used and efficient in every way, but require commutator and brushes.	Not many used, and not very efficient, except at full load. A special clutch or rings and starting resistance required.
Starting torque (max.)	Series-wound motor. Six times running torque, and high efficiency.	The best that can be done is about three times running torque with low efficiency.
Arc lighting..	Most suitable, because of crater in positive carbon. No noise in working.	Can be used, but does not give such good results as continuous-current arcs. Noisy.
Electric welding	Suitable, especially for small welds.	Suitable, especially for fairly large welds.
Electric traction	Suitable, and very extensively employed. Only one trolley wire or conduit conductor is necessary.	Two conductors are necessary, as single-phase no good. The first tramway worked with three-phase motors has just been tried at Lugano.
Electrolytic work	Suitable.	Unsuitable.
Metallurgical work	Suitable.	Suitable, but not employed to any great extent.
Charging accumulators	Suitable. Most useful for storing power and steadying pressure.	Unsuitable.

In Table XIII. the writer has endeavoured to summarise the advantages and disadvantages of continuous and alternating currents, considered principally from the point of view of the local distribution of power in factories, and he thinks that the general conclusion which one must come to, after thoroughly looking into the matter, is that the user will get the best service all round out of continuous currents.

In an engineering works, especially, where *lighting* (arc and incandescent), *power work* (at both variable and constant speed), electric welding, electric traction, electrolytic work, and charging accumulators (for running the office lights and motors on overtime work) may all be employed, the advantage of having only one type of generating plant which will do all the above efficiently and without conversion is obvious.

Like all other thorough changes, this change to electrically-driven machinery must come gradually; but there can be no doubt that engineers and manufacturers are becoming awakened to the fact that motors afford not only a more convenient arrangement of machines, but that there is also an actual increase in economy both in number and cost of machines, and also in the power necessary to carry out a given piece of work.

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VERBAND DEUTSCHER ELEKTROTECHNIKER.

EISENACH MEETING.

(BY OUR SPECIAL CORRESPONDENT.)

(Continued from page 781.)

After the new rules for "safety with high-tension conductors" had been passed, a further report from the Standard Glow Lamps Committee was introduced. The object of the committee was to define what should be meant by the normal lamps, and the limits of variation permitted in normal lamps of certain nominal candle-powers, voltages, current, and life. In other words, if in the future a lamp-maker shall guarantee that his lamps conform to the standard of the Verband Deutscher Elektrotechniker, the buyer shall know what he is buying. The committee advised the use of an incandescent lamp as a standard for photometric purposes, and this came in for some adverse criticism. The lamp in this case will be incandesced to its normal brilliance. The arrangement of connections suggested by Mr. Heller, of Berlin, for comparison with other lamps of different voltages is shown in Fig. 4. In this the

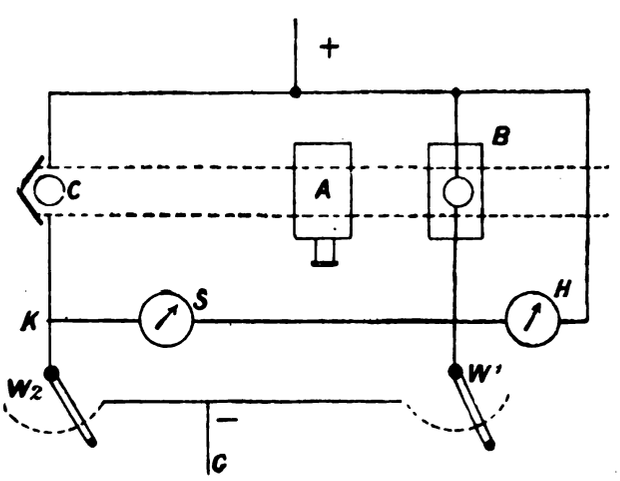

FIG. 4.

standard lamp, C, is placed in front of two reflectors placed at right angles to each other, so that the angle of the filament shall not seriously affect the results. The lamp to be tested, "B," is placed on the other side of the photometer in the usual way. The resistances, W^1 and W_2, shown underneath, then allow of the voltage on either or both lamps being adjusted at will. The voltmeters and ammeter also allow of the electrical readings being readily taken. One advantage of this arrangement is that small fluctuations in the E.M.F. of the supply act on both lamps and will not seriously upset the photometric balance.

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After some discussion, chiefly on the question of the standard lamp for photometric purposes, it was decided to reappoint the committee for another year. It seems that the central-station engineers had not had time given them to assist in this report. I could not but be struck with the business capabilities of the society in matters of trade regulations. The secret of their success in this department seems to me to be that committees of energetic men who feel the need of the regulations they are about to draw up are appointed. The secretary of the society, Mr. Gisbert Kapp, also may claim a lion's share of the credit, as the success of any institution depends largely on the energy and business tact of its secretary. Thus, since the meeting I first attended in Munich in 1895, the following sets of regulations have been framed and adopted: the safety rules for electric lightning conductors on houses, the rules as to standard electric fuses, the rules as to standard sizes of small screws to be used in electrical accessories and instruments. Now, this year the high-tension safety rules have been passed, and the normal lamp report has been read. I may also add that although the rules for house installation contained some drastic reforms, such as the total condemnation of wood casing, and also fixed a standard of insulation resistance, low, compared to our English regulations, yet, in spite of these changes and of the stir they created at the time amongst the authors of other sets of rules, the fire offices have recognised them, and beyond this have this year asked the Verband to appoint inspectors in each district to see that the rules are carried out. These inspectors' reports will be accepted as final by the fire offices, or, at least, by the greater number of these offices. Hence the German wiring contractor will be freed from the burden of having to comply with different rules in different installations, and, besides the benefit of a standard set of rules, will, further, have only to comply with the requirements of one responsible engineer in such matters. There are other advantages that will suggest themselves from the various fire offices taking the report of one official connected with the Verband. One important factor is that in this way a reliable man can be retained and paid well for his services, instead of each office having its own electrical expert without having enough work for him to warrant a high salary. Another point is that the conflicting reports of different fire office officials, as now found in electrical matters in England, will be avoided, and this will reassure the public as to the safety of their installations. It will be remembered in this connection that our Institution of Electrical Engineers have had a set of fire rules on the stocks for the past five years at least, and that they are, from all that we can see, as far off completion as ever.

The next business before the meeting was a paper read by Prof. Hermann Aron on his new electricity meter. This I shall be able to give full details of shortly, but it will suffice now to say that the meter is not an experiment, but the outcome of a long series of trial designs each effecting improvement. It is arranged to overcome all the objections which may be raised to a clock meter. The various new points were described to the meeting by their genial inventor. His face was wreathed in smiles as he dealt with the offspring of his inventive brain. In this new meter the pendulums are electrically driven, and the counting gear is made independent of the time-keeping properties of the clocks. In order to do this, the connections between the clocks and counting gear are reversed at frequent intervals. So if, due to one clock being slow, too much energy is recorded in the first interval, after reversing the action this fault is reversed and too little is recorded in the second interval. The meeting had little to say on this paper, but the members pressed to see the models of the meter which were on view. We then adjourned to the next room, and partook of the various meats and drinks provided. Caviare, ham sandwiches, and other thirst-promoting edibles had a good demand, and then the company returned to the large hall of the "Gewerbehaus," and continued smoking during the rest of the session. The opposition to the annual report of the Verband then had a hearing. I think the fact that only seven supported the amendment would be enough to say on this score, did not the points raised throw light on the constitution of the society. The first speaker on the opposition was a country member, and he claimed that the Verband was conducted on lines too favourable to the Berlin members, and that the members from other towns bore the greater part of the expense without gaining a fair return. After examining the books of the society, he was obliged to admit that this was not so. It is a fact, however, that the country members appear to pay each about three times more per annum to the Verband than do the Berlin members. This is due to the following: The Berlin Electrical Verein practically owned the *Elektrotechnische Zeitschrift* before the Verband was formed, and the cost of this paper raised the Verein membership fee much above that of the other local electrical societies, so the promoters of the Verband made arrangements that all their members should also belong to some electrical society, and that a total subscription of £1 per annum should entitle members to a copy of the paper weekly as well as to the privileges of the two societies. The members of the Berlin Verein had previously had to pay nearly this amount per annum, so that it appears as though a few shillings extra was their only contribution to the Verband. In the case of several local electrical societies the subscription only amounted to 5s. per annum, so that they have to pay 15s. per annum to the Verband. Of course the value of the *Zeitschrift* was overlooked, and the fact that a large portion of the Berlin Verein's subscriptions were for this paper. The opposition on this head fell through after the leader had spent some two hours investigating the accounts. The next gentleman had a grievance with which all are troubled. He complained that the trade competition was too keen, and that such competition made it hard to get work at a paying price. He expected the society to take the matter up and to fix, I suppose, standard prices, below which no firm should go. As he got half a dozen gentlemen to support him, I conclude that they believed that good could be done by the Verband in this direction. The large body of members present, however, recognised the hopeless task of trying to rule the market or to control the laws of supply and demand. The report of the past year was then passed with acclamation, and two other papers were then read. The first was by Mr. Rentzsch, on "Arc Lamp Supports." The apparatus described was on view in a room below. It consists of a flexible conductor for arc lamps, into which is stranded two iron cores for supporting the lamp. In this way the conductors and supporting wires are in one, and no loose flexible wires are required. It is the usual practice in Germany to have arc lamps to lower into the street for trimming, and hence the method may be found useful. The cable is wound direct on the drum for hoisting, etc., and end contacts on the drum complete the circuit to the lamp.

The other paper was by Mr. Braun, of Berlin, on electrical traction. The paper was too good and too long to bear abstraction, and hence will be held over. The business and paper had taken us from 10 a.m. till after 4 p.m., and the smoke and heat had been quite exhausting. So a party for a bathe was organised to refresh the members willing to have a swim.

The next function was a dinner at the Rautenkranz Hotel at 6 p.m. Practically everyone was present, and the large room allowed the whole party to be within easy distance of each other. The dinner was a typical German one, well served, and with speeches interspersed which were models of brevity and wit. After the usual loyal toasts and the health of the ladies had been proposed by Gehr. Slaby, the speeches were of the go-as-you-please order. The humorous speech of the last-mentioned gentleman, in which he showed how in all points the ladies excelled in electrical engineering, brought down the house. The health of Mr. Kapp was the first to be accorded musical honours, showing how much his work is appreciated by the members. After that we had the usual speech proposing the health of the grand old statesman Bismark, and I noticed that the proposer elevated his voice to accord with the magnitude of the subject. Up to this I had enjoyed the toasts, but when Mr. W. Fricker, of Magdeburg, began to talk of the English electrical engineers, and in proposing their health coupled my name with the toast, I found that my period of listening had come to an end. A few words, however, released me from my responsibility, and then a crowd of members came to

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clink glasses with me. More speeches followed, till at 11 we left the table and the good wine to drink beer elsewhere. During conversation, which even on this occasion tended towards shop at times, I learned that the Leicester Corporation had decided to place an order with Messrs. Ganz and Co., of Budapest, for inductor alternators to replace those at present in their electric light station.

(To be continued.)

THE ELECTRICAL MACHINERY AT THE BLACKPOOL WINTER GARDENS.

The directors of the company running the Blackpool Winter Gardens considered the subject of electric lighting in 1895, and after taking advice decided to put in their own plant.

Having thus decided, the directors lost no time, and specifications having been prepared, the contracts for the work were placed early in 1896. Messrs. Tinkers, Limited, of Hyde, secured the contract for the boilers, pumps, steam and exhaust connections, etc., and the contract for the supply of the engines, dynamos, switchboards, etc., was placed with Messrs. Verity's, Limited, of London and Manchester. The directors also decided, after fully considering the magnitude of the undertaking, to retain Mr. E. M. Lacey, of Westminster, as consulting electrical engineer to advise on all matters in connection with the machinery and wiring. Before giving a full description of the works, it may be well to say a few words which will give some idea as to the importance of this undertaking, which may fairly be described as the largest private electric lighting plant in the country. On the completion of the works there will be installed machinery of upwards of 1,100 h.p., capable of supplying current to 20,000 lamps at one time.

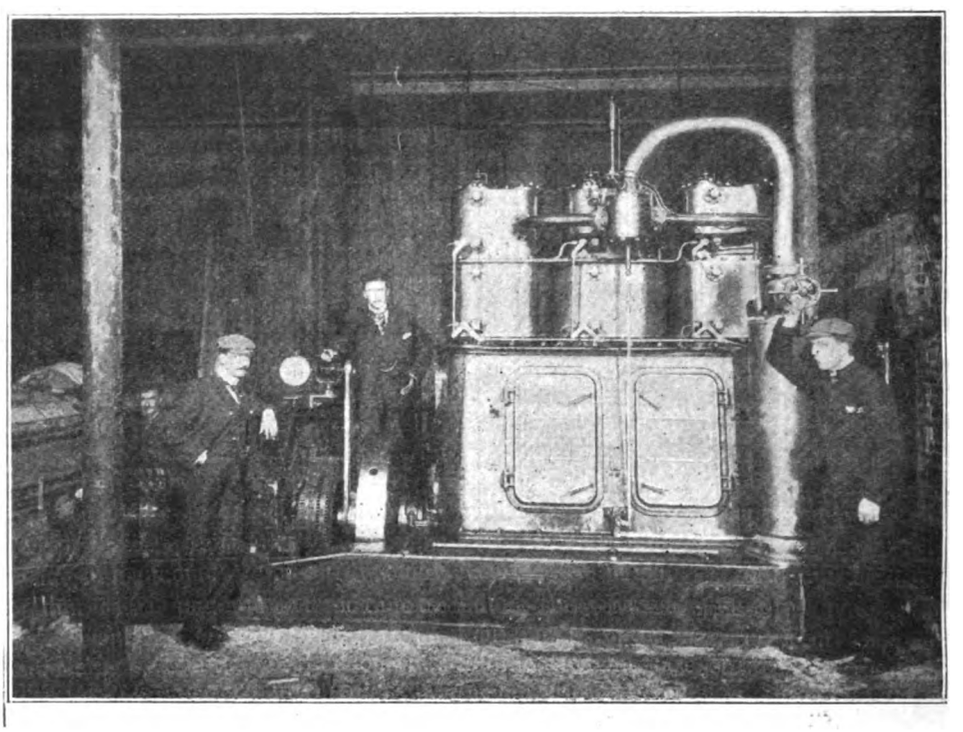

FIG. 1.—View of the Engine-Room at the Blackpool Winter Gardens.

The Generating Machinery.—The boiler and engine houses are situated on the right-hand side of the new ballroom, at the back of the Indian lounge, and will be open for the inspection of visitors at stated times. Four boilers have been fixed; three of these, by Messrs. Tinkers, are marine type, and are each capable of evaporating 5,000lb. of water per hour. The fourth boiler, by Messrs. Babcock and Wilcox, Limited, is of their well-known water-tube pattern, and is capable of evaporating 8,000lb. of water per hour. This boiler is fitted with steam-jet blowers for forced draught, so as to ensure quick steam raising in cases of necessity. The water supply is at present obtained from the Blackpool Corporation, and a storage tank has been provided holding about 7,500 gallons. From this tank the water is drawn by two Watson's vertical marine-pattern pumps, each capable of delivering 2,500 gallons per hour, and fed into the boilers through an improved exhaust-steam feed-water heater. Through this heater the exhaust steam from the engines is passed for the purpose of heating the feed-water supply to the boilers. The system of steam-piping is arranged in a ring form, valves being provided to allow of any portion being cut out without interference with the supply to the engines. The main and branch pipes are of mild steel with cast-steel flanges, the tie-pieces being also of cast steel. The bends and branches to the engines are of copper, and on the branch to each engine a McDougal steam-dryer has been provided. Suitable means have been provided for draining the sections of the steam-pipes. The main exhaust-pipe is of cast iron, 15in. diameter, and is carried up the chimney, branches being provided for the purposes of forming a way either through or by the heater.

When completed, the engine-room will contain three Belliss quick-revolution engines of 300 i.h.p. each, and one of 110 i.h.p. The dynamos are mounted on the engine bed-plates and driven direct (see Fig. 1). At present, two of these engines are erected and the others in course of manufacture. They are three-cylinder compound type coupled to three cranks at 120deg., and are each capable of developing 300 i.h.p. at 330 revolutions per minute with a steam pressure of 140lb. per square inch, non-condensing. The engines are of the enclosed type with forced lubrication to all moving parts. The governors are of the throttle-valve type, and are extremely sensitive to small variations of speed. When tested, the speed variations between full load and no load did not exceed 2 per cent., the test being taken by switching the whole of the load off the dynamo at one time. The dynamos are of the four-pole type manufactured by Messrs. J. H. Holmes and Co., of Newcastle. The output of each machine is 1,750 amperes at 110 volts. When tested at the makers' works each of the combined sets, engine and dynamo, was found to have an efficiency at full load of over 84 per cent. The consumption of steam by the engines, when working non-condensing with 120lb. of steam, was 21lb. per i.h.p.

The switchboard was constructed and supplied by the contractors for the whole of the electrical plant, and consists of panels of enamelled slate supported on an iron framework. The current from the dynamo is carried to omnibus bars on the board, and thence distributed to the various portions of the buildings. All the necessary

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regulating gear and measuring instruments for the whole installation are provided on this board. Each machine is provided with an automatic cut-out switch and shunt-breaking switch. No trouble or expense has been spared to facilitate the easy working of the station. From the engine-room 12 distributing mains are carried to the various portions of the Winter Gardens, where they serve sub-switch-boards, off which circuits are taken to the lights. These main cables have been supplied by Messrs. Verity's, Limited, who have also excuted the whole of the wiring for the new premises. Each distributing board consists of a separate enamelled slate slab, mounted with 'bus bars, double-pole fuses, and single-pole switches, enclosed in neat polished wood cases with glass doors. The largest of these controls 75 25-ampere circuits.

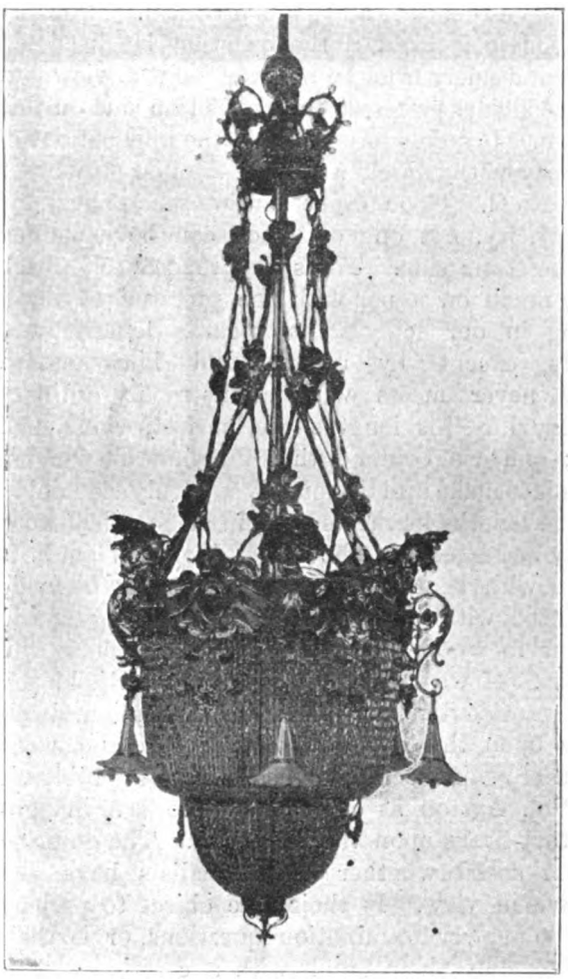

FIG. 2.—View of the Large Electrolier

In order to give a general idea as to the magnitude of the installation, it would be well to give approximately the number of lights in the equivalent of 8 c.p. installed throughout the buildings and grounds:

Empress ballroom, stage, and entrances	1,980
Indian lounge	1,000
Floral hall	1,000
Pavilion promenade	1,700
Opera house	1,050
Pavilion theatre	3,500
Billiard bars, cloakrooms, etc.	500
Fernery	400
Entrances	700
New saloons, restaurant, and offices	1,200
Gigantic wheel	1,000
Illuminated gardens	3,000
Stores, cellars, underground kitchens, etc.	350

The lighting of the Empress ballroom is of the most brilliant description. In the centre are suspended three of the largest electroliers ever manufactured; each weighs two tons, the over-all length is 26ft., and the over-all width 11ft. 6in. The large cut-glass bag can completely enclose 10 full-sized men. The lighting of these fittings is by means of carefully blending arc and incandescent lamps of various candle-powers, the latter arranged in the ornamental brasswork on the exterior of the fitting. The combination has the most brilliant effect. The general appearance of the fitting, as seen from the illustration (Fig. 2), is extremely handsome, and we learn that the bulk of the parts consists of hand-beaten brass, the shells and shields being the largest that have ever been so made. The fittings are suspended from specially designed winches fitted with automatic brake, and so geared that the fittings can be raised or lowered by two men. The side lighting of the ballroom is carried out by means of 35 very handsome copper and brass electroliers, suspended round the arches of first gallery, each containing four 16-c.p. incandescent lamps enclosed in handsome cut-glass vases. The lower galleries and staircase are lighted by means of seven-light cluster fittings of hand-beaten brass, and are also of handsome design. The lounge adjoining the ballroom has been treated in a plainer but most effective manner as regards the illumination of the fine decorations, there being no less than 744 incandescent lamps fixed to the ornamental plaster work on the arches, which form the border round the room between the vaulted roof and the handsomely hand-painted cove on the ceiling. From each of the domes are suspended very fine electroliers of Moorish design, the metal work being of brass, heavily finished in electro-gilt, relieved with silver; one of these fittings contains 25 lamps and the others 10 each. The general lighting of the grounds and front entrances to the buildings is carried out by means of over 200 arc lamps. The vaulted roof of the floral hall has been studded with hundreds of incandescent lamps of various colours, and the effect of these when viewed from among the fine palms which abound in this portion of the premises is extremely artistic. The lighting of the new pavilion stage will be carried out on the latest and most approved lines, and will be on a more extensive scale than any other theatre in this country, as the Winter Gardens Company are noted for the magnificent electrical effects which they produce every year in their ballets.

The whole of this important installation has been carried out by Messrs. Verity's, Limited, from their Manchester offices, under the personal direction of Mr. Charles S. Northcote; and the Winter Gardens Company have appointed Mr. A. R. Sillar resident electrical engineer to supervise the work on behalf of Mr. Lacey, who has designed the whole of the engineering portion of the scheme.

In concluding this description of the electric lighting installation, we must congratulate Mr. Charles R. Brighten, the manager of the Winter Gardens Company, and the chairman, Mr. James Pearson, on the success of their labours, as these gentlemen have spared neither time nor trouble in the matter.

FORTHCOMING EVENTS.

There is a meeting of the Physical Society this (Friday) afternoon; the programme is given elsewhere. The Telephone Athletic Association have an athletic *fête* and garden party at the Grove Hotel, Dulwich, to-morrow (Saturday). On Monday, June 28, Lord Kelvin opens the Shoreditch central station. On the same evening the King's College old students' dinner takes place at the Holborn Restaurant; Lord Kelvin will preside, and the Duke of Cambridge is expected. June 30 is the date of a London Chamber of Commerce meeting at the Salters' Hall (Sir G. Taubman-Goldie), and of the annual meeting of the Dundee Institute (at Dundee). The Municipal Electrical Association's convention begins at Manchester on 30th inst. and finishes on July 3. The Institution of Junior Engineers on Saturday, July 3, visit the engineering laboratories of Cambridge University, by invitation of Prof. J. A. Ewing. The train leaves Liverpool-street at 2.30 p.m.

Shoreditch Electricity Works.—Lord Kelvin has consented to open the Shoreditch combined electricity and dust destruction works on Monday, June 28, and the chairman of the London County Council will preside at a commemorative banquet to be held in the Shoreditch Town Hall on the same evening, and the streets of Shoreditch will be lighted from the works for the first time. At the generating station there are destructor cells capable of burning 20,000 tons of ashbin refuse per annum, and it is calculated that the heat given off will be sufficient for providing electric light and power for the whole of Shoreditch, with a population of 124,000 inhabitants, besides providing heat for the adjoining baths and wash-houses, which will effect a saving of £500 per annum in fuel. On the same site a public library and museum and technical institute are provided, the whole scheme costing upwards of £200,000.

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THE

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All communications intended for the Editor should be addressed C. H. W. Biggs, *139-140, Salisbury Court, Fleet Street, London, E.C. Anonymous communications will not be noticed.*

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BOUND VOLUMES.

Vol. XVIII. of new series of "THE ELECTRICAL ENGINEER" can be had bound in blue cloth, gilt lettered, price 8s. 6d. Subscribers can have their own copies bound for 2s. 6d., or covers for binding can be obtained, price 2s.

METHODS OF TEACHING.

Examinations for the time are almost ended. Teachers and students rest from their labours till the autumn comes, with its longer and cooler evenings. Now is a time when matter and method can be examined, and the steps in the ladder of progress considered. During the bustle of the examination season, Lord Kelvin, in one of his admirable addresses, suggested that the tendency of modern teachers was to employ wrong methods when dealing with the subject of electricity. He would have us commence with static electrical phenomena and proceed thence to all that is practical. Probably Lord Kelvin is right if the question be discussed simply and solely from an abstract point of view, but we have always preferred the opposition side on this question. It seems to us that all the applications of electricity with which a boy is familiar are other than statical. Upon every side we see applications of electricity, not one of which can be explained from the static side. To us the proposal to go back is very much on a par with the proposal to teach nothing in our schools as regards lengths and weights except by metres and kilogrammes. A boy never meets with a metre in ordinary everyday life—his lengths are in feet, yards, and miles; and we contend that the first duty of his master is to make him thoroughly and truly acquainted with the lengths he meets with in all practical work directly he leaves the schoolroom doors. When he is familiar with such measurements, he may be made acquainted with those beloved of the foreigner and by those to whom everything foreign is noble and precious. If we remember rightly, Dr. Hopkinson in his presidential address to the Institution, dwelt largely upon this question of teaching, and went altogether against commencing with static problems, and Prof. Ayrton at once claimed to have inaugurated text-books upon the new plan. The question is often asked whether educationalists have any objective in view. Is their sole object to prepare pupils to answer examination questions, or is their object to equip their pupils with a certain amount of knowledge that can be put to use in practical work? Not long since it was a common saying that a youth as soon as he left school, or commenced in practical work, had to forget almost all he had learnt, and begin his education anew. We must give such men as Profs. Ayrton and Thompson all credit for having done much to get rid of such a state of things, and for having so prepared their schemes of lectures that the subject-matter consisted of useful information rather than of information which had to be forgotten at the earliest possible moment. Still, the trammels and ties of examinations have been a curse, and not a blessing. The most modern, the most progressive, of examination papers is always tainted with the vanity of the examiner, who seems desirous of finding out what the candidate does not know rather than what he does know. Unfortunately, there is no appeal from an examiner's decision, yet the very questions he asks frequently shows him to be utterly unfit for the position he holds. But this is outside our present purpose. We do not for the

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moment desire to discuss questions of examiners, but the best method to teach a subject which is of an entirely practical character. The applications of electricity are many. As we have said, few of these applications arise from statical phenomena, and that being so, the laws of dynamic electricity form the groundwork of the technical knowledge of all practical men. Telegraphy, telephony, electric lighting, transmission of power in factories, in traction work and elsewhere, electrolytic work, and so on, employ scores of thousands of hands, and, with the exception of an instrument or two, none of the apparatus used is of a statical character. True, some of the newer developments not yet extensively used in the domains of practice are statical rather than dynamical, but though we strongly advocate teaching commencing with current electricity, we do not banish static entirely. That will come second, not first. It is a pity that divergent views should hold in high quarters, because such divergency leads to many troubles on the part of masters. They have to endure enough rough criticism as it is without putting another weapon in the hands of those who think their ways fit butts to shoot every available weapon at. Depend upon it, the parent will condemn the master for the faults of the pupil; and all masters cannot tell a man he does not know what he is talking about, or send him to Jericho without hesitation.

DROP IN ALTERNATING-CURRENT LINES.*

BY RALPH D. MERSHON.

When alternating currents first came into use, when transmission distances were short, and the only loads carried were lamps, the question of drop or loss of voltage in the transmission line was a simple one, and the same methods as for direct current could without serious error be employed in dealing with it. The conditions existing in alternating practice to-day—longer distances, polyphase circuits and loads made up partly or wholly of induction motors—render this question less simple, and direct-current methods applied to it do not lead to satisfactory results. Any treatment of this, or of any engineering subject if it is to benefit the majority of engineers, must not involve groping through long equations or complex diagrams in search of practical results. The results, if any, must be in available and convenient form. In what follows the endeavour has been made to so treat the subject of drop in alternating-current lines that if the reader be grounded in the theory the brief space devoted to it will suffice, but if he do not comprehend or care to follow the simple theory involved, he may nevertheless turn the results to his practical advantage.

Calculation of Drop.—Most of the matter heretofore published on the subject of drop treats only of the interrelation of the E.M.F.'s involved, and, so far as the writer knows, there have not appeared in convenient form the data necessary for accurately calculating this quantity. The table and chart given herewith include in a form suitable for the engineer's pocket-book everything necessary for calculating the copper of alternating-current lines. The chart is simply an extension of the vector diagram (Fig. 1), giving the relations of the E.M.F.'s of line, load, and generator. In Fig. 1, E is the generator E.M.F.; *e* the E.M.F. impressed upon the load; *c* that component of E which overcomes the back E.M.F. due to the impedance of the line. *c* is made up of two components at right angles to each other—one is *a*, the component overcoming the C R or back E.M.F. due to resistance of the line; the other is *b*, the component overcoming the reactance E.M.F. or back E.M.F. due to the alternating field set up around the wire by the current in the wire. The drop is the difference between E and *e*. It is *d*, the radial distance between two circular arcs, one of which is drawn with a radius *e*, the other with a radius E.

The chart is made by striking a succession of circular arcs with *o* as a centre. The radius of the smallest circle corresponds to *e*, the E.M.F. of the load, which is taken as 100 per cent. The radii of the succeeding circles increase by 1 per cent. of that of the smallest circle, and, as the radius of the last or largest circle is 140 per cent. of that of the smallest, the chart answers for drops up to 40 per cent. of the E.M.F. delivered.

The terms resistance volts, resistance E.M.F., reactance volts, reactance E.M.F. refer, of course, to the voltages for overcoming the back E.M.F.'s due to resistance and reactance respectively. The figures given in the table under the heading "Resistance Volts for One Ampere, etc.," are simply the resistances of 2,000ft. of the various sizes of wire. The values given under the heading "Reactance Volts, etc.," are, a part of them, calculated from tables published some time ago by Messrs. Houston and Kennelly. The remainder were obtained by using Maxwell's formula. The explanation given of the sheet itself is thought to be a sufficient guide to its use, but a few examples may be of value.

Problem.—Power to be delivered, 250 kilowatts; E.M.F. to be delivered, 2,000 volts; distance of transmission, 10,000ft.; size for wire, No. 0; distance between wires, 18in.; power factor of load, ·8; frequency, 7,200 alternations per minute. Find the line loss and drop.

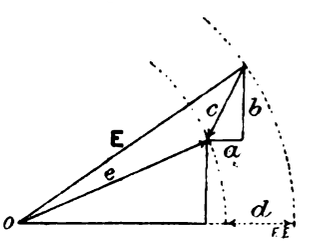

FIG. 1.

Remembering that the power factor is that fraction by which the apparent power or volt-amperes must be multiplied to give the true power, the apparent power to be delivered is $\frac{250 \text{ kw.}}{\cdot 8} = 312{\cdot}5$ apparent kilowatts. The current, therefore, at 2,000 volts will be $\frac{312{,}500}{2{,}000} = 156{\cdot}25$ amperes. From the table of reactances under the heading "18 inches," and corresponding to No. 0 wire, is obtained the constant ·228. Bearing the instruction of the sheet in mind, the reactance volts of this line are 156·25 (amperes) × 10 (thousands of feet) × ·228 = 356·3 volts, which are 17·8 per cent. of the 2,000 volts to be delivered.

From the column headed "Resistance Volts" and corresponding to No. 0 wire is obtained the constant ·197. The resistance-volts of the line are, therefore, 156·25 (amperes) × 10 (thousands of feet) × ·197 = 307·8 volts, which are 15·4 per cent. of the 2,000 volts to be delivered.

Starting, in accordance with the instructions of the sheet, from the point where the vertical line, which at the bottom of the sheet is marked "Load Power Factor" ·8, intersects the inner or smallest circle, lay off horizontally and to the right the resistance E.M.F. in per cent. (15·4), and "from the point thus obtained" lay off vertically the reactance E.M.F. in per cent. (17·8). The last point falls at about 23 per cent., as given by the circular arcs. This, then, is the drop in per cent. of the E.M.F. delivered. The drop in per cent. of the generator E.M.F. is, of course, $\frac{23}{100+23} = 18{\cdot}7$ per cent.

The percentage loss of power in the line has not, as with direct current, the same value as the percentage drop. This is due to the fact that the line has reactance, and also that the apparent power delivered to the load is not identical with the true power—that is, the load power factor is less than unity. The loss must be obtained by calculating $C^2 R$ for the line, or, what amounts to the same thing, by multiplying the resistance volts by the current. The

* From the *American Electrician*.

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resistance volts in this case are 307·8 and the current 156·25 amperes. The loss is $307·8 \times 156·25 = 48·1$ kilowatts. The percentage loss is $\frac{48·1}{250+48·1} = 16·1$ per cent. Therefore, for the problem taken, the drop is 18·7 per cent. and the loss is 16·1 per cent. If the problem be to find the size wire for a given drop it must be solved by trial. Assume a size of wire and calculate the drop; the result in connection with the table will show the direction and extent of the change necessary in the size of wire to give the required drop.

The effect of line reactance in increasing the drop should be noted. If there were no reactance, the drop in the above example would be given by the point obtained in laying off on the chart the resistance E.M.F. (15·4) only. This point falls at 12·4 per cent., and the drop in terms of the generator E.M.F. would be $\frac{12·4}{112·4} = 11$ per cent., instead of 18·7 per cent. Anything therefore which will reduce reactance is desirable.

Reactance can be reduced in two ways. One of these is to diminish the distance between wires. The extent to which this can be carried is limited in the case of a pole line to the least distance at which the wires are safe from swinging together in the middle of the span; in inside wiring, by the danger from fire. The other way of reducing reactance is to split the copper up into a greater number of circuits and arrange these circuits so that there is no inductive interaction. For instance, suppose that in the example worked out above two No. 3 wires were used instead of one No. 0 wire. The resistance volts would be practically the same, but the reactance volts would be less in the ratio $\frac{1}{2} \times \frac{·244}{·228} = ·535$, since each circuit would bear half the current the No. 0 circuit does, and the constant for No. 3 wire is ·244 instead of ·228—that for No. 0. The effect of subdividing the copper is also shown, if in the example given it is desired to reduce the drop to, say, one-half. Increasing the copper from No. 0 to No. 0000 will not produce the required result for, although the resistance volts will be reduced one-half, the reactance volts will be reduced only in the ratio $\frac{·212}{·228}$. If, however, two inductively independent circuits of No. 0 wire be used, the resistance and reactance volts will both be reduced one-half, and the drop will therefore be diminished the required amount.

The component of drop due to reactance is best diminished by subdividing the copper or by bringing the conductors closer together, and is little affected by change in size of conductors.

An idea of the manner in which changes of power factor affect drop is best gotten by an example. Assume distance of transmission, distance between conductors, E.M.F. and frequency the same as in the previous example. Assume the apparent power delivered the same as before and let it be constant, but let the power factor be given several different values; the true power will therefore be a variable depending upon the value of the power factor. Let the size of wire be No. 0000. As the apparent power, and hence the current, is the same as before and the line resistance is one-half, the resistance E.M.F. will in this case be $\frac{15·4}{2}$, or 7·7 per cent. of the E.M.F. delivered. Also the reactance E.M.F. will be $\frac{·212}{·228} \times 17·8 = 16·5$ per cent. Combining these on the chart for a power factor of ·4 and deducting the drop in per cent. of the generator

By means of the Table calculate the *Resistance-Volts* and the *Reactance-Volts* in the line, and find what per cent. each is of the E.M.F. delivered at the end of the line. Starting from the point on the chart where the vertical line corresponding with power-factor of the load intersects the smallest circle, lay off in per cent. the resistance E.M.F. horizontally and to the right; from the point thus obtained lay off upward in per cent. the reactance-E.M.F. The circle on which the last point falls gives the drop in per cent. of the E.M.F. delivered at the end of the line. Every tenth circle arc is marked with the per cent. drop to which it corresponds.

Size of Wire B.&S.	Weight—Pounds per 1000 ft. Single Wire.	Resistance-Volts in 1000 ft. of Line (2000 ft. of wire) for One Ampere ($\sqrt{}$ Mean Square).	Reactance-Volts in 1000 ft. of Line (=2000 ft of Wire) for One Ampere ($\sqrt{}$ Mean Square) at 7800 Alternations per Minute for the Distance Given Between Centers of Conductors.										
			½"	1"	2"	3"	6"	9"	12"	18"	24"	30"	36"
0000	639	.098	.046	.079	.111	.130	.161	.180	.193	.212	.225	.235	.244
000	507	.124	.052	.085	.116	.135	.167	.185	.199	.217	.230	.241	.249
00	402	.156	.057	.090	.121	.140	.172	.190	.204	.222	.236	.246	.254
0	319	.197	.063	.095	.127	.145	.177	.196	.209	.228	.241	.251	.259
1	253	.248	.068	.101	.132	.151	.183	.201	.214	.233	.246	.256	.265
2	201	.313	.074	.106	.138	.156	.188	.206	.220	.238	.252	.262	.270
3	159	.394	.079	.112	.143	.162	.193	.212	.225	.244	.257	.267	.275
4	126	.497	.085	.117	.149	.167	.199	.217	.230	.249	.262	.272	.281
5	100	.627	.090	.121	.154	.172	.204	.223	.236	.254	.268	.278	.286
6	79	.791	.095	.127	.158	.178	.209	.228	.241	.260	.272	.283	.291
7	63	.997	.101	.132	.164	.183	.214	.233	.246	.265	.278	.288	.296
8	50	1.260	.106	.138	.169	.188	.220	.238	.252	.270	.284	.293	.302

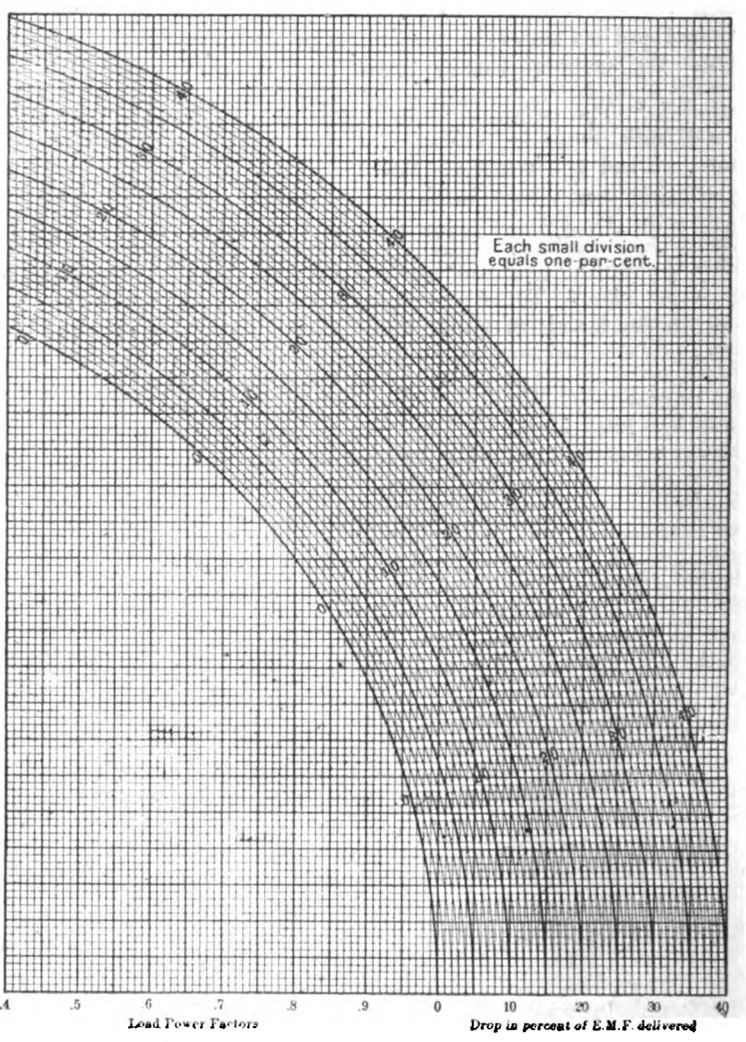

Table and Chart for Obtaining the Drop in Alternating-Current Lines having Self Inductance and Resistance.

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E.M.F., the value obtained is 15·3 per cent.; with a power factor of ·8 the drop is 14 per cent.; with a power factor of unity it is 8 per cent. If in this example the true power instead of the apparent power had been taken as constant, it is evident that the values of drop would have differed more widely, since the current, and hence the resistance and reactance volts, would have increased as the power factor diminished. The condition taken more nearly represents that of practice.

If the line had resistance and no reactance the several values of drop instead of 15·3, 14, and 8, would be 3·2, 5·7, and 7·2 per cent. respectively, showing that for a load of lamps the drop will not be much increased by reactance, but that with a load, such as induction motors, whose power factor is less than unity, care should be taken to keep the reactance as low as practicable. In all cases it is advisable to place conductors as close together as good practice will permit.

When there is a transformer in circuit, and it is desired to obtain the combined drop of transformer and line, it is necessary to know the resistance and reactance volts of the transformer. The resistance volts of the combination of line and transformer are the sum of the resistance volts of the line and the resistance volts of the transformer. Similarly, the reactance volts of the line and transformer are the sum of their respective reactance volts. The reactance and resistance E.M.F.'s of transformers may usually be obtained from the makers, and are ordinarily given in per cent.* These percentages express the values of the reactance and resistance E.M.F.'s when the transformer delivers its normal full-load current, and they express these values in terms of the normal no-load E.M.F. of the transformer.

Consider a transformer built for transformation between 1,000 and 100 volts. Suppose the resistance and reactance E.M.F.'s given are 2 per cent. and 7 per cent. respectively. Then the corresponding voltages when the transformer delivers full-load current are 2 and 7 volts or 20 and 70 volts, according as the line whose drop is required is connected to the low-voltage or high-voltage terminals. These values, 2-7 and 20-70, hold no matter at what voltage the transformer is operated, since they depend only upon the strength of current, providing it is of the normal frequency. If any other than the full-load current is drawn from the transformer the reactance and resistance volts will be such a proportion of the values given above as the current flowing is of the full-load current. It may be noted, in passing, that when the resistance and reactance volts of a transformer are known, its regulation may be determined by making use of the chart in the same way as for a line having resistance and reactance. As an illustration of the method of calculating the drop in a line and transformer, and also of the use of table and chart in calculating low-voltage mains, the following example is given:

Problem.—A single-phase induction motor is to be supplied with 20 amperes at 200 volts; alternations, 7,200 per minute; power factor, ·78. The distance from transformer to motor is 150ft., and the line is No. 5 wire 6in. between centres of conductors. The transformer reduces in the ratio $\frac{2,000}{200}$, has a capacity of 25 amperes at 200 volts, and when delivering this current and voltage its resistance E.M.F. is 2·5 per cent.; its reactance E.M.F., 5 per cent. Find the drop.

The reactance of 1,000ft. of circuit consisting of two No. 5 wires 6in. apart is ·204. The reactance volts, therefore, are $·204 \times \frac{150}{1,000} \times 20 = ·61$ volt. The resistance volts are $·627 \times \frac{150}{1,000} \times 20 = 1·88$ volts. At 25 amperes the resistance volts of the transformer are 2·5 per cent. of 200, or 5 volts. At 20 amperes they are $\frac{20}{25}$ of this, or 4 volts. Similarly the transformer reactance volts at 25 amperes are 10, and at 20 amperes are 8 volts. The combined reactance volts of transformer and line are $8 + ·61 = 8·61$, which is 4·3 per cent. of the 200 volts to be delivered. The combined resistance volts are $1·88 + 4$, or 5·88, which is 2·94 per cent. of the E.M.F. to be delivered. Combining these quantities on the chart with a power factor of ·78, the drop is 5 per cent. of the delivered E.M.F., or $\frac{5}{105} = 4·8$ per cent. of the impressed E.M.F. The transformer must be supplied with $\frac{2,000}{·952} = 2,100$ volts, in order that 2,000 volts shall be delivered to the motor.

The table is made out for 7,200 alternations, but will answer for any other number if the values for reactance be changed in the direct proportion to the change in alternations. For instance, for 16,000 alternations multiply the reactances given by $\frac{16,000}{7,200}$. For other distances between centres of conductors interpolate the values given in the table. As the reactance values for different sizes of wire change by a constant amount, the table can, if desired, be readily extended for larger or smaller conductors. The table is based on the assumption of sine currents and E.M.F.'s. The best practice of to-day produces machines which so closely approximate this condition, that results obtained by the above methods are well within the limits of practical requirements.

Polyphase Circuits.—So far single phase circuits only have been dealt with. A simple extension of the methods given above adapts them to the calculation of polyphase circuits. A four-wire quarter-phase (two-phase) transmission may, so far as loss and regulation are concerned, be replaced by two single-phase circuits identical (as to size of wire, distance between wires, current, and E.M.F.) with the two circuits of the quarter-phase transmission, provided that in both cases there is no inductive interaction between circuits. Therefore, to calculate a four-wire quarter-phase transmission, compute the single-phase circuit required to transmit one half the power at the same voltage. The quarter-phase transmission will require two such circuits.

A three-wire, three-phase transmission, of which the conductors are symmetrically related, may, so far as loss and regulation are concerned, be replaced by two single-phase circuits having no inductive interaction, and identical with the three-phase line as to size, wire, and distance between wires. Therefore to calculate a three-phase transmission calculate a single-phase circuit to carry one-half the load at the same voltage. The three-phase transmission will require three wires of the size and distance between centres as obtained for the single-phase.

A three-wire, quarter-phase transmission may be calculated exactly as regards loss and approximately as regards drop, in the same way as for three-phase. It is possible to exactly calculate the drop, but this involves a more complicated method than the approximate one. The error by this approximate method is generally small. It is possible also to get a somewhat less drop and loss with the same copper by proportioning the cross-section of the middle and outside wires of a three-wire, quarter-phase circuit to the currents they carry instead of using three wires of the

* When the required values cannot be obtained from the makers they may be measured. Measure the resistance of both coils. If the line to be calculated is attached to the high-voltage terminals of the transformer, the equivalent resistance is that of the high-voltage coil plus the resistance obtained by increasing in the square of the ratio of transformation the measured resistance of the low-voltage coil; that is, if the ratio of transformation is 10, the equivalent resistance referred to the high-voltage circuit is the resistance of the high-voltage coil plus 100 times that of the low-voltage coil. This equivalent resistance multiplied by the high-voltage current gives the transformer resistance volts referred to the high-voltage circuit. Similarly, the equivalent resistance referred to the low-voltage circuit is the resistance of the low-voltage coil plus that of the high-voltage coil reduced in the square of the ratio of transformation. It follows, of course, from this that the values of the resistance volts referred to the two circuits bear to each other the ratio of transformation. To obtain the reactance volts, short-circuit one coil of the transformer and measure the voltage necessary to force through the other coil its normal current at normal frequency. The result is nearly enough the reactance volts. It makes no difference which coil is short-circuited, as the results obtained in one case will bear to those in the other the ratio of transformation. If a close value is desired, subtract from the square of the voltage reading the square of the resistance volts, and take the square root of the difference as the reactance volts.

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same size. The advantage of the course is not great, and it will not be considered here.

The above statements as to calculation of polyphase circuits are made subject to certain conditions in arrangement of conductors. These conditions will be considered.

Arrangement of Conductors.—The two circuits of a quarter-phase transmission should be so arranged that there is no inductive interaction. Such arrangement may be accomplished in either of the ways shown in Figs. 2 and 3.

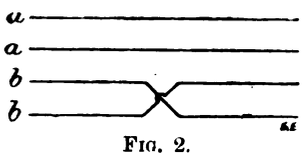

FIG. 2.

Fig. 3 shows the two wires, *a a*, of one circuit and the two, *b b*, of the other circuit at opposite ends of the diagonals of a square. With such an arrangement there is no inductive action between the two circuits, since none of the lines of induction due to the one can be linked through the other. Fig. 2 shows the two circuits side by side (they may be in any other relative position providing it is preserved throughout), and the wires of the circuit, *b b*, interchanged at their middle point. Such an arrangement fulfils the requirements, since all the linkages from *a a* to *b b*, and from *b b* to *a a*, in one half the transmission, are exactly offset by the same number of opposite linkages in the other half of the transmission.

FIGS. 3 AND 4.

The three wires of a three-phase transmission should be so arranged that they are symmetrically related. Figs. 4 and 6 show two methods of accomplishing this. In Fig. 4 the three wires are at the three corners of an equilateral triangle. In Fig. 6 the wires are all on the same cross-arm, and are twice interchanged, once at one-third and once at two-thirds of the transmission distance. In Fig. 4, since

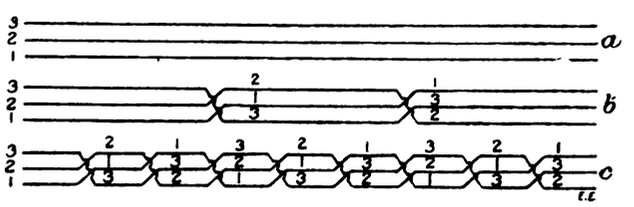

FIG. 5.

the wires bear equal currents, of symmetrical phase relation, and because of the symmetry of arrangement, the inductive action between any one wire and the remaining two is the same, no matter which wire be considered. In Fig. 6 the same is true, as may be seen by tracing the wires throughout their length. The arrangement of Fig. 6 answers for the case of all the power transmitted to the end of the line, and under such conditions only the two transpositions shown are necessary. If power is tapped off at intermediate points

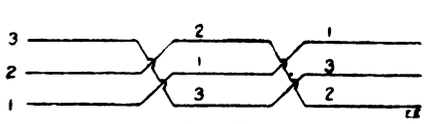

FIG. 6.

and perfect equalisation is desired, the wires should be interchanged as shown in Fig. 6, between all points at which there is connection made to the line—that is, there should be two transpositions between the power station and the first receiving station, two between the first and second receiving stations, and so on.

In some cases where the triangular arrangement of conductors is employed, the wires are in addition interchanged. This is unnecessary unless it is not possible to arrange the wires in a triangle which is practically equilateral, or unless there are two or more circuits adjacent, and it is desired to have them inductively independent. When the latter is the case, the circuits should be disposed as in Fig. 5, which represents a top view of the triangular arrangement. The first circuit, *a*, runs straight through; the second, *b*, is interchanged twice; the third, *c*, is interchanged eight times; the fourth would be interchanged 26 times, etc. If it is necessary to interchange the first circuit because of inequality in the sides of the triangle, *b* must be taken as the first circuit, *c* the second, etc. *b* and *c* of Fig. 5 also answer for the disposition of circuits, of which the three wires are on the same cross-arm as in Fig. 6; then *b* is the first circuit, *c* the second, etc.

In a quarter-phase, three-wire circuit there is little advantage, if any, in arrangement other than that of wires equidistant and side by side without interchange. The two circuits of the three-wire, quarter-phase transmission cannot be made inductively independent, and the complication already mentioned in accurately calculating the drop is due to this fact.

If some such arrangement as those given is not employed—that is, if the four wires of the quarter-phase or the three of the three-phase are strung straight through on the same cross-arms, the unbalanced inductive action will be the cause of an unbalancing of the system, which in a short transmission may not amount to much, but which in a long transmission may cause considerable annoyance.

The rule given some time back for calculating a three-phase line applies closely but not exactly to Fig. 6. Fig. 6 cannot be exactly replaced by two single-phase circuits, the wires of which are the same distance apart as the adjacent wires of Fig. 6. No two wires of Fig. 6 are the same distance apart throughout their length. They are one distance apart for two-thirds their length and twice that distance for the remaining third. The equivalent single-phase circuits must, therefore, have between wires a distance intermediate between that of adjacent and extreme wires of Fig. 6. Consider a three-phase line, of which adjacent wires are 18in. apart. The equivalent single-phase circuits must have their wires apart a distance intermediate between 18in. and 36in. What this distance is can be determined by the table of reactances. Suppose the wire be No. 0. The constant for 18in. is ·228, that for 36in. is ·259. Therefore the constant of the equivalent single-phase circuit is $\frac{\cdot 228 + \cdot 228 + \cdot 259}{3} = \cdot 238$, which corresponds to a distance of about 22in.

This shows one advantage which the triangular arrangement has over that of Fig. 6; for the same distance between adjacent conductors the reactance with the triangular arrangement is less than with that of Fig. 6. If close results are wanted with an arrangement like Fig. 6, the average constant for any two wires must be taken in calculating the reactance volts.

Compensation for Drop.—However the drop in feeders is compensated for, whether by "boosters" or by the use of choke coils or resistances, it is necessary, in order to secure good regulation, that there be employed some means of indicating at all times the voltage delivered at the receiving end of the transmission. One of the oldest devices for this purpose is that of using "pressure wires" or leads run from the end of the feeder back to the generating station, where they are attached to a voltmeter. This method was first employed in direct-current work. It answers equally well for alternating currents, providing the two pressure wires are the same distance from any other wires bearing alternating current, or are frequently interchanged so that no inductive effect is upon them.

Pressure wires are objectionable, however, on the score of cost, especially in the case of numerous and long feeders. Other contrivances, designed to do away with pressure wires, have been used. They depend for their action on the direct or indirect measurement of the current flowing in the feeders, and are supposed to give an indication directly proportional to this current. Although they answer well enough when used on feeders carrying a lamp load only, they are useless on feeders carrying a load of motors or lamps and motors. The reason for this is that

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with the same current flowing, the drop in a line may vary considerably because of variations in the power factor of the load. This is clearly shown in one of the problems taken up under calculation of drop. The power factor of a load made up wholly or in part of induction motors will from time to time vary quite widely. This is especially true of a circuit carrying a day load of motors and a night load of lamps.

So far as is known to the writer, there has never been published a device which will, with regard to the nature of the load, indicate the voltage at the receiving end of an alternating-current line; which will, in other words, take account of current, power factor, reactance, and resistance. Such a device is, however, possible. Supposing that at the station there were produced three E.M.F.'s proportional to and in step with respectively the E.M.F. impressed upon the line at the station, the reactance E.M.F., and the resistance E.M.F., and that these three were combined in the same way as are their counterparts in the line. Their resultant would be proportional to and in step with the E.M.F. at the far end of the line, and a voltmeter actuated by this resultant would at all times give an indication proportional to the E.M.F. of the load.

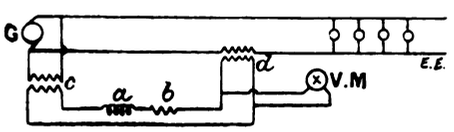

FIG. 7.

Figs. 7 and 8 show methods of connection which fulfil the required conditions. Many variations from these connections are possible, but they all involve the same principle. In Fig. 7 *d* is a converter in series with the main line, and yielding in its secondary circuit a current always proportional to and in step with the line current. *c* is a converter connected across the generator terminals and supplying in its secondary circuit an E.M.F. in step with and proportional to that of the generator. *a* is an inductive resistance or reactance coil and *b* an ohmic resistance, both so adjusted with respect to the current from converter *d* that for a given current through them their respective E.M.F.'s have the same value relative to the E.M.F. of converter *c* as the reactance and resistance E.M.F.'s of the line have to the

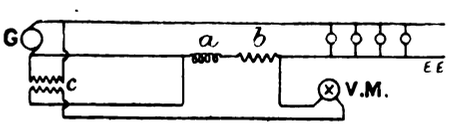

FIG. 8.

E.M.F. of the generator. The current supplied by converter *d* being in step with and proportional to the main current, the reactance E.M.F. of *a* and the resistance E.M.F. of *b* will be proportional to and in step with the corresponding quantities of the line and with the connections shown in the figure, they will reduce or cut down the E.M.F. of *c* in the same proportion as their line counterparts do the generator E.M.F. The voltmeter will therefore always give an indication proportional to the voltage delivered at the end of the line. Fig. 8 accomplishes the same result without passing any current through converter *c*, except that necessary for the voltmeter. This method of indicating the load voltage has proven itself perfectly satisfactory.

THE COX THERMO-ELECTRIC GENERATOR.

Our readers will remember our description of the above apparatus which appeared in our issue of February 26, 1897. We then referred to Mr. Cox's original and somewhat misleading method of describing the output of his generators. On May 20 the inventor (Mr. H. Barringer Cox) delivered a lecture before the New York Electric Society on the generators, which, with the discussion, we abstract from our American contemporary, *Electricity*.

Unfortunately, both for the lecturer and his adience, some of the apparatus and its various parts which he had intended to exhibit had been delayed in the Custom House, but two of his piles were exhibited in operation.

After a humorous description of his early experiences in thermo-electricity, Mr. Cox detailed the method of construction of his most recent apparatus, which he claimed was a thoroughly practical device.

In studying the problem he had concluded that the obtaining of high voltage and amperage was not the chief aim, but rather it was to make a machine that would not rapidly deteriorate, and would give a large current output without regard to the voltage, with the slightest expenditure of heat, and at a cost to manufacture that should not be excessive.

In all previous thermopiles the internal resistance even when first constructed was exceedingly high, and the rapid disintegration of the thermo-electric junction caused it to rise still further, and finally resulted in the destruction of the couple. Realising these defects, Mr. Cox had set himself the task of remedying them, and the thermopiles exhibited to his audience embraced his improvements.

As will be remembered from our previous description, the generator consists of a ring of thermo-electric couples connected in series, and the complete pile is built up of a number of these rings, the gas flame or other source of heat occupying the centre. The series of castings are composed of an alloy of two parts of antimony and one of zinc. In the piles shown these castings were about 2in. in their longest dimensions and about $\frac{1}{2}$in. thick. These are connected by a thin strip of copper bent over at time of casting, so that one end extends into the inner end of the casting and the other end into the outer end. The casting is done at a high temperature and under pressure for two purposes: (1) to insure homogeneity of product, and (2) to make a complete junction between the copper and the alloy. In fact, Mr. Cox says one of the main features of his invention is that there really is no junction between the two, but that on account of the high temperature involved the metals unite, forming a graduated alloy, so that instead of there being a line of demarcation between the copper and the enclosing antimony-zinc alloy, there is a gradual blending between the two—a progressive change from pure copper to the normal alloy, and hence no junction of dissimilar metals to break down, become oxidised, and to otherwise give trouble. It has usually been believed that the closer the junction to the surface and the more abrupt the transition from metal to metal, the better the thermo-electric properties of the junction, but Mr. Cox says that this is not true, and his discovery has enabled him, by utilising the graduated junction just described, to obviate most of the pitfalls experienced by others.

The lecturer, after describing the water jacket used and the other mechanical features of the generator, showed one at work, which rang a bell, drove a fan, a medical coil, and worked a telegraphic instrument simultaneously. Mr. Cox expressed himself a disbeliever in many of the usually accepted dogmas of thermo-electricity—one of these being that the hotter the hot junction, and the cooler the cold junction, the greater the electrical efficiency. He did not believe that this was true, for experience had taught him that care had to be taken not to get the cooler junction too cool. He had also found that varying the temperature of the cool junction between 60deg. and 185deg. in a five-volt machine only reduced the E.M.F. by a few tenths of a volt.

After this, the following discussion took place, and in our opinion more is to be learnt from the discussion than from the paper. The direct reply to each speaker puts life into the discussion.

President Emery: I suggest that the gentlemen remain seated, and that questions be asked, and then, after the business of the meeting has been finished we will give all an opportunity to examine the apparatus. I was going to ask a question—I suppose there are three machines in series?

Mr. Cox: No, sir; there are three machines, but they are not electrically in series. One is operating this fan motor, the other one this, and the current of the third one is not being used. Each one is independent.

Mr. Emery: What is the voltage of each machine?

Mr. Cox: 2·5 volts, 4·5 volts, 10 volts.

Mr. Emery: What constant current can you maintain?

Mr. Cox: The current is constant. The reading should be taken as though it were a primary battery without polarisation.

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Mr. Emery: In doing work continuously what is the output?

Mr. Cox: The output of this machine, when it is properly supplied with gas (the pressure is low to-night) is 10 volts on open circuit and three amperes on closed circuit. This one, four volts, 4 5 amperes.

Mr. Emery: How many couples in one of the batteries?

Mr. Cox: Seventy-five; 15 in a row. A row is made as one couple. The couples in this machine are ¼in. thick, and in this one, a very small couple, not over ¼in thick. The ¼in. is a high-voltage machine. The ¼in. couple machine runs between four and five volts. The ¼in. runs between 10 and 12 volts, being practically the same size. The machines we ordinarily sell are listed as between four and five volts. For high voltage the current is less; for low voltage the current is more.

Mr. Sachs: How many couples are there in the 10 volt machine? I would like to make a mental calculation to get at the volt per couple That would be an interesting point, to find out whether it was different in the two sizes of machine, from the 10-volt to the four-volt machine, or whether it remains constant for the different sizes.

Mr. Cox: I would really have to guess; I don't know.

Mr. Sachs: There are 75 in the four-volt machines?

Mr. Cox: Yes; and I should judge there were four times the number in the 10-volt machines.

Mr. Sachs: If the voltage increased directly with the number of couples, there ought to be 2½ times the couples in the 10 volt machine.

Mr. Cox: You are going to the theoretical and not the practical. You cannot run a couple of that size to any such heat as the larger ones.

Mr. Sachs: Would it not bring them up to the higher efficiency to get the same voltage with half the number of couples?

Mr. Cox: I show this machine of 10 volts more as a matter of curiosity. I could build you a machine with an output at the rate of seven couples to a volt; and you can imagine what the output in E M.F. would be with 200 couples—very nearly 30 volts.

Mr. Lieb: What is the output in watts in the external circuit that the four-volt machine is capable of maintaining continuously with 2½ft. of gas per hour?

Mr. Cox: I have Weston instruments here—a volt and ammeter. I wish some of you gentlemen would tell me how many watts there are. I have travelled all over the world, and found the electrical watt, as apparently indicated by my machine, as distinctly different as are the characteristics of the people.

President Emery: On that invitation I will ask Mr. Lieb to step forward and put the instruments in circuit and make the calculation. We can put bells in circuit and put the ammeter on, and see what it will do.

Mr. Lieb: I prefer not to test a machine like that with a vibrator in circuit.

Mr. Cox: Let Mr. Lieb take one of the machines home with him and make an efficiency test, and report to this society later. He is welcome to one.

President Emery: The gentlemen want the information to-night. Let Mr. Lieb step forward and make the test.

Mr. Lieb: I do not think we have the proper instruments.

Mr. Cox: What is the watt? How is it arrived at? Is it necessary to put anything in circuit to find the watt? I think it is sufficient to take the readings of these two instruments here—the voltage and the amperage. Why is it necessary to put anything in circuit in order to find the watt efficiency of the machine? I came here to talk on thermo-electricity, not on electrical measurements. Wherein is the difficulty of making measurements when you have a Weston voltmeter and a Weston ammeter?

Mr. Dunn: A very simple way to measure the output would be to short-circuit the machine through the ammeter. Then we know when it is giving half the number of amperes it is giving the maximum number of watts at half the voltage on the open circuit.

Prof. Crocker: As to the output, as Mr. Dunn has said, the amperes on short-circuit gives twice the amperes registered when the external resistance equals the internal. At the same time we get only half the volts in the external circuit that we get on open circuit; and therefore if we multiply one half the amperes given on short-circuit by one half the volts on open circuit we get the actual watt output, which is the maximum to be obtained from any source of that kind, thermo electric or otherwise. I have tested some electric batteries repeatedly, and that has come out correctly. You also get half the voltage when you have the external equal the internal; half the total voltage is available from the external circuit. It is a well-known fact, and is, of course, true in this case.

Concerning the hot and cold juncture, or junction, differing in temperature, I have observed the same fact as stated by Mr. Cox, that if you cool or reduce the temperature of the cool junction, and make it still cooler, you do not get a much increased E.M.F. Mr. Cox interpreted that to mean that a greater difference of temperature does not give a greater E.M.F. In that conclusion from that observed fact I do not agree, because I think it is a fundamental law that the E.M.F. is proportional to the difference of temperature. It is used in physics as an absolute method for the determination of temperature, and when it is used in low temperature it is even more reliable than a thermometer. The law is that the E.M.F. is in proportion to the difference of temperature. It is true of this battery as in every combination of thermo-electrics. I explain that phenomenon, which is undoubtedly observed, in this way: If you cool the junction having the lower temperature, the other one follows it down, and you simply have practically the same difference of temperature as before. You say—why?—Does not the higher temperature remain at that higher temperature? No; simply because it has a limited heating surface, and can only maintain a certain difference of temperature between the ends; and if one end is cooler, the other can only be the same number of degrees above it in temperature, and if the cool one goes down, the higher temperature then follows and maintains the same difference between the two ends, or substantially so.

It always struck me that it does not pay to cool by water or otherwise the cool junction. I tried it and found if we drop cold water on the cool junction, or even put ice on it, there was no great increase in the E.M F. Therefore I argued it was not worth while to complicate the device by attempting to cool the lower temperature junction It has been suggested by Mr. Bradley, who is present, that the thermo-electric battery is just like a boiler, that it has a capacity of output proportional to its heating surface. In a boiler we have so many square feet of heating surface and there is so much possibility of producing energy. If more attention was paid to the fact, we might increase the heating surface of the battery and get a greater difference in temperature, which I feel positive will give a greater E.M.F.

In regard to the number of couples, Mr. Cox is right in preferring a smaller number, and therefore less complication, provided he does not need a higher E M.F. If it is necessary to have a higher E.M F., he suggests that it can be obtained by transformation. Unfortunately, the only way of transforming direct current now open to us is by means of the motor-dynamo, a fairly good device, but having an efficiency of not much more than 85 per cent, and that is somewhat of a disadvantage. Perhaps it would be better to have fewer larger couples and sacrifice efficiency in order to get simplicity with a few couples. If I wanted 100 volts, I would rather get it by a sufficient number of couples rather than by a small number of couples and a motor-dynamo.

I do not think the empirical method is always the best one, and I am quite sure that the watt is about the same here as it is elsewhere, and that there is an actual output there in watts which would be the same measured under any reasonable conditions. I think the efficiency expressed in exact terms, however low it may be, is the thing for everyone to consider, particularly anyone studying the matter, and I feel it can only be by gradual improvement in the efficiency, as we have seen in the case of the dynamo working up from an efficiency of a thousandth of 1 per cent. to an efficiency of 93 per cent. and higher; and this has only been possible after slow and gradual improvement.

Mr. Bradley: As to the difference in the watts, is the machine irregular or is it the man who measured the watts?

Mr. Cox: It must be the machine. One man will say four volts times four amperes are sixteen watts. Is it sixteen watts? Someone else says no, it is not sixteen watts, it is eight, because the external resistance and internal resistance must be equal, consequently the amperage is only one-half—then it should be four volts times two ampere equal eight watts. People will dispute the watt measurement in a primary battery, or in any other form of electrical energy. The same law which governs the output of this machine governs everything electrical which we have. There is nothing at all strange about it that I know of. I calculate the watt output of this machine by multiplying the voltage on open circuit and the amperage on closed circuit and dividing the product by four. For instance, five volts times four amperes is 20; divided by four is five watts.

Mr. Dunn: At the request of the president and Mr. Cox, I have tested this machine to get the watt output. I first connected the voltmeter across the terminals on open circuit, which showed a voltage of 2·6; with the leads there shown, I short circuited to the ammeter, and got a current of 3·9 amperes. I took the half each of these values and multiplied them, and got an output of 2·53 watts.

Mr. Cox: I did not come here for scientific discussion of the watt as a unit of energy, or of electrical measurement. I came here to show you the practical working of these machines. I think you will be far more convinced by examining the machines than by discussing them. This machine which Mr. Dunn says is only giving 2·53 watts is running that fan motor.

Dr. Dupin: I would like to say a word in support of Mr. Cox's views. I do not think the test which Mr. Dunn made is quite unobjectionable. I think where a battery can work with the expenditure equal to the supply the theory is right about the watts; but suppose the battery gives current at a much larger rate, and does its work at a much larger rate, than the supply of energy, then, of course, the voltage would drop. A battery is not the same thing when it gives this large current as it is when it gives the small current. It is quite possible, if a thermo-electric battery is short-circuited and gives a large current, that the gas-jet is not capable of supplying the heat at the rate at which the electrical energy demands it, and the actual voltage of the thing drops, and then the battery would not work under the same conditions as it would work if the heat supply was large enough to keep the actual difference of potential constant. It is a fact similar to the polarisation cell; and when I see this motor work at 2·5 volts, as stated, I do not believe that it can do it.

The suggestion was made that Mr. Dunn make a second test of the machine by placing the ammeter in circuit with the machine and motor, as it was then running, and at the same time take the voltage from the terminals of the machine while the motor was in operation. This was done, and at the request of the **President, Mr. Dunn** announced that he found the watt energy to be 3·70 watts.

Mr. Cox: If anyone can tell me what the real watt energy of that machine is, I will be very much obliged to him.

Mr. Leonard: It seems to me that neither the first method of arriving at the watt energy nor with the motor in circuit is the proper way. If we are going to reach a conclusion as to watt

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energy, we want something in the circuit which is not going to operate in the way of counter E.M.F. Nobody would question the fact that a large storage battery with a couple of volts might have a larger energy than that represented by the fan; and yet the fan would not take more than two watts run on the terminals of a storage battery.

Mr. Cox: The question of the output is one which I leave to you gentlemen entirely. It is utterly beyond me, as you can see, for me to say anything as to what the output in watts really is. It may even have grown should we make another test, and be six or eight watts now. The question of watt energy is always in dispute, and I think this discussion fully bears out my statement that I have found the watt as varied as are the characteristics of the people. I buy the best instruments money can purchase, but all I care for is how quickly, how cheaply, and how practically I make that fan motor go.

ON RATING ELECTRIC POWER PLANTS UPON THE HEAT-UNIT STANDARD.*

BY WM. S. ALDRICH.

(Concluded from page 791.)

6.—Proposed Use of Heat Units in Electric Plants.

It is proposed to state the performance of steam-power electric plants in kilowatts per 1,000,000 B.T.U. supplied to the steam used in the complete plant.

It is apparent that the same line of arguments, *pro* and *con.*, is quite likely to arise as in the case of similar ratings for pumping plants. However, such a basis is equally adapted to meet the growing requirements for some standard in these latter types of steam-power plants.

In this case, moreover, it is possible to start upon a right basis from the beginning. The practice of rating the performance upon the watt-hours per pound of coal has not become so rooted that it cannot be changed to that now proposed. The necessity for such a standard in this case is none the less real, nor is its final adoption less probable, on account of the radically different conditions under which these two types of power plants are regularly operated—namely, uniform loads in pumping plants and extreme and often rapidly-varying loads in the electric plants.

As long as electricity continues to be generated by machinery driven by heat engines, as well as when it comes to be generated from coal direct, it is believed that there is no better standard than that already adopted in steam engineering. The unit of measure for the total heat put into the system—namely, the British thermal unit—is that upon which the output in kilowatts may be most satisfactorily based.

7.—Determination of the Heat Supplied to the Steam.

The method and procedure by which the quantity of heat supplied to the system is determined from the feed-water measurements has been ably set forth in the report† of the Committee on Duty Trials of Pumping Engines. It is equally applicable to the case of the electric plant, and is as follows: "Starting with a heat-unit basis of computing duty, it is proposed to make the computation from the quantity of heat supplied to the complete plant, using not only that supplied to the engine cylinders, but that supplied to all the necessary parts of the engine, such as the steam-jackets, the donkey feed-pump, the independent air-pump, if this be driven with steam, and any other apparatus using steam which is necessary to the operation of the engine. In contract tests, if a steam-pump be used for the boiler-feed pump, the quantity of heat supplied for operating this apparatus is to be included in the total quantity, not only in cases where both boiler and engine are supplied by one party, but also where the boiler is furnished by a separate contractor. In this connection it should be added that if the engine contractor does not furnish the boiler-feed pump, he should be permitted to specify, if he desires, the kind of feeding apparatus which shall be used during the test. The heat-unit method requires that the actual total heat of the steam shall be known, and for this purpose allowance will necessarily be made for any moisture or superheat contained by the steam furnished to the engine."

The method is further thus specified in Mr. A. F. Hall's paper, previously referred to: "Each pound of water fed to the boiler is to be debited with the heat required to raise all of the water from the temperature it has at its entrance to the boiler to that corresponding to the boiler pressure, and the amount of heat required to convert 97 per cent. of the water into steam of boiler pressure from the temperature corresponding to this pressure."

This is allowing for 3 per cent. moisture. The amount of moisture in any case would be determined by calorimetric measurements of the quality of the steam supplied by the boiler to the engine, and similarly allowed for.

8.—Performance of the Boiler not in Evidence.

This is the case for similar reasons to those which have ruled out the boiler performance in determining the duty of pumping plants. The steam generating plant and the steam motive power installation form two elements wholly distinct from each other. They may be, in some cases are, quite independent of each other.

The thermal value of the fuel used must be brought into the case if the performance of the plant is to be based upon the heat supplied to the boiler furnace. Such a coal basis is too uncertain, and is the least desirable one at present from which to determine the heat supplied.

The boiler plant is the only portion of the installation in which the human element has a hand in the economic performance.

It is most desirable to eliminate this as far as possible. Upon the skill of the fireman, or what may be called his personal equation, very much of the economy and efficiency of the boiler will depend. If mechanical stokers are used, even then the skill of the attendant is quite an important item.

However, at this stage of development builders of engines and dynamos do not care to be responsible for the performance of the boiler plant, which is often furnished and installed by entirely different parties. They wish to know the "duty," as in the case of pumping engines, regardless of the boilers or irrespective of how the steam is supplied, provided it is commercially dry.

9.—Determination of the Work Done by the Electric Generators.

This reduces simply to voltmeter and ammeter readings at the switchboard. These are to be further corrected for any instrumental errors. The load during trial should be maintained as nearly constant as practicable. Latest forms of recording instruments make it quite possible to obtain accurate records throughout any specified period. The extreme simplicity and the high degree of accuracy attainable, in the case of the electric plant, should be strong points in favour of adopting such a standard rating as here proposed.

Direct-connected units in electric plants makes this method as feasible and as practicable as in direct-acting pumping engines. It is, of course, possible, but quite improbable, that steam-power electric plants of any magnitude will be belt-driven in the future. The standard performance of such installation involves taking into account the small percentage of loss due to the slipping of the belt or rope drive. This must be stipulated in the specifications and allowed for in like manner to the percentage of slip in steam pumping-engine trials. The cases are not exactly analogous, but they may be similarly considered in the specifications and determined in the contract trial.—*Electricity* (New York).

* Presented at the Hartford (Conn.) meeting (May, 1897) of the American Society of Mechanical Engineers. The author is a member of the society, residing at Morgantown, W. Va.

† *Transactions* of the American Society of Mechanical Engineers, vol. xi., No. 381, "Report of Committee on a Standard Method of Conducting Duty Trials of Pumping Engines."

CONTRACTS FOR ELECTRICAL SUPPLIES.

CONTRACTS OPEN.

Madrid.—The Spanish Government Post and Telegraph Departmental Authorities will receive tenders at Madrid on July 12 for 20,000 battery zincs for telegraph work.

Gelnhausen (Germany).—Tenders will be received on July 3 by the Burgomaster of Gelnhausen for the supply of a dynamo, motor, pump, and accessories for pumping work.

Ghent.—The city of Ghent has put out for competition the electric tramway service. Particulars are obtainable on application to le secretariat de la ville de Ghent, Belgium, and tenders must be in by July 2.

Herve (Belgium).—Offers will be received up to October 1 by the Municipal Authorities of Hervé, in the Province of Liège, for an installation of town lighting. No information is given as to the system (electrical or otherwise) which would be preferred.

Madrid.—Tenders will be received by the Spanish Government for the supply of 14 tons of sulphate of copper for the Spanish telegraphs. Delivery at Bilbao or Huelva. Tenders, on stamped paper, and with a security of 10 per cent., and particulars on application to the Direccion-General de Cerros y Telegrafos, Madrid.

London, N.—The Metropolitan Asylums Board are prepared to receive tenders for the supply and running of mains in the grounds and for the wiring of the nurses' quarters now in course of erection at the North-Western Fever Hospital, Haverstock Hill. Sealed tenders are to be delivered at the chief office of the Board not later than 11 o'clock on July 8. For further particulars see advertisement.

Neath.—The Corporation invite tenders of rental for the working by horse or mechanical traction of the existing line of tram-

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ways about to be reconstructed by the Corporation, extending from Skewen to Briton Ferry, through the market town of Neath, a distance of about 4¼ miles. Tenders, marked "Working of Neath Tramways," are to be delivered by 28th inst. to Mr. Edwin C. Curtis, town clerk.

St. Helens.—The Electric Lighting Committee of the Corporation are prepared to receive tenders for the supply and erection of plant for the extension of the municipal electricity works. Tenders (sealed and marked "Tender for Electric Lighting") must be addressed to Mr. W. J. Jeeves, town clerk, at the Town Hall, St. Helens, and be delivered on or before July 20. For further particulars see advertisement.

London, S.E.—The St. Mary's (Newington) Vestry require tenders for the supply and fixing of clocks (electrical or otherwise) at the new baths and washhouses, Manor-place, Walworth. A schedule of the clocks required, with a description of the size of each dial, may be obtained from Mr. L. J. Dunham, vestry clerk, Vestry Hall, Walworth, S.E., to whom tenders are to be delivered, marked "Tender for Clocks," by July 5.

Belfast.—The Electric Committee are inviting tenders for building the new electric station, Lagan Bank-road. Plans and specification can be seen at the office of Messrs. Graeme-Watt and Tulloch, architects, 77A Victoria-street. Copies of the schedule of quantities can be obtained from Messrs. S. and W. H. Stephens, Donegall-square North. Tenders to be lodged with Sir Samuel Black, town clerk, by 10 a.m. on July 1.

Rio de Janeiro.—The Secretary of State for Foreign Affairs has received a despatch from H.M. Consul-General at Rio de Janeiro enclosing a translation of an official notice setting forth the conditions under which tenders are invited for the telephonic service of that city and its suburbs. The tenders are to be presented by June 30, and the conditions may be inspected at the Commercial Department of the Foreign Office any day between 11 and 6.

Huddersfield. — The Electric Lighting Committee of the Huddersfield Corporation have for disposal a 100-h.p. compound vertical Brush engine and a 50-unit Mordey alternator (2,000 volts 25 amperes). Sealed tenders, endorsed "Tender for Purchase of Plant," must be delivered free of charge, addressed in the handwriting of the tenderer or his agent, to the Town Clerk, Town Hall, Huddersfield not later than July 14 See advertisement.

Dover.—The Town Council invite tenders for the erection of a car-shed at Buckland. Forms of tender, specification, and schedule of prices may be obtained on payment of £2. 2s. (returnable on receipt of a bona fide tender), and conditions and drawings inspected at the office of the borough engineer, Mr. Henry E. Stilgoe, A.M.I.C.E., Town Hall, Dover. Tenders, endorsed "Tender for Car-Shed," to be sent to Mr. E. Wollaston Knocker, town clerk, Castle-hill House, Dover, by 12 noon on 29th inst.

Belfast.—The Electric Committee require tenders for the supply and erection of the following plant: (Section B 2) pumps, steam, exhaust, and feed pipes, etc. Specification and conditions of contract may be obtained on application to Mr. Victor A. H. M'Cowen, Corporation electrical engineer, on payment of £1. 1s. per copy, which sum will be refunded on the return of the specification with a bona fide tender. Sealed tenders, endorsed "Tender for ——," must be lodged at the office of Sir Samuel Black, town clerk, by 10 a.m. on July 1.

South Shields.—The Corporation are inviting tenders for the supply and erection of the following plant: (Section A) boiler and boiler mountings; (B) pumps and accessories. Firms tendering are at liberty to tender for any of the sections, but not for part of a section, and no tender for any plant which is not in strict accordance with the specification will be considered. Copies of specification, including conditions of tender and form of contract, can be obtained at the Borough Electrical Engineer's Office, West Holborn, South Shields, on payment of £1. 1s., which sum will be returned on receipt of a bona fide tender. Tenders, sealed and marked "Tender for Electric Lighting, to be delivered to Mr. J. Moore Hayton, town clerk, South Shields, by noon on July 9.

Inverness.—The Highland Railway Company require tenders for the following among other articles, in such quantities as they may require, from July 1, 1897, to June 30 1898, delivered free of all charges, viâ Dunkeld, at the company's storehouses, Inverness: galvanised telegraph wire, telegraph instruments and fittings, and telegraph construction material. Forms of tender may be obtained on application to Mr. J. G. Bulmer, stores superintendent, Inverness. Tenders, properly endorsed, sealed, and addressed to the Directors, must be lodged with Mr. Wm. Gowenlock, secretary, Inverness, by 19th inst Separate forms of tender will be provided for each contract; parties are therefore requested to specify the particular contract or contracts in respect of which they propose to submit tenders. Patterns can be seen at the stores warehouses, Inverness, but cannot be sent away for inspection.

Lincoln.—The Corporation require tenders for the supply, delivery, and erection, according to specifications, of the following plant: (Section A) two dry-back marine-type boilers; (B) high-speed engines, continuous-current dynamos, steam and other pipes, pumps, motors, and travelling crane; (C) a fuel economiser; (D) storage batteries; (E) a main switchboard and instruments; (F) armoured concentric and triple-concentric cables, and pilot wire cables. Specifications, general conditions of contract, and plans for all or any of above sections may be obtained at the office of Mr. C. S. Vesey Brown, city electrical engineer, Corporation Offices, Silver-street, Lincoln, on payment of a deposit of £1. 1s. for each section; the deposit will be refunded on the return of the specification, etc., with a bona fide tender. If a tender is accepted, such acceptance will be subject to the sanction of the Local Government Board being obtained to the borrowing by the Corporation of the moneys required for the carrying out of the works comprised in the above contracts. Sealed tenders, addressed to the Electric Lighting Committee of the Lincoln Corporation, endorsed with the words "Tender for Section A, B, C, D, E, or F (as the case may be) Electricity Works," must be delivered to the office of Mr. H. K. Hebb, deputy town clerk, St. Peter's Churchyard, Silver-street, Lincoln, by noon on July 14.

RESULTS OF TENDERS.

Belfast.—The Corporation have accepted the tender of the Edison and Swan Company for arc lamps.

Bedford.—At the meeting of the Urban Sanitary Authority the tender of Mr. Harry South, of London, to supply electric motors, centrifugal pumps, etc., at the sewage pumping station for £600 was accepted.

Roehampton.—The following tenders have been received for electrically lighting Holy Trinity New Church, Roehampton, S.W.:

Tickner and Partington	£201 11 6
Brush Electrical Engineering Company	186 16 6
Belshaw and Co.	179 11 6
W. P. Adams	164 14 0
Electrical and General Engineering Company	151 8 6
Laing, Wharton, and Down, Limited, London (accepted)	151 0 0

Brighton.—The following tenders have been received for the completion of the electric light wiring, etc., of the Municipal School of Science and Technology, Richmond-terrace, for the Council:

If in wood casing, with the exception of the basement and other situations mentioned in the schedule.

W. Lucy and Co., Limited, Oxford, five weeks	£571 0 0
Belshaw and Co., London, five weeks	835 0 0
Fowler, Lancaster, and Co., Limited, Birmingham	665 17 9
J. H. Pickup and Co., Limited, London, one month	639 14 2
Page and Miles, Brighton, six weeks (accepted)	560 15 0

If in insulated iron pipes throughout.

Globe Electrical Company, London	997 0 0
W. J. Fryer, London, completed in six weeks	814 17 4
Bergtheil and Young, London, three months	1,257 14 0
Lloyd and Read, Bristol	546 0 0
Laing, Wharton, and Down, Limited, London, six weeks	875 0 0
Laing, Wharton, and Down, Limited, eight weeks	855 0 0
W. Lucy and Co., Limited, five weeks	646 0 0
Belshaw and Co., five weeks	1,010 0 0
J. H. Pickup and Co., Limited, one month	739 16 7
Page and Miles, eight weeks	740 0 0

BUSINESS NOTES.

Chester.—The Town Council have given instructions for a number of electric street lamps to be fixed and lighted.

Paisley.—The electric light street lamps have been erected, and the current was turned on on the evening of Jubilee day.

Dover.—A Local Government Board enquiry has been held respecting the application of the Corporation to borrow £31,000 for municipal electric tramways. There was no opposition to the scheme.

Edinburgh —Prof. Kennedy, the consulting engineer to the Town Council, has prepared a report as to supplying Portobello with electricity, and discusses the advisability of establishing a second station.

Liverpool Overhead Railway —The traffic receipts of this railway for the week ended June 20 amounted to £1,389, as compared with £1,221 in the corresponding week of the previous year, being an increase of £168.

Catalogue.—We have received an exceedingly well-produced catalogue of ornamental fittings from the Zurich Incandescent Lamp Company, 47, Victoria-street, Westminster, which is full of very useful illustrations and particulars.

Bristol Tramways and Carriage Company, Limited —The traffic returns for the week ended June 18 were £2,441. 6s. 4d. compared with £2,312. 15s. 9d. for the corresponding period of last year, being an increase of £128. 10s 7d.

Barcelona Tramways.—The Barcelona Tramways Company, Limited, notify that the third half-yearly dividend on the 5 per cent. cumulative preference shares, being in respect of the half-year ending 30th inst., will be paid on 1st proximo at the National Bank.

Hornsey.—The District Council have adopted the plans for the central public library in Tottenham-lane, and it is proposed to provide gas fittings adaptable for the electric light so that when the bath buildings are erected electricity may be supplied from across the road.

Bromley.—At the Rural District Council meeting a draft of the proposed electric lighting provisional order for Chislehurst was submitted. The Clerk observed that the Council had already approved of it, and it was sent on to the Chislehurst Parish Council for their observations.

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City and South London Railway.—The returns for the week ended June 20 were £1,093 compared with £836 for the corresponding period of last year, being an increase of £257. The total receipts for the half-year 1897 were £25,308, compared with £23,178 last year, being an increase of £2,130.

Gloucester.—Mr. Robert Hammond has been appointed consulting electrical engineer to the city. His first duty will be to report to the Electric Lighting Committee upon the general question of electricity supply for lighting and other purposes, and upon the advisability of the Corporation establishing works in conjunction with refuse destruction.

Notice of Removal.—We are informed that the offices of Messrs. Julius Sax and Co., Limited. have been moved from 7, Ridgemount-street. W.C., to their electrical works at 119, Coldharbour-lane, Camberwell, S.E. Mr. A. Slatter has severed his connection with the firm, and all communications should be addressed to Mr. E. M. Winter, who has taken up the management of the firm.

Railways Electric Supply Syndicate, Limited.—This Company has been registered, with a capital of £10,000 in £1 shares, to acquire letters patent No. 27,558 of 1896, granted to W. Andrews, for an improved electrical fog signal for railways, and to acquire and carry on the business of an electrician and electrical engineer, carried on at 7, Broad Oak-street, Nottingham, and elsewhere, by W. Andrews.

Broadstairs.—At the Urban District Council meeting the Clerk (Mr. L. Skinner) read various draft orders to be included in the order of the Isle of Thanet Light Railways (Electric). In these there were provisions that certain thoroughfares should be paved with wood blocks, and that the railway promoters should, at their own cost, widen the roadway that passed under the L.C.D.R. line and crossed railway No. 8.

Personal.—We understand that Mr. Geipel, M.I.E.E., has resigned his position as superintending engineer of the Brush Electrical Engineering Company, in whose service he has been for 15 years, in order to enter into partnership with Mr. F. M. T. Lange, A.M.I.C.E , M.I.M.E.. M.I.C.E. (France), nephew of the late Sir Daniel Lange, C.E., etc., of Suez Canal fame. These gentlemen have purchased the Westminster business of Messrs. Paterson and Cooper, which they intend to carry on and extend.

Brierley Hill.—At the Urban District Council meeting, the report of the Tramways Committee, of which Councillor J. Fisher has been appointed chairman, stated that before approving or otherwise of the scheme prepared by the British Electric Traction Company, Limited, it be recommended that they be asked upon what terms or concessions, if any, the assent of the other authorities concerned had been or was about to be obtained, and particularly as to the borough of Dudley. The Council ratified the recommendation.

Torquay.—At the meeting of the Devon County Council, Mr. Iredale asked if the Bridge and Main Roads Committee had received any notice with regard to the enquiry to be held in connection with the application for powers to construct an electric tramway at Torquay. Mr. Coleridge said the matter was mentioned to the committee that morning, but it was not before them formally. The authorities ought to forward proper statements. The clerk was instructed to attend the enquiry and protect the interests of the Council.

Stafford.—Alderman Peach stated at the Town Council meeting with regard to the electricity department, that Dr. Hopkinson had certified that his assistant had tested the battery and it was fully up to the specification. They should now pay the contractors for the battery, and were quite satisfied. The consumption of electric energy had been nearly 50 per cent. more this May than last. The report was agreed to, and it was decided, on the suggestion of Alderman Turkington, that the arc lamps in the market place should be kept lighted all Jubilee night.

St. Pancras.—The Electricity Committee recommended, at the meeting of the Vestry, that a bonus of £20 be divided among the stokers at the Regent's Park electrical station, and also a bonus of £20 among the stokers at the King's-road station, for every tenth of a penny saved in the cost of the coal bill below a certain maximum limit. Mr. H. J. Menzies, the chairman of the committee, explained that if the stokers could be induced to use small coal at 14s. a ton in lieu of the coal at 18s. 3d. a ton that was now being consumed, a saving of at least £400 per annum would be effected.

The Isle of Man Trams.—A deputation from Brierley Hill, Rowley Regis, and Kingswinsford. in the Dudley district of the Black Country, accompanied by Mr. Sellon, C.E , London, last week went over the Douglas and Laxey Electric Tramway, and ascended the Snaefell Mountain Railway with the object of inspecting the system of electric traction in operation with a view to converting, if practicable, the steam tramways in their own district into the overhead electrical system. The deputation inspected the system of traction, generating, and accumulator stations.

Leamington.—A letter was read at the Town Council meeting from the Midland Electric Light Company, London, stating that it was their intention in the ensuing session to apply to the Board of Trade for a provisional order under the Electric Light Act to enable them to supply electric light for public and private purposes with certain portions of the borough. The Mayor observed that he thought there would probably be an application made to them during the course of the afternoon to consider certain subjects in committee, and suggested that it would be possibly better to postpone the matter and consider it in committee. This was agreed to,

Kingswood.—The plans for the Hanham light railway were considered at the Urban District Council. The following resolution respecting this railway, moved by the Chairman, was carried *nem. con.*: "That this Council desires to express its gratification that the Bristol Tramways Company have adopted the suggestion of the Council that they should extend their system to Hanham, and the Council hopes that no time will be lost in pushing forward the application to the Light Railway Commissioners, so that the district may have the benefit of electric tramway accommodation at the earliest possible moment."

Anderson Electrical Traction Syndicate, Limited.—This Company has just been registered, with a capital of £5,000 in £1 shares, to acquire, develop, work, turn to account, and deal with all or any of the patents and patent rights belonging to Christopher Anderson, of Hunslet, near Leeds, for improvements in apparatus for working electric tramways by means of an underground cable contained in a closed circuit, to enter into a certain agreement with the said Christopher Anderson, and to carry on the business of contractors, machinists, fitters, founders, mechanical engineers, electricians, electrical engineers, and electric apparatus manufacturers.

Plymouth.—At the meeting of the Borough Council Mr. Bray moved the adoption of the Tramway Committee's report, which recommended the adoption of an overhead electric tramway between the Theatre Royal and Prince Rock at a cost of £7,500. Mr. Bray said up to 12th inst. there was an increase in receipts and a balance in hand of £300, including advertisements, etc. The Prince Rock section had proved a great success. He thought the Tramway Committee was going to be charged too much for the electric traction. The electric traction would cost £2,229 per year, whereas at present the Prince Rock section only cost £1,526. Mr. T. Jinkin seconded, and the report was adopted.

Maidenhead.—The Lighting Committee reported at the Town Council meeting that a letter had been received from a firm of electrical engineers and contractors asking whether the Council would be willing to consent to their application to the Board of Trade for a provisional order for electric lighting, and intimating that they are prepared to apply, with the consent of the Council, for electric lighting powers, or in the event of the Council deciding to obtain a provisional order to negotiate with them for a transfer of their powers thereunder. The Town Clerk replied that the Council intended to apply for a provisional order, and that at present the question of transferring their powers could not be entertained.

Appointments.—The Managers of the District Asylum, Mullingar, are advertising for a qualified engineer, with a thorough knowledge of electric lighting plant. Candidates must not be over 35 years of age, and be competent to take charge of boilers, engines, dynamos, and general heating apparatus. Salary, £70 per annum all found, including clothing. Applications, with copies of not more than four recent testimonials, together with copies of certificates of indentures, to be forwarded to the Medical Superintendent on or before the 5th prox.—The Morecambe Urban District Council invite applications for the appointment of resident electrical engineer to take charge of and manage the electricity works about to be erected. For full particulars see advertisement.

Hertford.—At the meeting of the Hertford and Ware Joint Hospital Board, the Clerk read a letter from Mr. Grant, the architect, with reference to the lighting of the new hospital by electric light. He pointed out that an engine would have to be provided for the work in the steam laundry, and it could be so arranged, if thought desirable, that a dynamo for electric lighting purposes should be driven by the same engine. In that case an engine of larger size would probably be required, and the cost of plant and fittings would be from £160 to £200. On the motion of the Chairman the matter was referred to a sub-committee to report upon the probable cost as compared with that of other schemes. The committee was composed of the chairman, Dr. Shelly, Messrs. Page, Woollatt, Frank Smith, and Ashwell.

Huddersfield.—The Electric Lighting Committee reported at the Town Council meeting that they had adopted the recommendation of sub-committees of the Electric Lighting and Health Committees, that they should extend their mains to the sanatorium at Mill-hill subject to the Health Committee undertaking to bear at least £200 towards the cost of such extension. The engineer reported that the number of consumers had increased from 445 in May to 459 in June, whilst the lamps connected had increased during the same period from 32,745 to 33,511. During the month of May 18,681 units were metered, as compared with 11,492 during the corresponding period of last year, the increase of 7,189 representing 62 per cent. Accounts amounting to £899. 15s. 6d. have been passed for payment. The minutes were adopted.

New Issue.—The Edison and Swan United Electric Light Company, Limited, offer for subscription at par an issue of £90,000 4 per cent. debenture stock, which with the £110,000 already issued will form part of a total amount of £350,000 authorised, which stock is to be placed from time to time for the purpose of redeeming the £100,000 4½ per cent. stock issued in 1894, and also of providing for the rapid growth of the business. The stock now offered will be subject to redemption at £110 per cent., and will be secured on the redemption of the existing stock, which will be completed on 30th inst , as a first charge on the uncalled capital and other assets, totalling £417,346. The profits for the two years ending June 30, 1896, were £25,876 and £27,526 respectively, and the company's capital paid up on the "A" shares is £383,478. Applications will be received up to and including 30th inst.

York.—Alderman Dodsworth, in accordance with notice, moved the following resolution at the City Council meeting: "That the

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whole question of the electric lighting of the city be referred to a special committee, and that all resolutions inconsistent with this resolution be rescinded." Mr. Page seconded the resolution. Alderman Wragge argued that the resolution was a vote of censure on the Streets and Building Committee, and pointed out that the committee had done as much as any other committee could possibly do. They had brought up reports time after time, and these had been referred back to the committee, so that the Council, and not the committee, were to blame for the delay that had taken place. Alderman Agar (the chairman of the Streets and Buildings Committee) stated that the committee had recently obtained information which, he believed, would enable them shortly to bring up a definite proposal before the Council. On the vote being taken the numbers were—for, 18; against, 11; neutral, 8. The motion was therefore carried.

Dundee.—At the annual meeting of the Gas Commission, Treasurer Ritchie proposed that a departure be adopted in regard to the supply of electricity, to the effect that in future, instead of supplying this illuminant at a uniform rate of 5d. per unit, the charge be 5d. per unit for the first 821 hours, in order to pay the original charges, and 3½d. per unit afterwards. Several members of the Board objected to the departure in the charging of electricity, and ex-Bailie Speed contended if they were to adopt any arrangement of the kind proposed with regard to electricity, they were bound to do the same in reference to the supply of gas and water. He moved that a uniform rate of 4½d. per unit be charged, and this was supported by most of those present. Ex-Provost Brownlee said he was confident the change proposed was a sound one, but as in the meantime the Council was not prepared for it, he suggested Treasurer Ritchie should not press his motion. On a division, the rate was fixed at 4½d per unit by a large majority, and afterwards the estimates were appproved.

Bakewell.—At the Urban District Council meeting, the Clerk said he had received a letter from the secretary to the gas company stating that they did not consider the offer of the Council to purchase their shares at par value worthy of consideration, but adding that the directors were prepared to advise the shareholders to submit their interest in the company to arbitration. Mr. Morton thought before they entertained such a proposal the Council must know what it was they were going to arbitrate upon, and after some discussion a committee was formed to confer with the directors of the company. Mr. T. H. Brown said he had given the question of lighting the town by electricity considerable consideration. He was prepared to prove that there was ample power in the river, now running to waste, to work a dynamo giving a 15-candle light for the whole of the town. The outlay in round figures would not exceed £4,000, and for that sum they could erect works and supply electricity at 2½d. per unit, or an equivalent to 1,000ft. of gas at 1s. 3d. per 1,000. A committee was appointed to further consider the question.

Ramsgate.—The electric railway scheme was finally discussed at the adjourned Town Council meeting last week, and the following resolution was carried: "That this Council approve and support the application of the Isle of Thanet Light Railways (Electric) Company, Limited, for an order authorising the construction of the proposed light railway from Pegwell, through Ramsgate, Broadstairs, and Margate, subject to the insertion in such order of the provisions for the protection and advantage of the Corporation and the public referred to in the draft order signed by the solicitors to the company, and now submitted to the Council, excepting that the Council require the carriages used by the company to be not wider than 6ft. 6in., that no advertisement be placed on the windows of such carriages, and further that the company be required to remove, at their own expense, all snow coming from time to time on the railway, and to pay all expenses incurred by the Corporation in relation to the order up to the date of its confirmation by the Board of Trade; and that the town clerk be directed to take the necessary steps to give effect to this resolution."

Glasgow.—At a meeting of the Town Council last week there was a discussion relating to the negotiations between the Tramways Committee and the Electric Lighting Committee. As our readers know, it has been decided to equip the Springburn route of tramlines with the overhead trolley system, and the Electric Lighting Committee are very desirous of supplying the current for this purpose from their John-street station, which will be idle when the street arc lamps are transferred into the low tension network during the course of the next month or so; this station being at present equipped with high-tension machines which, it is thought, could easily be altered and made suitable for traction purposes. However, the Tramways Committee appear to wish to keep the generating plant in their own hands, and have intimated as much to the Town Council; but the question has cropped up as to whether they are at liberty to generate electricity for themselves without parliamentary powers. It is a pity if two committees of a Town Council begin to fight over a matter of this kind, especially as there is another private company within the Corporation tramway district which will be only too ready to take advantage of any disagreement of this kind.

British Insulated Wire Company, Limited.—This Company has been formed to acquire and take over the business of the British Insulated Wire Company, which was established in 1890 at Prescot to manufacture lighting, power, telegraph, and telephone cables, and other electrical appliances. The Company acquired at various times many patents, and will assign about 55 British and foreign to the new company. The object of the transfer is to secure new capital to meet an extension of business. The new company will have an authorised share capital of £200,000 in 6 per cent. cumulative preference shares of £5 each, and £200,000 in ordinary shares of £5 each. The preference shareholders will have no voting powers at the company's meetings unless their dividend is in arrear, except on certain specified questions, such as a sale of the Company. There are now offered for subscription 14,470 preference and 10 375 ordinary shares, leaving £100,000 preference shares for future issue, and the balance of the shares are taken by the vendor company as the purchase-money of their concern. (The equivalent in cash, as estimated in the prospectus, is £175,775.) The new Board and the staff will be the same as that of the old company. The list opens on Monday and closes on Thursday, July 1. The London office is at 11, Charing Cross-road, W.C.

Jubilee Illuminations.—Among the interesting illuminations for the Jubilee was the one of illuminating Lambeth Palace from the terrace of the Houses of Parliament, which was placed in the hands of Mr. Leo Sunderland, of the Brush Electrical Engineering Company, Limited. The work consisted of one of the largest projectors made by the Brush Company, taking a current of 100 amperes, and giving a light of 30,000 c.p. The light was thrown across the river, by special permission of the Thames Conservancy, on to the palace, and the colours of the light were changed at intervals, and created a very interesting effect. Messrs. J. S. Cunnington and Co., of Charing Cross-road, designed and manufactured a unique and beautiful piece of decoration. It took the form of a piece of drapery with gold fringe and tassels, and measured about 15ft. by 8ft. It bore the words, "God Bless Our Queen—1837-1897," which were formed with different-coloured incandescent lamps of 5 c.p. and 8 c.p., which were fixed through pierced zinc enamelled white, thus accentuating the lettering and affording additional protection. The whole device was surmounted by a crown similarly formed, and it was greatly admired; for it was equally effective both by daylight and also when its 250 lamps were aglow. Electricity was pretty extensively used for decorative and illuminating purposes, not only in London but in the provincial towns, such as Hastings, Brighton, Manchester, Blackpool, Birmingham, and elsewhere.

Swansea.—At the meeting of the Corporation, Alderman Leeder drew attention to the item of expenditure recommended on account in connection with the triple scheme, which was £4,180. Certain proceedings, he understood, would be taken with regard to the validity of the payment of those accounts, and he wished to give those who desired not to commit themselves a chance of not voting for the payments. He moved that all payments relating to the Tramways Bills of 1895-96-97 be deferred till all the accounts are rendered to the General Purposes Committee. On a division the motion was rejected by 20 votes to 14. Mr. Martin then moved the adoption of the minutes of the Tramways and Electric Lighting Committee, recommending that the Corporation oppose the tramway company's Bill in Parliament. He said he moved the adoption of the minutes with regret, because the committee adjourned for an indefinite period without coming to a conclusion as to whether the triple scheme was to be revived or not, and so the public, who looked for guidance on the question, were prevented from having it. To him, the question was one entirely of the gas company against the ratepayers of Swansea, and it was for the Council to say whether they would sit down quietly and take defeat at the hands of the company or take up the matter again, and in spite of any obstacle, if it were the wish of the ratepayers, to revive the scheme, and see that that wish was carried out. Alderman Tutton seconded, and the report was adopted.

Bath.—At the meeting of the Urban Sanitary Authority, Alderman Sturges, as chairman of the Electric Lighting Committee, moved the adoption of this committee's minutes, and dealt at length with the recommendation of the Authority that they apply to the Local Government Board for power to borrow a further sum of £3,750 for the purpose of carrying out the works mentioned in Mr. Hammond's report. Mr. Phillips, who seconded, expressed the hope that the Press would be admitted to the meetings of that committee. Alderman Ricketts expressed very great surprise that nothing was known of these necessary works when the alterations and renovation of the buildings were carried out under a contract by Messrs. Hayward and Wooster a short time ago. He considered that the amount of money being spent by this committee was far too large. They ought to have some enquiry into the matter, and he moved as an amendment, "That a special committee be appointed to consider the position of the Electric Lighting Committee and their works, and to report before we sanction the expenditure of any more money." Mr. Peacock seconded, believing that some such enquiry was necessary. Mr. Vincent, in supporting the amendment, said, although the £10,000 had not been granted yet, the committee were spending part of the money. This was a wrong thing to do. Alderman Clarke said it occurred to him in looking through the report that in a few years the present works would be quite insufficient for their purpose. He thought, therefore, that before they incurred the expense proposed, they should look well into the question and have some further investigation. After further discussion, the amendment was rejected by an overwhelming majority.

Cambuslang.—Arrangements have now been completed for the introduction of the electric light into Cambuslang, a small town on the outskirts of Glasgow. The street-lighting is at present in the hands of the Gas Commissioners, and this body recently decided to lay down a small plant to light the streets. The contract has been given to Messrs. Hunter and Jack, electrical engineers, St. Vincent-street, Glasgow, who are to put down plant at the gasworks capable of running 20 10-ampere arc lamps. In the meantime only the main street is to be lighted, and for this purpose 12 lamps will be required. The gas-engine will be one of Messrs. Crossley's "Otto" engines, driving a dynamo of the

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Electric Construction Company's make. The order for the arc lamps has been placed with the Brockie-Poll Arc Lamp Company, Limited, while Messrs. McDowall, Steven, and Co. will supply some very ornamental cast-iron pillars for them. The mains will all be laid underground, and will be of Messrs. Walter Glover and Co.'s make. The arc lamps will be run in long series off a constant-current machine. The pillars are fitted with overhanging brackets, and the effect is expected to be very good. It is expected that the installation will be completed and the lamps lighted on September 1 next, so as to be in plenty of time for next winter's needs. This installation should induce other small towns to consider the merits of electric lighting in a small way at first, if they are not in the meantime prepared to go in for a more extensive scheme. We hope, when this installation is running, to be able to put some figures relating to costs before our readers, and we have little doubt that the advantages of electric lighting will be apparent from them, even when introduced on such a small scale as in this case.

Radcliffe.—At the meeting of the Electric Lighting Committee, the Clerk reported that Mr. Clayton, previous to proceeding with the examination of the draft conveyance for the land in Dale-street, was waiting for the decision of the Council with reference to a clause which the vendors insist upon—namely, the right to get all minerals under the site of the market without paying any compensation for damage which may be occasioned thereby, and that a similar clause be inserted in the conveyance of the Dale-street plot, and that he proposed to wait upon the Markets Committee. It was resolved that this committee do meet the Markets Committee, when Mr. Clayton will wait upon the said committee with reference to the conditions for the purchase of the land in Dale-street. At the joint meeting of the Electric Lighting and Markets Committee, Mr. Clayton read the correspondence between himself and Messrs. Grover, Humphreys and Son, the solicitors to the Earl of Wilton's trustees, with reference to the clauses inserted in the draft conveyance to the market which the Council object to—viz, the right to get the mines and minerals without paying compensation for any damage occasioned thereby, the payment by the Council of any chief, quit, or other rents (if any), the payment of interest from the date fixed for completion to the day of completion, as well as the receipt of the rents from the tenants, and the refusal to allow Factory-street to be removed without their sanction, and it was resolved that the chairman and vice-chairman of the Council and Mr. Clayton interview Mr. Walker with reference to the Council's objections to the foregoing clauses, and if they consider it necessary, do see Messrs. Grover Humphreys and Son thereon and ask them to make the alterations as requested by the Council. These minutes were confirmed at the Urban District Council meeting.

Advertising Device.—The O'Brien-Lennard illuminating device has been on view at 135, Victoria-street. In ordinary arrangements in incandescent electric lamps, the lamps are extinguished suddenly either all at once or successively. The point of the present device is to use a gradual dimming. The design is made up in lamps of different colours, each colour being on a separate circuit. By the various strengths of the illumination of the different circuits, different parts of the design assume different degrees of prominence. Saturday last was not exactly the best night for viewing illumination, and the apparatus has hardly as yet taken its final form or had the opportunity of showing its capabilities. The gradation of current is effected by the use of movable (lead) electrodes in a water resistance—*i.e.*, really dilute sulphuric acid. In the apparatus as set up on Saturday, one set of electrodes is mounted on a spindle which is rotated by an electromotor. It can therefore be arranged so there is anything between a tiny fraction of an inch of water when the electrodes pass to nearly a couple of feet. The apparatus, which was only a roughly constructed affair to try the effect of the idea, worked effectively enough on Saturday as a temporary installation. It would, of course, require some considerable amount of modification before the arrangement could be conveniently applied to regular work night after night as an advertising device. The O'Brien-Lennard Company at the same time exhibited their arrangement for electric lights on dinner tables. The lamp is on a candlestick which has two needles protruding from the base. Flexible is laid under the tablecloth, and terminates in a small square containing slots, in which are two brass springs with a piece of insulating material between them. The contact is made by the needles pinning down into the brass springs. In this way one escapes the alternative of either damaging the tablecloth or having to lay flexible over the top of it.

Maidstone.—The Urban District Council are still in a state of curious indecision as to what to do with regard to their provisional order. The question came up at the last meeting after having been postponed for several months, and it again fell flat. The situation of the town makes it a good field for commencing an area of supply, but the Council evidently want someone to point out what the value is of the opportunity now before them. Because there is the likelihood of a year or two of loss at the commencement the Council want someone else to take the risk. This attitude of over-cautiousness is getting somewhat out of date, and we recommend the Council to appoint a committee to enquire and report generally as to the success which towns of similar size have had with the electric light. There is no need to trouble about large places like Manchester and Brighton, where the Corporation electric light undertakings have reaped such huge profits, for there are plenty of smaller towns where more useful lessons and more satisfactory comparisons can be had. We cannot quite understand the voting on the Electric Lighting Committee's report. They recommended that the provisional order should be carried out by the Council, and that the committee should be instructed to take the matter into consideration and report fully to the Council. Eight voted for and eight against, and the Mayor declined to record his casting vote. Probably it was the wording of the report that accounted for this. It does not seem diplomatic to recommend a thing to be carried out before the matter has been taken into consideration, and it would have been better, perhaps, if the first part of the report had been left out altogether. It asked the Council for too much of a pledge, and considering the strength of the gas interest in the town it would be wiser to let the committee make official enquiries before tackling the question again. There is little doubt that their report would practically settle the question in favour of municipal ownership, to the everlasting benefit of the town.

Wakefield.—At the City Council meeting, Alderman Sherwood proposed the adoption of the minutes of the Electric Lighting Committee, containing the following items: That £800 be paid to Messrs. J. Fowler and Co., Limited, of Leeds, on account of their contract for Lancashire boilers. A report from Mr. Hammond was read, recommending that the ratio of transformation from high to low tension be altered, and that arrangements be made with Messrs John Fowler and Co., Limited, to wind the transformers for a ratio of from 2,000 to either 200 or 400 volts at will, and after Mr. Hammond had given explanations upon the matter, the report was adopted, on the proposition of Councillor Wigham, seconded by Councillor Rhodes. Mr. George Summers, of Wakefield, who tendered for the construction of central sub-electric lighting station, in Westgate, having declined to be bound to complete the work within two months, the tender, for £275. 18s. 9d., of Mr. A. Kellett, of Manchester, was accepted, he having agreed to perform the work in the specified time and provide proper securities. Councillor Wigham seconded, and in doing so asked the chairman of the committee if he had any information with regard to the proposed alteration of the standard of pressure from 100 to 200 volts. It had been explained by Mr. Hammond that the alteration could be made for a very nominal sum, and he also explained that if they did not make it now they would as time went on find it to their advantage to do so. If they were not going to make the alteration they would have to alter their class of lamps in the future when the alteration was made. On the point of economy it would be preferable to begin with a 200-volt standard. Alderman Sherwood replied that they would commence with a standard of 200 volts throughout the city, except in the case of the County Council's offices, and they were trying to obtain the sanction of the City Council also to their use of the same standard of electric light. As to Councillor Harrison's question, he might inform the Council that the vice-chairman of the committee (Councillor Rhodes) and himself had inspected the construction of the engines and were satisfied with the progress being made. What he had said on May 11 respecting the light would be amply fulfilled; everything was going on as smoothly as possible. The minutes were adopted.

Shoreditch.—The surveyor to the Vestry has submitted the following important report on the cost of electric lighting conduits: "For your information, and to correct the erroneous statement made on the 27th ult. to the Vestry by the chairman of the Electric Lighting Committee, that the carrying out of this work by the Vestry's own staff had involved the parish in an extra cost of £5,000 above what the work would have cost by contract, I now have the pleasure to place the following facts before you: The work was commenced in April, 1896, and was not completed until April 16 last, the account having just been properly made out, although the statement was made to you on April 27. The total cost of the work done, including the trenches for Telephone Company's mains, amounts to £7,424. 7s. 7d.; the amount to be refunded by the Telephone Company amounts to £1,495. 3s. 6d., which, with an allowance of £109. 15s. 10d., made for plant, tools, etc., returned to stock, makes a total deduction of £1,604. 19s. 4d., leaving the net cost chargeable to the Electric Lighting Committee of £5,819. 8s. 3d. The total length of trenches opened upon footways, carriageways, crossings for electric lighting conduits, lamp connections, boxes, etc., has been 18,375 yards, or about 10½ miles, which length, divided into the total costs, works out at 6s. 4d. per yard run. An additional length of 333 yards was excavated exclusively for the Telephone Company's mains. In many streets the conduits are laid at a considerable depth below the surface, as much as 8ft. in places, on account of the numerous gas, water, and other mains in the way, and where the mains were laid under the carriageways it was necessary to break through and to reinstate from 6in. to 12in. of hard concrete, a heavy and very laborious work. For the greater part of the work three gangs were working in different streets at the same time, at the request of the Lighting Committee, who feared the laying of the conduits was not keeping pace with the fitting up of the generating plant. This proved quite unnecessary, and increased the expense by giving less opportunity for the proper and requisite supervision of the very casual workmen. Vaults, pipe connections, and branch drains have been interfered with, and required much attention and careful repair, the whole cost of which is included in the above-mentioned total, except about £300 for compensation, claims, accidents, and other extraneous matters. The contract recently entered into by the Vestry is for 8s. 6d. per yard run, but this includes the supplying and laying of two-way 4in. conduits." In conclusion, Mr. Rush Dixon expressed the hope that his report would be sufficient to at once remove the unfair reflection cast on the work of his department, who had endeavoured to carry out this unusual work as efficiently and economically as possible.

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PROVISIONAL PATENTS, 1897.

JUNE 14.

14395. An improved automatic time meter for telephonic conversations. John Martin Bösl, 18, Buckingham-street, Strand, London.

14397. Improvements in the generation and utilisation of hydrogen gas and electricity for motive power, lighting, and heating purposes. Luther Henry Wattles, 55, Chancery-lane, London.

JUNE 15.

14421. Improved apparatus for supplying or measuring a current of electricity. William Dobson Watson and Thomas Humphreys, 4, St. Ann's-square, Manchester.

14432. Improvements in electrical cable suspenders. Joseph Fincham, 37, Chancery-lane, London.

14439. Improvements in the manufacture or production of an insulating material and the application thereof to the insulation of electrical conductors. Henry Edmunds, 47, Lincoln's-inn-fields, London.

14456. Improvements in electrical pushes and contacts therefor. Max Byng and Valentine Holt, 73, St. Stephen's-road, Upton Park, London.

14457. Improvements in dynamos and in electrical distribution of mechanical and other power. Reginald Wood, 35, Nightingale-road, Harlesden, Middlesex.

14475. Improvements in systems of distribution of electricity. The British Thomson-Houston Company, Limited, 70, Chancery-lane, London. (Edwin W. Rice, jun., United States.) (Complete specification.)

14476. Improvements in insulators for electric conductor rails and feeders. The British Thomson-Houston Company, Limited, 70, Chancery-lane, London. (Sam H. Libby, United States.) (Complete specification.)

14477. Improvements in and relating to insulators for electric conductor rails. The British Thomson-Houston Company, Limited, 70, Chancery-lane, London. (Sam H. Libby, United States.) (Complete specification.)

14478. Improvements in electric meter apparatus. Eustace Oxley, 28, Southampton-buildings, Chancery-lane, London. (Complete specification.)

14506. Improvements in telephone systems and in apparatus for use therein. Cornelius Claude Gould, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

14508. Improvements in primary batteries or cells. Isidor Kitsée, 45, Southampton-buildings, Chancery-lane, London. (Complete specification.)

14520. Improvements in and relating to electric and other autocars. Henry Harington Leigh, 22, Southampton-buildings, Chancery-lane, London. (Société Charles Mildé, fils et Compagnie, Robert Mandos, and Auguste Courtant, France.) (Complete specification.)

14524. Improvements in electric brushes and the like. Jonathan O. Fowler, jun., 11, Broadway, New York, U.S.A. (Date applied for under Patents, etc., Act, 1883, Sec. 103, November 16, 1896, being date of application in the United States.)

JUNE 16.

14526. Regulator to be affixed to the wire supporting pendent incandescent electric lamp for raising or lowering lamp. John William Gilliam Palmer, 1, Buckingham-street, Brighton.

14568. An improved method of changing illuminating or advertising electrically lighted devices. Edmond L O'Brien and Leonard Grant, 135, Victoria-street, London.

14605. Improvements in means for electrically indicating when a ship reaches a given degree of roll. Giles Henry Zeal, 23, Southampton-buildings, Chancery-lane, London.

JUNE 17.

14629. A regulating ring for electric stop motions on drawing frames used in cotton spinning. Mark Thomas Makin, Marple Bridge, Derbyshire.

14659. Improvements in and relating to the counting and recording of the number of messages transmitted over telephonic or other signalling circuits. Daniel Sinclair and William James Gray, Oxford-court, Cannon-street, London.

14673. Improvements in electrically-operated engraving tools. Max Byng and Henry Burge, 73, St. Stephen's-road, Upton Park, London.

14679. Improvements in electrical conductors. Walter Judd, Beechcroft, Hook-road, Surbiton.

14694. Improvements in portable electric primary batteries. Charles Hamilton Cole, 321, High Holborn, London. (Complete specification.)

14708. Improvements in apparatus for coating metal articles by electro-deposition. George Harry Nash, 4, South-street, Finsbury, London.

14709. Improvements in apparatus for coating metal articles by electro-deposition. George Harry Nash, 4, South-street, Finsbury, London.

JUNE 18.

14741. A new or improved electric alarm apparatus. George Houlsby Skee, Coundon, *vid* Bishop Auckland.

14743. An improvement in telephone transmitters. James Wade, 72, Albion-street, Leeds.

14804. Improved construction of electric alternating-current generators. Otto Titus Bláthy, 28, Southampton-buildings, Chancery-lane, London. (Complete specification.)

14811 A new or improved telephone holder. Heinrich Kann, 115, Cannon-street, London.

JUNE 19.

14910. Improvements in electric motors for driving motor carriages, winches, and stationary machinery, also as a portable motor for rotary hair and cleaning brushes, for drilling, milling, and other purposes. Henry William Headland, 77, Chancery-lane, London.

14923. Improvements in alternate-current motors. Alfred Soames, 24, Southampton-buildings, Chancery-lane, London.

14924. Improvements in telegraphy. Mervyn Joseph Pius O'Gorman, 24, Southampton-buildings, Chancery-lane, London.

SPECIFICATIONS PUBLISHED.

1896.

11421. Dynamos and electromotors and the gearing of same. Andrews.

12531. Switches for making or breaking electric circuits. Slatter and Rixom.

14639. Apparatus for the production of electricity from the waste heat of gas, steam, or other heat engines. Dowsing.

16516. Accumulator batteries. Vaughan-Sherrin and Sherrin.

16534. Filaments for use in electric glow lamps. De Mare.

16801. Electrical cut-outs. Farkas.

28612. Telephonic systems and apparatus employed therein. Boult. (La Société Anonyme de telephonie privée.)

1897.

7696 Method of regulating the speed of series electric motors. Parshall.

7774. Selective signal apparatus for party telephone lines. Kingsbury. (The Western Electric Company.)

10250. Electric arc lamps. Thompson. (Hansen.)

COMPANIES' STOCK AND SHARE LIST.

Name.	Paid.	Price Wednesday
Birmingham Electric Supply Company	5	9¼-9¾
Brush Company, Ordinary	3	1½ 1⅝
—— Non. Cum., 6 per cent. Pref.	2	1½-1¾
—— 4½ per cent. Debenture Stock	100	105-109
—— 4½ per cent. 2nd Debenture Stock	100	95-99
Callender's Cable Company, Debentures	100	110-115
Central London Railway, Ordinary	10	10-10⅛
——	6	5⅞-6¼
Charing Cross and Strand	5	12⅜-14½
Chelsea Electricity Company	5	9⅜-10¼
—— 4½ per cent. Debentures	100	112-115
City of London, Ordinary	10	23½-24½
—— 6 per cent. Cumulative Pref.	10	17-18
—— 5 per cent. Debenture Stock	100	131-136
City and South London Railway, Consolidated Ordinary	100	58-60
—— 4 per cent. Debenture Stock	100	137-139
—— 5 per cent. Pref. Shares	10	15⅝-16
County of London and Brush Provincial Co., Ordinary	10	12⅞-13½
—— 6 per cent. Cum. Pref.	10	15-15½
—— 4½ per cent. 2nd Debenture Stock	10	14⅜-15½
Crompton and Co., 7 per cent. Cum. Pref. Shares	5	1¼-2¼
—— 5 per cent. Debentures	—	90-95
Edison and Swan United Ordinary	3	2⅛-2⅜
—— 5 per cent. Debentures	5	3½-4¼
—— 4½ per cent. Debentures	100	105-110
Electric Construction, Limited	2	1⅝-1⅞
—— 7 per cent. Cumulative Pref.	2	2⅜-3¼
Elmore's Copper Depositing	1	⅞-1
Elmore's Wire Company	2	⅝-⅝
W. T. Henley's Telegraph Works, Ordinary	10	18½-19½
—— 7 per cent. Preference	10	18½-19½
—— 4½ per cent. Debentures	100	108-113
House-to-House Company, Ordinary	5	8½-9
—— 7 per cent. Preference	5	10-10½
India Rubber and Gutta Percha Works	10	20½-21½
—— 4½ per cent. Debentures	100	104-107
Kensington and Knightsbridge Ordinary	5	12¾-13¼
—— 6 per cent. Pref.	5	8-8½
London Electric Supply	5	1⅞-2⅜
Metropolitan Electric Supply	10	16½-17½
—— 4½ per cent. First Mortgage Debenture Stock	100	120-124
National Telephone, Ordinary	5	6⅜ 6⅞
—— 6 per cent. Cum. First Pref.	10	15-17
—— 6 per cent. Cum. Second Pref.	10	15-17
—— 5 per cent. Non. Cum. Third Pref.	5	6-6½
—— 3½ per cent. Deb. Stock	100	105-109
Notting Hill Company	10	15-16
Oriental, Limited, £1 shares	1	1½-2
—— £5 Shares	5	8½-8⅞
—— £4½ shares	4½	7¼-7⅞
Oriental Telephone and Electric Company	1	⅜-½
Royal Electrical Company of Montreal, 4½ per cent. First Mortgage Debentures	—	102-104
St. James's and Pall Mall, Ordinary	5	15½-16½
—— 7 per cent. Pref.	5	10-11
Telegraph Construction and Maintenance	12	36-39
—— 5 per cent. Bonds	100	103-106
Waterloo and City Railway, Ordinary	8	10⅞-11½
Westminster Electric Supply, Ordinary	5	15-16
Yorkshire House-to-House	6	8½-8¾

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